Research Highlights in Education and Science 2017

EDITORS

Dr. Mustafa Pehlivan
Dr. Wenxia WU

ISRES Publishing

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Editors: Dr. Mustafa Pehlivan & Dr. Wenxia Wu

Editorial Assistant: Mustafa Tevfik Hebebci

Language Editor: Dr. Kemal Izci

Cover Design and Layout: Mustafa Tevfik Hebebci

This book was typeset in 10/12 pt. Times New Roman, Italic, Bold and Bold Italic.

Research Highlights in Education and Science 2017

Published by ISRES Publishing, International Society for Research in Education and Science (ISRES).

Includes bibliographical references and index.

ISBN: 978-605-67951-2-1

Date of Issue: December, 2017

Address: ISRES Publishing, Iowa State University, 509 Ross Hall, Ames, IA 50011-1204, U.S.A.

E-mail: isresoffice@gmail.com

www.isres.org

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Section 1: Teaching and Learning

PRAGMATISM AND ITS IMPLICATIONS ON TEACHING AND LEARNING IN NIGERIAN SCHOOLS

Joseph Olusola Adeleye
Department of Educational Foundations College, Nigeria

ABSTRACT: The problem surrounding what to teach and how to teach in our schools has been a lot of concern to the philosophers of education, school administrators, policy formulators, parents, teachers and the students as well. Plato, an Idealist, believes that teacher should be at the centre of teaching activity in the school while Rousseau an advocate of child centred education is of the view that student should be given consideration and allowed to contribute his ideas during classroom activities. Pragmatists strike a balance between the two positions. They believe that teaching should pave way for both the teachers and the students to take active participation in the teaching and learning processes. Based on these assumptions, this paper examines principles of pragmatism and its influence on teaching and learning.

Keywords: teaching, learning, pragmatism

INTRODUCTION

Etymologically the word pragmatism is derived from the Greek word 'Pragma' which means activity or the work done. Some other scholars think that the word pragmatism has been derived from the word 'Pragmatikos' which means practicability or 'utility'. Thus, according to this ideology, great importance is laid upon practicability and utility. Pragmatists tenaciously hold the view that activity or experiment is done first and then on the basis of results, principles or ideas are derived. Pragmatism is also known as experimentalism or consequentialism. It is called experimentalism because pragmatists believe experiment constitutes the only criterion of truth. To them 'truth', 'reality', 'goodness' or 'badness' are all relative terms. These concepts are not predetermined and absolute. They are proved by man's own experiences. Moreover, pragmatists believe that truths are many and they are in the making. Man researches these areas only by means of his own experiments and experiences. Hence, only those things which can be verified by experiments are regarded to be true.

Pragmatists hold that whatever was true yesterday; need not to be the same today. Under these circumstances no definite and determined principle or current use can stop the world from moving forward on the path of progress. Pragmatism is called consequentialism, because any human activity is evaluated in terms of its consequences or results. If the activity results in utility, then it is true. It may be noted that the fundamental start of pragmatism is "change". In this sense no truth is absolute and permanent. It is always changing from time to time, from place to place and from circumstance to circumstance. Thus, those ideas and values which are useful in certain circumstance, time and place, need not prove to be the same in changed circumstances, places and times. Hence, pragmatists do not uphold any predetermined philosophy of life. To them, only those ideals and values are true which result in utility to mankind in certain circumstances, places and time.

It is therefore obvious that pragmatism is very intimately connected with human life and human welfare. The chief proponents of pragmatism are C.B. Pearce, William James, Shiller and John Dewey.

Principles of Pragmatism

The following according to Singh (2007) are the principles of pragmatism.

The changing nature of truth: Pragmatists do not believe in predetermined truths. According to them truth always changes according to time, place and situation. They also believe that a thing which is true to an individual at a specific time, place and situation, need not be true to others or to anyone else at some other place or time. Hence, a certain thing which was true to a person yesterday, need not be the same for him today or will remain the same for tomorrow. In short, according to pragmatism, truth is always changing according to times, places and situations.

Truth is formed by its results: Pragmatists uphold that truth is not a fixed and definite entity. It is a relative term which can be changed according to the stages of development and situations which confront a person in his process of growth and progress. The reason for this is that change in situations throws up new problems to be solved by new thoughts and new efforts. Out of these thoughts, only that thought of the whole lot is true which serves to solve the problem and attain the desire results. Hence, pragmatists firmly hold that it is the result which goes to form or build a truth. Only those things are truth for the individuals which develop their personality to the full and which promote individual good and welfare of others as well.

Democratic social value: Pragmatism holds that man is a social being. He is born into society and all his development takes place in and through society. Hence, pragmatists uphold democratic social attitudes and values. Pragmatists also laid emphasis on the principle of utility. Pragmatism to a reasonable extent shares utilitarian ideology which holds that the reality of a principle lies in its utility. Any idea or thing which is useful to individuals, is proper and right. In case it is of no use, it is improper, wrong and untrue. In other words, only those ideas and things are true, when they have a utility for man. Things are true because they are useful.

Placing high premium on activity: The pragmatists also attached importance to activity. This is, because it is their belief that ideas are born out of activities. Man is an active being, he learns by his activities, which he always engaged in on his path of life. Thus, the greatest contribution of pragmatism to education is this principle of learning by doing.

Influence of Pragmatism on Teaching and Learning

Pragmatists generally believe that experience is the source of all knowledge. In the same way, they define education in terms of experience. Education comes as a result of experience, it is a lesson learnt from experience. But it is not every experience that is education. The experience that is educative is the type that makes possible other experiences in future. The experience must be productive and must not be a limiting experience. An experience is limiting, if it hinders other possible experiences. For example, the armed robber who faced the firing squad on the Lagos bar-beach was having an experience, but for him it could not be an educative experience, since the firing terminated any possibility. This could be the reason John Dewey, as cited by Akinpelu (1981), defined education as the continuous reconstruction or reorganization of experience which adds to the meaning of experience, and which increases the ability to direct the course of subsequent experience. Since knowledge comes through the processing of experience by intelligence, using the problem – solving method, the aim of education is therefore the development of learner's ability to deal with future problems. Education is the process of developing the habit of problem-solving, and there is no limit to the development of this ability. The more varied and the more complex the problems that a learner solves, the greater the growth of his intelligence is. Hence teacher must develop this in the learner. Thus, education is also defined as growth, the growth is not a biological or physical one, but rather mental, it is the growth in intelligence. Since the problems to be solved arise in the course of daily living, it means that the child is learning as he lives from day to day, and each day's experience, if it is educative, increases his power of solving his problems. Learning in this sense is not an activity that should take place in a secluded spot or isolation from the child environment.

John Dewey, a pragmatist prefaced his own recommendations on education with a stringent criticism of many aspects of the formal education of his days. First, the traditional school, which is somehow, seems to be in practice in Nigerian educational system treats the immature experience of the youngster as something to be quickly passed over so that he may quickly grow up as an adult. In the traditional school, education becomes a preparation for a future adult life: the child is to be equipped with the skills of an adult, he is given 'a set of notes' as Dewey graphically described it, which he is to be redeemed when he reaches maturity, but which unfortunately he may not live long enough to redeem. He is being educated for the future, being equipped for the life, he will lead as an adult, while he misses the joy of learning, and the skills of coping with his present problems. The teacher according to the pragmatists ought to prepare his student to solve their present problems.

Pragmatists attacked also the contents of curriculum that are traditionally the same for every child. It is their belief that the children are all massed together and uniformly taught as though they want the same things and are learning at the same rate. What is more, they are all fed on dead information which, being remote from their life experience, has to be memorized and absorbed. The dead information is parceled out in little bits of knowledge in the name of disciplines. The relevance of these disciplines and life are not clear to the children. The result is what Akinkuotu (1996) quoting Whitehead described as little bits of knowledge from which nothing follows. Thus, the experience of the children which is normally an integrated unit is fragmented for him as he changes from one unrelated subject to another unrelated subject and switches his thinking from religion to mathematics at the sound of the bell. Another point is that in that type of school, knowledge is imparted into the students as the finished product of other people's experience and students are not allowed to realize that they too can produce knowledge from processing their own experience.

The method of the teaching itself is not such that can motivate the pupils. The children learn more from the fear of the teacher who talk to the students rather than with the students. Since the teacher towers so much above the students and exercises so much an authority, the pupils have no option but to sit quietly, listen passively and absorb the facts passively as a sponge absorbs water. What is most important to the teacher in such a school is the presentation of subject-matter while the psychological conditions of learning, in terms of the child's interest, ability and stage of development and the sociological factors in terms of the relevance of the subject for the social life of the child and the community are of secondary importance. The child is supposed to see the relevance for his life at some future date, and integrate the fragmented pieces of learning all on his own. Finally, this type of education naturally breeds a type of attitude and disposition that is anti-social. This is because the child is made to learn in isolation and to achieve results only through individual efforts rather than group learning or co-operative efforts, only his individualistic rather than social nature is fostered. Dewey (1959) believes that mere absorption of facts and truths is so exclusively individual, an affair that it tends naturally to pass into selfishness.

After this thorough criticism of the traditional and discipline – centred school education, Dewey also sketched out the pragmatic view of what the school, the curriculum, the teaching method and the role of the teacher.

The school must essentially be an extension of the home so that the experience of the child both at school and in the home, can be related and continuous. School is a specialized agency set up by society to facilitate acquisition of experience by the child by making the process of learning more fast and thorough. As Dewey himself describes it:

The school is primarily a social institution.
Education being a social process, the school
is simply that form of community life in which
all those agencies are concentrated that will be
most effective in bringing the child to share in
the inherited resources of their race, and to use
his own powers for social ends.

The school, therefore, cannot be isolated from the community, nor should it removed the child from the community in which life, the child is expected to participate. The school is not only a part of the community; it is a community itself, a mini-community in which the child is to experience group-living and co-operative learning activity. The school is only to simplify the existing complex social life so as to make it easy for the child to absorb. The school cannot directly change society, but it can reform it by equipping the children with social intelligence, and by holding up the ideas of the life in that society. All these can only be actualized through a professional teacher. The pragmatist's position in determining a professional teacher can be analysed based on the pragmatic principles earlier mentioned.

First on the issue of changing nature of truth. It is established by the pragmatists that truth is not constant; it is not every time a teacher could behave professionally and one could not see him as always reliable since truth itself is not constant. Therefore, a teacher must be ready to change in his act of teaching, knowing the appropriate method of teaching because the situation may change and students may also change. Teacher may not claim to know everything and even the subject content may change going through pragmatists' principles. Hence, he is bound to change since the students too are constantly changing, teacher must be prepared to change and be flexible in his teaching. For example, the way Mathematics was being taught in the olden days by the professional teachers could not be the same in this era of computer. In determining the experience to use, what worked for teaching yesterday may not work today, and the students' experiences are not the same. Since topic is not always the same, a teacher may teach a topic today proceed to another topic tomorrow. Hence, the assessment of the students' performance must not be constant. So also, there are individual differences in the students. Teacher should not be dormant but always ready to change to enhance his professionalism.

On the second principle that truth is formed by its results. This implies that, what is true is what has consequences from the society's aspiration. True knowledge for the teacher is what the society expects him to know. For example, in the society we are in today, a teacher is expected to have good knowledge of computer since that is the present need or expectation of the society. Teacher has to teach what is relevant and he has to know the relevant method to use and this has to be done with relevant experience in order to be a professional teacher, and making relevant assessment of himself and the students to know the need of the society in which he finds himself.

On the principle of democratic social value, the teacher should understand the democratic value of the society of his immediate environment in order to know the appropriate things to teach and learn the appropriate instructional methods acceptable by the society.

On the principle which attaches importance to activity, this entails that for anything to be pragmatic, it has to be practical and activity controlled. This is in the sense that a teacher must understand what he is to teach practically and also understand its relevance to the society. He should understand the practical ways of teaching it too. Teacher should also make use of practical knowledge demonstrated by his students. He should make his assessment on what the students can do and not the ideas they exhibit.

With the teaching described in these ways, the curriculum is nothing more than the social life of a community, simplified and translated into the classroom. The school selects what to include in the curriculum on three criteria: these are psychological, the sociological and the logical criteria. The psychological and the sociological factors seem to be most important. The psychological relates to the interest, the problems and the needs of the child as a determinant of what should be offered to him. His needs are not just what he feels as his needs, important as this is, but also what he will need as a participating member of the society. What will promote the harmony and welfare of the society are thus equally important. The forms into which the required experiences are cast, and the arrangements of the learning task in each form constitute the logical dimension. In other words, the traditional subjects or academic disciplines must be organized in such a way as to start from the present experience of the child and gradually lead to new experiences.

In specific terms, the contents of the curriculum will be those that involve the child in exploring and discovering knowledge by himself. The sciences are much favoured in this type of curriculum, and they will be taught not in the ways of learning the laws and theories in physics and chemistry, but by ways of the child exploring and being aided to discover new knowledge by himself (Ayeni, 2013). The social sciences are important as representing the social environment and the factors that affect human behaviour in the community. The humanities are not to be left out because they deal with the cultural heritage of the child's race. History, for example, is to be regarded and treated as the record of man's social life and progress; while language is to be taught as an instrument of communication. The aesthetic subjects like arts, drama, literature, music and among the others are to be included for the development of the creative abilities of the child. In all cases, the subject should be taught with a view to helping him solve his problems, rather than store up information to be reproduced on demand.

In teaching of any subject, one of the important things to be considered is the method of teaching. The teaching must be child-centred, that is, it must take the child as a person in his own right. If the child is treated as a means to an end or as someone else advantage, then one could not claim that the child is at the centre of the education. In addition, the child readiness and development should be also taken into consideration. There is no point assuming that the child is able to do this or that, if he is psychologically incapable to do so on, the ground of efficiency and common sense. It should be realized that each child is a unique individual and as such should be treated differently. The present needs, interest and ability of the child, must also be taken into consideration though this should not stop with the present needs alone.

Also, teaching must also make the child actively involve in class activity. Learning by doing is a method which uses more than one of the senses in the process of acquiring knowledge and it is one in which the child obtains his theoretical knowledge abstracted from the solution of problems. Hence, what is taught must involve practical activity or practical application of his knowledge. The subject must be brought to the level of the child, and the examples used must be within his present experience.

Group method or co-operative learning should also be encouraged. The project-learning, in which problems to be tackled are set for groups, is the best method of encouraging group learning. The method has the advantage of allowing the children to display their free initiative and native intelligence in solving problems. More importantly, it is the major ground for the development of social and co-operative living, and of organized social intelligence. The method of teaching necessarily leads to the role of the teacher. The idealist and realist "schools" of philosophy of education have made the teacher into an authority figure, the embodiment of all wisdom, and the custodian of knowledge. Rousseau, Pestallozzi and Froebel had portrayed the teacher as an interested, but passive observer of the child's learning activities. This is supported with the analogy of the gardener, whose contribution has nothing to do with the growth of the garden; in the same way, the child's natural abilities unfold on their own.

The pragmatists strike a middle path between these two conceptions of the role of the teacher. He is not the authoritarian and fearful figure as presented in the traditional education, but also not the dispensable element in the Rousseau's type of child-centred education. The teacher is essentially an organizer and a moderator of the child's learning in the pragmatists' view. By reason of his superior natural experience, and expert training, his principal role is that of guiding the child's learning activities. He must be thoroughly familiar with the individual child's needs and interest, and with what types of experiences are of greatest use to him in his society. The teacher is to select the learning tasks on the basis of these, and moderate the interaction between members of group, for the best gain by each member. Thus, the teacher is not a spectator but rather a participant in the learning activity, sharing experiences among them, fostering their problem – solving abilities and promotes the development of intelligence of the Nigerian learners.

CONCLUSION

Based on the above principles and practices of the pragmatists, one may conclude that teaching should pave ways for democratization of ideas in which both the teachers and the learners would have their interest considered in the classroom activities. This could be seen as the only means of making teaching a problem-solving activity.

RECOMMEDATION

This paper consequently submits that the pragmatists position that teaching should neither in totality be teacher-centred as idealists recommended nor in extreme sense, child-centred as postulated by the naturalists. Instead, striking a balance between the two positions looks more plausible and realistic to meaningful education growth and total involvement of the two major participants in the educational enterprise.

REFERENCES

Akinpelu, J. A (2005). *Essays in Philosophy and Education.* Ibadan: Stirling-Horden Publishers (Nig.) Ltd.

Ayeni, J. O (2001). *Rudiments of Philosophy of Education:* Ibadan leadway Publishers.

Ayeni, M. A (2003). *Philosophy of Education: An Introduction.* Ado Ekiti. Petoa Educational Publishers.

Berlinger, William (2007). Teacher Training in *www.google.com*

Dewey, J. (1948). *Education and the Philosophic Mind. New York* The Macmillian Co.

Federal Republic of Nigeria (2008). *National Policy on Education. Lagos: NERDC.*

Jekayinka, A. A (2011). Cited in Adeyinka (1988). *Development of Teacher Education in Nigeria. Retrieved from www.google.com*

Singh, J. A (2007). *Philosophical Foundation of Education. New* Delhi: A.P.H. Publishing Corporation.

ISSUES WITH CAREER AND TECHNICAL EDUCATION AND DIPLOMA OPTIONS IN THE UNITED STATES: A DEEPER LOOK INTO GEORGIA

Aaron Douglass Talley
University of West Georgia, Georgia

Angela Christine Fain
University of West Georgia, Georgia

Cynthia Head
University of West Georgia, Georgia

ABSTRACT: Throughout the Unites States, diploma options and graduation paths vary from state to state. The most common diploma option nationwide is the College Preparatory diploma. In an examination of diploma options and graduation requirements across the nation in 2007, Johnson, Thurlown, and Schuelka reported that all states offered a standard diploma to both students with and without disabilities, eleven states offered a Special Education diploma and three states offered an Occupational diploma, to students with disabilities only. Prior to 2008, the state of Georgia was one of many states offering several standard diploma options, called tiered diplomas. However, at the end of 2007, the State cited the need for all students to follow a rigorous academic path throughout high school, regardless of their post high school intentions. The purpose of this paper is to discuss the disparity between federal legislation of Career and Technical education (CTE) and actual practice as well as to examine the effects of the removal of the tiered diploma options for students in Georgia. A mixed methods design was used to collect and present data. Descriptive statistics were used to report student graduation rates for students with and without disabilities under the different graduation rules. A survey given to Georgia educators regarding the effects of streamlining diploma options was analyzed. Results and implications from this study are presented.

Keywords: diploma, technical, vocational, Georgia, students with disabilities

INTRODUCTION

ISSUES WITH CAREER TECHNICAL EDUCATION AND DIPLOMA OPTIONS IN THE UNITED STATES

High school graduation is one of the most discussed topics in education throughout the world. The United States has been responsively developing and implementing educational reforms since the early 1900s based on the needs of an evolving and growing economy. However, the impacts of these reforms on student achievement are often overlooked. Decades of legislation centered on technical education and post-secondary outcomes in the state of Georgia have resulted in our students being left with inadequate diploma options during their high school career. Specifically, these academic boundaries have limited students with disabilities who lack either the desire, or ability, to attend a four-year institution. Options, such as a *Technical Preparatory (Technical Prep)* diploma, that allow students with disabilities to capitalize on their unique strengths, interests, and abilities are imperative for their secondary and post-secondary success. This research aims to examine the unintended consequences created by the ever-changing policies and legislation centered on CTE at the national level and discuss the trickle-down effect of those consequences on students in the state of Georgia.

THE EVOLUTION OF VOCATIONAL EDUCATION IN THE UNITED STATES

The Smith-Hughes Act (PL 65-347) of 1917 was one of the first pieces of legislation advocating for vocational education in high school curriculum. This law provided over a million dollars for state vocational education and sought to ensure that vocational education: (1) provided meaningful curriculum for all individual students, (2) provided opportunities to prepare all students for life and work, (3) encouraged a different learning process through the idea of learning by doing, and (4) introduced the idea of an education being a functional tool for students (Friedel, 2011). In 1929, Congress passed the George Reed Act (PL 70-702), expanding vocational education, agriculture, economics and increasing federal funding of those programs. Occupational education became a buzz word between the 1940s and the 1960s, when a nationwide interest in educating students with significant disabilities began taking shape. Funding continued to increase through the George-Ellzey Act of 1934 (PL 73-245), the George-Deen Act of 1936 (PL 74-673), and the George-Barden Act of 1946 (PL79-586). Efforts centralized on functional, vocational, and social skills in order to help these students become serviceable members of their local communities and ultimately of society. Teachers began creating lesson plans that quickly spread across the nation leading to public interest and eventually public awareness (Neubert, 1997). States began adopting curriculum and the numbers of students with severe disabilities increased in the public schools increased due to occupational education (Neubert, 1997).

By the 1960s and 1970s, the interest shifted from "training" students with severe disabilities to educating them and facilitating their transition into the workplace. With this focus on preparation for the workplace, an awareness also shifted from students with low-incidence disabilities, those that occur less frequently, to students with high-incidence disabilities, those that occur more frequently. Examples of low incidence disabilities include visual and hearing impairments, physical disabilities, severe autism, and moderate to severe intellectual disabilities. High incidence disabilities such as learning disabilities, attention deficit disorders, and speech impairments are seen more often.

Education was seen as a means to an end and legislation shifted to having an "equal emphasis on education for living and education for making a living" (Rich, 2010, para. 4). The ultimate goal of education emphasized the final product, which the government viewed as skilled workers. The Vocational Education Act of 1963 (PL 88-210) authorized federal funds to build and establish vocational education schools, expand research, and provide training. It also introduced the idea of students working to earn money to help pay for their education, creating work study programs. During the mid-1980s and 1990s, all vocational legislative efforts were directed at increasing academic rigor, graduating all students, and successfully transitioning students into post-secondary options (Neubert, 1997). The Carl D. Perkins Act of 1984 (PL 98-542) refocused the goals of The Vocational Education Act of 1963, and its successive amendments to include the needs of a growing and demanding economy. Areas of trade and curriculum within vocational education were expanded to incorporate the instruction of sought-after skills, to increase the economic value of graduates (Friedel, 2011). The Perkins Act was reauthorized with the Perkins Vocational and Applied Technology Act of 1990 (PL 101-392) and then again in 1998 with the Perkins Vocational and Technical Education Act (PL 105-332), titled Perkins II and Perkins III, respectively.

Even with the promising legislation born through a governmental push to increase student achievement and state accountability, (1) public education problems were perceived as systematic (Cobb & Johnson, 1997; Thurlow & Johnson, 2000), (2) "falling behind" other countries in *A Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence in Education, 1983), (3) "falling short" of providing opportunities for all U.S. children in *The Forgotten Half: Pathways to Success for America's Youth and Young Families* (Grant Foundation, 1988), and (4) not preparing students for the labor market in The Secretary's Commission on Achieving Necessary Skills (U.S. Department of Labor Secretary's Commission on Achieving Necessary Skills: SCANS, 1991). Federal and state education reforms such as the School to Work Opportunities Act of 1994, Goals 2000: Educate America Act of 1994, and the Improving America's Schools Act of 1994 promoted comprehensive strategies and reforms that stress high academic and occupational standards and influenced special education programs (Johnson, Stodden, Emanuel, Lueking, & Mack, 2002).

More notably, the Individuals with Disabilities Education Act (IDEA) was passed in 1990, reauthorizing and renaming the originally passed law, the Education for All Handicapped Children Act (PL 94-142) passed in 1975. In 2004, President George W. Bush reauthorized The IDEA to align closer with the standards put forth by the No Child Left Behind Act (NCLB), which he signed into law in 2002. The NCLB Act pushed for accountability and improved student outcomes to help close the achievement gaps between groups of students. The purpose of the NCLB act was "to ensure that all children have a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging state academic achievement standards and state academic assessments" (NCLB, 2002). As part of the requirements of IDEA, the document addressed significant changes regarding the education of students with disabilities. Specifically, there was a change in the definition of "transition services" for a child with a disability, defining it is a coordinated set of activities that:

> Is defined to be within a results-oriented process, that is focused on improving the academic and functional achievement of the child with a disability to facilitate the child's movement from school to post-school activities, including post-secondary education, vocational education, integrated employment (including supported employment); continuing and adult education, adult services independent living, or community participation; is based on the individual child's needs, taking into account the child's strengths, preferences, and interests; and includes instruction related services, community experiences, the development of employment and their post-school adult living objectives, and if appropriate, acquisition of daily living skills and functional vocational evaluation [34 CFR 300.43 (a)] [20 U.S.C. 1401(34)] (U.S. Department of Education, 2007).

The reauthorization of the IDEA in 2004 focused on providing students with disabilities access to higher expectations through general education curriculum in the regular classroom to the maximum extent possible. This reauthorization required, among others, that states provide a free appropriate public education (FAPE) to all children with disabilities in the state, and establish a goal for providing full educational opportunities to all children with disabilities, along with a time-table for accomplishing that goal.

The reauthorization of the Perkins Act in 2006, known as Perkins IV, brought about a change in terminology from "Vocational" to "Career and Technical Education" (CTE), and also brought a greater focus on academic rigor and achievement within the CTE classrooms to prepare students for the careers of the twenty-first century. This was the first federal law of its kind to bridge the gap between secondary and post-secondary institutions, aligning expectations and curriculum and requiring reciprocal relationships between the agencies. Perkins IV also reflected the recent NCLB (2002) legislation by (1) demanding increased accountability for all stakeholders and (2) requiring detailed data reporting and promising consequences for districts who fail to demonstrate performance on core indicators, such as proficiency on industry recognized technical assessments in CTE coursework. It was at this time that many states, including Georgia, began to make major changes regarding the education of all students that would have lasting effects.

GEORGIA DIPLOMA HISTORY

Some of the earliest documented graduation requirements in the state of Georgia date back to 1984 (Georgia Rule 160-4-2-.30, Georgia DoE). According to those Georgia Rules, state supported high schools were required to offer three diplomas to all students, *General Education (Gen Ed)*, *College Preparatory* (*College Prep*), and *Vocational Preparatory* (*Vocational Prep*) (Georgia Rule 160-4-2-.30, Georgia DoE). The *Vocational/Technical* (later changed from "Vocational" to "Technical" in accordance with Perkins IV) *Prep* diploma was available to students until 2011 in Georgia (Friedel, 2011). In addition to required academic courses, students pursuing the *Technical Prep* diploma were required to earn four credits in classes under the vocational/technical category, such as Business Education, Computer Education, Home Economics, Cooperative Vocational Education (CVE), Coordinated Vocational Academic Education (CVAE), or a Trade & Industry Area (Georgia Rule 160-4-2-.30, Georgia DoE). This focus on technical classes was an advantage to most students with disabilities, especially students with mild disabilities who can potentially demonstrate average or slightly below average academic achievement based on their unique disability characteristics, functioning, and demographics (Wagner, Newman, Cameto, & Levine, 2006). The *Technical Prep* diploma held students to different standards by requiring them to focus their efforts on both CTE and academic classes. In their annual report from 2007, the Georgia Department of Education (GADOE) noted the largest enrollment numbers of Career, Technical, & Agricultural Education (CTAE) in the program areas of business and computer science, architecture, construction, communication and transportation, and family and consumer Science (GADOE, CTAE Annual Report, 2007). In these career-focused classes, students learned hard skills they would need to work in their chosen career, also known as technical skills. This focus allowed students with disabilities to graduate with the necessary skills to join the workforce with knowledge and experience under their belt or successfully gain entrance into a technical or trade school. These crucial graduation requirements, which were the crux of the *Technical Prep* diploma would soon be an expectation of the past.

Current Diploma in Georgia

In 2007, the Georgia Board of Education joined 29 other states in the American Diploma Project Network (ADP) under the umbrella of Achieve, Incorporated (GADOE, 2010). Achieve, Inc. is an education reform organization leading a national paradigm shift focusing on college and career readiness by funneling all students through the same rigorous academic coursework, regardless of post high school graduation plans. Georgia joined this coalition with the hopes that raising standards would generate graduates more capable of achieving long-term success in college and in the workforce (GADOE, 2010). It is the belief of both Achieve, Inc. and the State of Georgia that students will "achieve what is expected of them" and that a single diploma option is the vehicle through which this success will be attained (Georgia Department of Education, 2010, p. 7). As a result, the 2007-2008 entering freshman class in Georgia was only offered a College Prep diploma boasting one common set of increased rigor academic course work requirements for all students. It was this "college for all" movement that marked the fundamental shift away from vocational education being graduation requirements in the state of Georgia. Johnson, Thurlow, and Schuelka (2012) pointed out in their Technical Report 62 that the overwhelming focus on being college-ready could potentially direct attention away from students who may not be able to make the transition from high school to college. In Georgia, an average of 36% of students with disabilities graduated with a Technical Prep diploma and 14.75% graduated with a College Prep diploma from 2008-2011 (GADOE, 2017). With the elimination of the Technical Prep diploma, the graduating classes of 2012 and beyond were left with only one option.

The College Prep diploma in Georgia consists of a rigorous academic workload designed to prepare students to enter a four-year college after high school. Students pursuing this diploma are required to earn 23 credits in academic and elective areas (Table 1). Although, foreign language is not currently a high school graduation requirement, students are required to complete two sequential years of a foreign language in order to meet university admissions requirements. Districts in Georgia also have the option of offering students more rigorous diplomas such as the International Baccalaureate Diploma Programme (IBDP) or the International Baccalaureate Career-Related Programme (IBCP), which are globally recognized high school diplomas that strictly prepare high school students for university studies. In order to offer IB degrees, schools must apply and complete an authorization process through a rigorous certification program hosted by the International Baccalaureate Organization (IBO) (IBO.org).

Current Career, Technical and Agricultural Education Options

Currently, the College Prep diploma does not require students to earn any credits in CTAE classes to graduate. Beginning with the cohort class of 2008 (graduating class of 2012), students were required to fulfill three units of their choice in the areas of foreign language, fine arts, or career tech classes (Georgia Rule 160-4-2-.48, Georgia DoE). As a part of this change, the state rolled out "Career Clusters" and "Pathways" and marketed the initiative to the public as the alternative to the *Technical Prep* diploma. However, this is not a separate track or diploma option for students. This is simply a series of extra-curricular courses that a student may choose to focus on within the *College Prep* diploma. For a student to be considered a Career Pathway completer, they must successfully complete all of the graduation requirements of the *College Prep* diploma.

Table 1. Graduation Requirements From 1993 Through 2016

Required Areas of Study	General Diploma						College Prep Diploma						Vocational/Tech Prep Diploma					
	< 93	93-94	95-97	98-02	02-08	08-16	< 93	93-94	95-97	98-02	02-08	08-16	< 93	93-94	95-97	98-02	02-08	08-16
ELA	4	4	-	-	-	-	4	4	4	4	4	4	4	4	4	4	4	-
Math	2	3	-	-	-	-	3	3	3	4	4	4	2	3	3	3	3	-
Science	2	3	-	-	-	-	3	3	3	3	3	4	2	3	3	3	3	-
Social Studies	3	3	-	-	-	-	3	3	3	3	3	3	3	3	3	3	3	-
Foreign Language	n/a	n/a	-	-	-	-	2	2	2	2	2	**	n/a	n/a	n/a	n/a	n/a	-
Health & PE	1	1	-	-	-	-	1	1	1	1	1	1	1	1	1	1	1	-
Business, Computer Tech, Voc Ed, Fine Arts, ROTC, Home Economics	1	3	-	-	-	-	1	1	1	1	1	**	1	1	1	1	1	-
Vocational/ CTAE	n/a	n/a	-	-	-	-	n/a*	n/a*	n/a*	n/a*	n/a*	3	4	4	4	4	4	-
Other/Electives	8	4	-	-	-	-	2	4	4	4	4	4	4	2	2	3	3	-
Total Minimum	21	21	-	-	-	-	21	21	21	22	22	23	21	21	21	22	22	-

** Area of Study combined with the 3 Vocational/CTAE units.
* Students who complete the CP requirements may also receive a Vocational Endorsement (<93-97) or Dual Seal (98-08) with 4 Vocational/CTAE units

Within those 23 credits required for graduation, three units in a progressive sequence of CTAE courses chosen by the student that align to his or her interests and post-secondary goals must be successfully completed. Completing a progressive sequence requires three successful years of course work in one career cluster. For example, if a student enrolled in Law Enforcement Services as a freshman/sophomore, they would take Intro to Law and Public Safety their freshman year, followed by Criminal Justice Essentials their sophomore year, and then Criminal Investigations their junior year. By the student's junior/senior year, upon successful completion of three sequential years of the [cluster title] pathway, their knowledge is then assessed by an End of Pathway Assessment (EOPA), which is in compliance with Perkins IV's core indicator of performance (GADOE, Georgia End of Pathway Assessment Guidance, 2016). Depending on the pathway, students have the opportunity to earn industry-validated credentials while still in high school.

Preparing and certifying students in a pathway is designed to address the need for both college and career readiness through "graduating students from high school with the academic skills, hands-on experience in real work environments, and intensive career guidance required to succeed in college, employment, and life-long learning" (GADOE, 2012, p.18). Industry certification standards are developed collaboratively by the Georgia Department of Education Program Specialists, state-level business associations, and input from CTAE instructors throughout the state. After initial certification, pathways go through a re-certification process every five years. Georgia makes the certification process open to districts and state officials decide which pathways will be industry certified. Districts are allowed to choose when they will initiate the certification process (GADOE, Business and Computer Science Industry Certification Process, 2012).

THE ICEBERG EFFECT

The Iceberg Theory, or the "theory of omission" was a style of writing coined by Ernest Hemingway in his early career. This style of writing emphasized current events without mentioning the underlying implications or interpretation (Trodd, 2007). Building on this theory, the Horace Mann League of the U.S.A. and the National Superintendents Roundtable released *The Iceberg Effect* in 2015, presenting an international comparison of performance indicators within school achievement with aspirations to illustrate a more holistic image of the inner workings of education. Floating above the water and visible to all are Student and System Outcomes, while below the surface lie Inequity & Inequality, Support for Schools, Support for Young Families, and Social Stress & Violence. This report stresses the importance of looking beneath the "scorecard" of results into the underlying factors as a necessary step to establish authentic accountability (The Iceberg Effect, 2015).

Building on these foundations, there is little doubt that educational reforms and state rulings regarding curriculum and graduation requirements have all been developed, adopted, and implemented with the best intentions in mind. Over the last few decades, those intentions to redesign an educational system that will adequately prepare all students for college and career readiness have resulted in students being tracked into one path to graduation, the *College Prep* diploma.

As a result, decisions made by policy makers at the federal and state levels have left students with disabilities in Georgia with limited options during their high school careers (see Figure 1). While opportunities for our lower preforming students have diminished to a single choice, options for academically advanced students have risen to an all-time high with the growing trends of Magnet Schools, IB World Schools, and Charter Schools. The iceberg effect of streamlining diplomas is one which attempts to visually emphasize the populations who are served and benefit the most from current diploma options and secondary opportunities available at public schools in Georgia. The *College Prep* diploma & *IB* diploma options benefit a small percentage of highest achieving students as depicted in the visible piece of the iceberg. Perhaps the biggest tragedy of all is the disappearance of the average student, who, under the new graduation rules, might be graduating but are not successful in post-secondary outcomes, seen as the water line which disappears amongst its counterparts. Although 60% of the 2012 cohort of Georgia high school graduates enrolled in a post-secondary institution, only 40% of those students completed one year of coursework within two years of enrollment (GOSA, 2017). The *College Prep* diploma discounts almost half of students with disabilities (56.56% graduation rate among students with disabilities in 2016) due to rigorous coursework requirements, which is depicted by the bottom chunk of the iceberg below the surface, not visible to the public or policy makers when making educational reform decisions. Students with disabilities in the Georgia cohort class of 2012 represented 5.3% of all graduates and of those graduates only 40.1% were enrolled in a post-secondary institution after graduation.

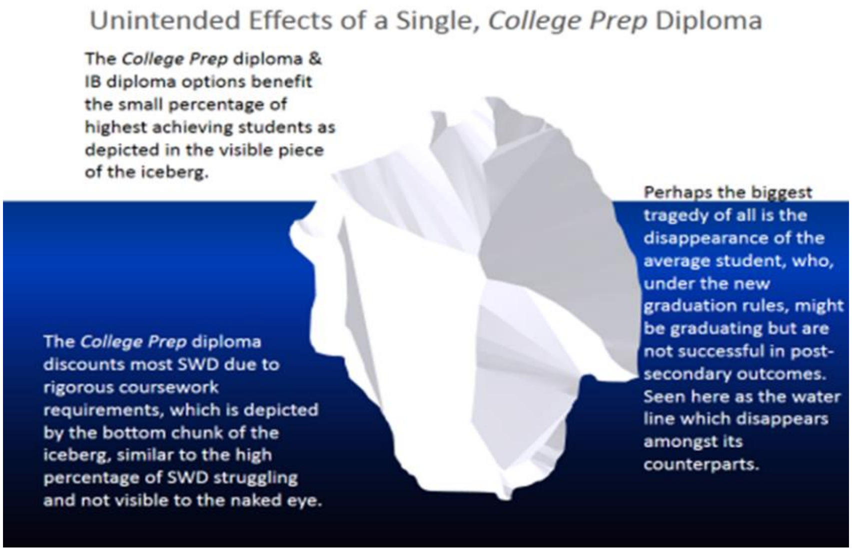


Figure 1. The Iceberg Effect Resulting from a Single Diploma

All high school students, including those with disabilities, are forced to progress through their high school career as if they are all going to four-year universities with intentions of earning a bachelor's degree. Holding all students accountable to the same graduation requirements and not offering them a vocational option has resulted in many students with disabilities either dropping out or earning a certificate of attendance. In 2017, GOSA reported 3,594 students with disabilities and 16,833 students without disabilities as dropouts during the 2015-2016 school year in Georgia, 3.4% and 15.8% respectively.

METHODS

The purpose of this study was to investigate the inconsistency of between CTE legislation and current practices, as well as to examine the effects of the removal of the tiered diploma options in Georgia. More specifically, the researcher team wanted to investigate the differences in the number of students with disabilities who received a *Technical Prep* diploma compared to other types of diplomas in Georgia high schools over the past decade and assess the effects of the removal of the *Technical Prep* diploma option for students with disabilities. A mixed methods design was chosen to collect and present data. Phase one examined statewide and national data to compare effects on graduation rates for students with disabilities across diploma types for the graduating years spanning from 2004 through 2016 to discover any potential effects of streamlining diploma options in Georgia. Phase two utilized a survey to collect perceptions of Georgia educators regarding the removal of diploma options. The research questions were:

1. Is there a difference between the percentage of special education students who received a Technical Prep diploma versus other diploma types in the years 2004-2011?
2. What are the effects of streamlining diploma options for Georgia high school students with disabilities as perceived by Georgia educators?

Data Sources

Phase one data was collected via statewide and national data sites such as gosa.georgia.gov, ga.doe.org, nces.ed.gov, eddataexpress.ed.gov. Data was also retrieved from data specialists employed at the Georgia Department of Education (GADOE) and the Governor's Office of Student Achievement (GOSA, 2017). All data regarding diploma types issued to Georgia high school graduates was obtained from the GADOE in the Exiting Credentials spreadsheet provided to the researcher by a data specialist with the state. State graduation rates were obtained from the GOSA website contained in a graduation rate document and national graduation rates were collected from the National Center for Education Statistics (NCES).

Instrumentation

Phase two consisted of a participant survey. A thorough search of EBSCO was conducted to locate a survey which had been designed and executed regarding educators' perceptions of the removal of the tiered diploma. No such survey examining educators' perceptions regarding diploma type, graduation rates, or any combination of the two topics could be located, so a survey was developed by the researcher. The research team developed the survey questions with similar structure to those which were found in multiple peer-reviewed journals using a Likert scale (Dodson, 2015). The survey was conducted through Google Forms, an online tool provided by Google Docs. Google Docs is in compliance with all applicable FERPA laws, and state laws/regulations for privacy. Survey responses were anonymous, contained no identifiable information, and responses are stored in a worksheet that can only be accessed through a Google account login by two of the researchers. All survey questions were to ascertain the Educators' perceptions of the removal of the tiered diploma options, possible effects of that removal, and perceptions of Career Pathways.

The first section of the survey contained operational definitions to familiarize the participants with key vocabulary used in the wording of the survey questions. A demographics section was designed to collect information about the participants such as age, gender, race, years and grade levels taught, highest degree earned, number of years' experience teaching students with disabilities, and administrative experience. Nine survey questions based on a Likert Scale measure (1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree) required the participant to rate their perception of each survey questions. Question number ten asked the participant to mark a check beside the group of students (all students, gifted, and all thirteen disability categories were listed) they felt could benefit from having the option of graduating with a *Technical Prep* diploma. The final question was one open-ended response asking the participant to list as many current Career Pathways with which the participant was familiar. This question was designed to gauge the familiarity of Georgia educators with the Career Pathway options currently available in high schools throughout the state. Finally, participants were encouraged to provide any additional comments they had on the subject matter in space provided at the end of the survey.

During Phase two, surveys were sent to district and state employees over a secure network and via district and state email addresses. The survey itself neither requested nor collected any identifiable data of the participants, including their email address or IP address. Email addresses were kept confidential and not attached to the participant's response Google Forms responses were stored in a worksheet that was only accessed through a Google account login. The transmission of data used Secure Sockets Layer (SSL) to encrypt the data during transport. The data is as secure as most other systems which take survey data and store it. Once in storage, responses were kept on a secure flash drive and were only transmitted through a secure University issued email address.

Data Screening

Surveys were sent to educators who are currently employed, previously employed, or retired from a Georgia school system. Surveys were sent to the employees' district issued email address where applicable. Retired employees received the survey via personal email address. All of the data received was screened to eliminate responders who have no experience teaching in Georgia or those who were not certified employees.

Data Collection Procedure

For Phase one of the study, all data obtained were either secured on an encrypted, password protected computer, or locked in a secure location. Furthermore, all identifiable information was removed from the data before given to the researcher. Raw numbers were transferred into tables or graphs to offer visual depictions of potential trends or changes over time. The researcher was in contact with several state employees both at the GADOE and the GOSA throughout the data collection process. Initial data regarding graduation rates was found on the official websites of the GADOE and the GOSA; however, the data on graduation rates readily available to the public on the GADOE website only dated back to the 2011-2012 school, which was the first-year graduation rates were calculated using the ACGR or Cohort method. In order to obtain previous years, a data request was submitted to a Data Specialist at the GADOE. Via this initial request, graduation rates were obtained dating back to 2004 on state and district levels for all students and subgroups. Data readily available for downloading on the GOSA website dated back to the 2010-2011 school year. The data available on GOSA was far more extensive than graduation rates, offering information such as statewide assessments scores, attendance data, information about district personnel, drop-out rates, and enrollment data, to name a few. Data crucial for this research was found in a document titled High School Completers. This document contained information about numbers of diploma types issued to Georgia high school graduates, including *College Prep, Technical Prep, Dual Seal, Special Education, and Certificate of Attendance*. A data request was also submitted requesting the High School Completers document for previous years dating back as early as 2001 to the GOSA data specialist, but no data was ever received by the researcher. This led to another data request being submitted to the GADOE requesting data detailing the diploma type breakout. Once the state confirmed they had this data, it was sent to the researcher. This data kept by the GADOE was titled Exit Credentials of High School Graduates, was broken down by race/ethnicity and gender, and was available on the state and district levels. Further data was requested regarding the diploma type breakouts of students with disabilities and was received shortly after the request. Data on national graduation rates was obtained via an internet search, downloaded, and collected from the National Center for Education Statistics (NCES), the United States Department of Education (USDOE), and the Education Data Express website provided by the USDOE.

RESULTS AND FINDINGS

For Phase one, in order to investigate the research question, "Is there a difference between the percentage of special education students who received a *Technical Prep* diploma versus other diploma types in the years 2004-2011?" a Mann-Whitney two-sample test was used to determine if the was a statistical difference between the percentage of students receiving a technical diploma and the combined percentage of students receiving college prep and dual diplomas. Alpha levels were set at 0.05 prior to conducting the study. Significant results were obtained and indicated that the percentage of special education students graduating with diplomas was greater for those with *Technical Prep* diplomas (Mdn = 12.5) than for those receiving college prep and dual diplomas combined (Mdn = 4.5), $z = -3371$, $p = 0.001$.

Phase two survey results showed most respondents fell into the age range of 36-40 at 18.8% or into the age range 51-55 at 15.6%. The majority of respondents were female and Caucasian at 88.2% and 83.6%, respectively. Respondents were well rounded in their total years of experience as an educator with 50.8% falling into the 6-20 years of experience teaching. Half of the respondents indicated between 6 and 20 years' experience teaching students with disabilities, 87.9% experience teaching at the high school level, and 22.1% experience as an Administrator. Regarding their own education, 50.7% of respondents hold a Master's, 38.8% hold a Specialist, and 26.9% have earned a Doctorate degree. Nearly 83% of respondents are certified in a core content area and 49% are certified in Special Education.

To answer the second question, "What are the effects of streamlining diploma options for Georgia high school students with disabilities as perceived by Georgia educators?", respondents overwhelmingly agreed that the students would benefit from having the option of graduating with a *Technical Prep* diploma option. *Technical Prep* diploma option adequately prepared students with disabilities to enter into technical colleges, community colleges, and/or the work force, 76.1% of respondents either agreed or strongly agreed. When asked if a reinstatement of the *Technical Prep* diploma option with reduced graduation requirements (1 less math and science) would be beneficial to students with disabilities 88.2% of respondents agreed or strongly agreed. When asked if it is realistic for all students to be college ready and required to earn a *College Prep* diploma, 61.8% of respondents strongly disagreed.

DISCUSSION

The goal of this research was to present an analysis of historical and current CTE federal legislation, review current practices at both the national and state levels, and examine data on graduation rates and diploma counts in Georgia to discover any unintended outcomes of the disparity between legislation and practice. The quantitative portion of this research was designed to specifically examine the effects of streamlining diploma options in Georgia on students with disabilities and answer the following question.

1. What are the effects of streamlining diploma options for Georgia high school students with disabilities on graduation rates?
2. What are the effects of streamlining diploma options for Georgia high school students with disabilities as perceived by Georgia educators

The data in Table 3 shows the numbers of diplomas issued in Georgia between the years of 2008 and 2011. These numbers and their corresponding percentages in Table 4 speak volumes about how many students, both with and without disabilities, were taking advantage of the *Technical Prep* diploma during the years of 2008-2011. Between the years of 2008-2011, an average of 36% of students with disabilities graduated with a *Technical Prep* diploma and 14.75% graduated with a *College* Prep diploma from 2008-2011 (GADOE, 2017). Along with this data showing that the *Technical Prep* diploma was benefiting students with disabilities, Georgia educators voiced their strong agreement that all students would benefit from having diploma options, such as the *Technical Prep* diploma.

Harvey (2001) emphasized that in order to keep students with disabilities enrolled in school and learning, educators need to be teaching them skills that will give them the competitive edge when they graduate and seek to gain employment. He stresses the importance of coaching and guiding students with disabilities through a successful pathway to achieve their post-secondary transition goals through vocational-technical education. The American

Institute for Research (AIR) recommends that states provide multiple pathways to post-secondary high school success (Brand, Valent, & Browning, 2013). Perhaps the answer lies in reintroducing a *Technical Prep* diploma as one meant for students whose endeavors do not include attending a four-year university or obtaining a bachelor's degree. Results from this research show that educators in Georgia strongly believe that the *Technical Prep* diploma adequately prepares students with disabilities to enter a technical school, community college, or into the workforce. In keeping with the current trends of increased accountability and academic achievement, could reintroducing a new and improved *Technical Prep* diploma track with increased rigor within the CTAE, built in work experience, equal collegiate opportunities for graduates, and an intentional focus on career readiness be a viable solution to the low number of students with disabilities who graduate? Vocational programs who utilize programs that put students to work during their high school years have better post-secondary outcomes for students. Research shows that students with disabilities are more likely to gain employment after graduation if they have work experience during high school (National Collaborative on Workforce and Disability for Youth, 2011).

If policy makers view the *Technical Prep* diploma as one that speaks to the lower achieving students, those with disabilities, or simply those who could not or had no interest in attending college, how is it acceptable to discount those populations by eliminating the only option those students had to study applicable coursework and graduate adequately prepared for multiple post-secondary outcomes? Significant results were found in the data analysis of diploma counts that showed more students with disabilities were graduating with the *Technical Prep* diploma than with *College Prep* or *Dual* diplomas. Was the removal of the *Technical Prep* diploma simply an over-reaching, overgeneralization of the concept that by raising the bar, all students will achieve? The Obama administration placed heavy emphasis on increasing graduation rates in the United States, even setting the goal of boasting the highest graduation rates in the world by the year 2020. Researchers have to ask the question, what does it say about the *College Prep* diploma if 100% of high school graduates can achieve it successfully? Robert J. Samuelson, a veteran columnist for the Washington Post, has argued that the movement "cheapens" four- year degrees and stigmatizes those who choose another path (Samuelson. 2012). Policy makers want the ultimate goal to be 'college for all' but is college for all students? It is absolutely an ideal notion, but not a realistic one. Results from the survey conducted in this research shows that educators in Georgia do not believe that it is realistic for all students to graduate from high school being college ready. Scott Carlson (2016) interviewed several key players in the areas of secondary, post-secondary, and workforce training, including Anthony P. Carnevale, director of the Georgetown University Center on Education and the Workforce, Mary Alice McCarthy, a senior policy analyst at New America, and Shaun R Harper, a professor at Pennsylvania State University, asking them all the question, is 'college for all'? The article presented several cruxes in post-secondary outcomes including the "cultural marginalization" (Carlson, 2016) of career and technical education, tracking in America, and inadequacies in transferring credits from technical colleges to four-year institutions. With opportunities for students to achieve beyond what is expected of them in high school, there should be equal supports and opportunities for those students who struggle with those same expectations. Offering a diploma designed to capitalize on individual strengths those struggling students has shown positive outcomes in the past and could be the vehicle by which overall graduation rates increase. Georgia educators strongly believe that not only would a reinstatement of the *Technical Prep* diploma would be beneficial to students with disabilities, but that all students would benefit from having diploma options such as the Technical Prep diploma.

Table 3. Graduation Rates on National and State Levels

Year	**National**		**Georgia**	
	All	SPED	All	SPED
2004	74.3	A	65.4	28.6
2005	74.7	A	69.4	29.4
2006	73.2	A	70.8	32.4
2007	73.9	A	72.3	32.9
2008	74.9	A	75.4	37.7
2009	75.5	A	78.9	41.4
2010	74.7	a	80.8	44.4
2011	79	59	80.9	43.3
2012 [a]	80	61	69.7	35.2
2013 [a]	81	61.9	71.8	35.2
2014 [a]	82	63.1	72.5	36.5
2015 [a]	83.2	64.8	78.8	54.3
2016 [a]	b	b	79.39	56.56

Table 4. Percentage of Georgia Diploma Types Issued

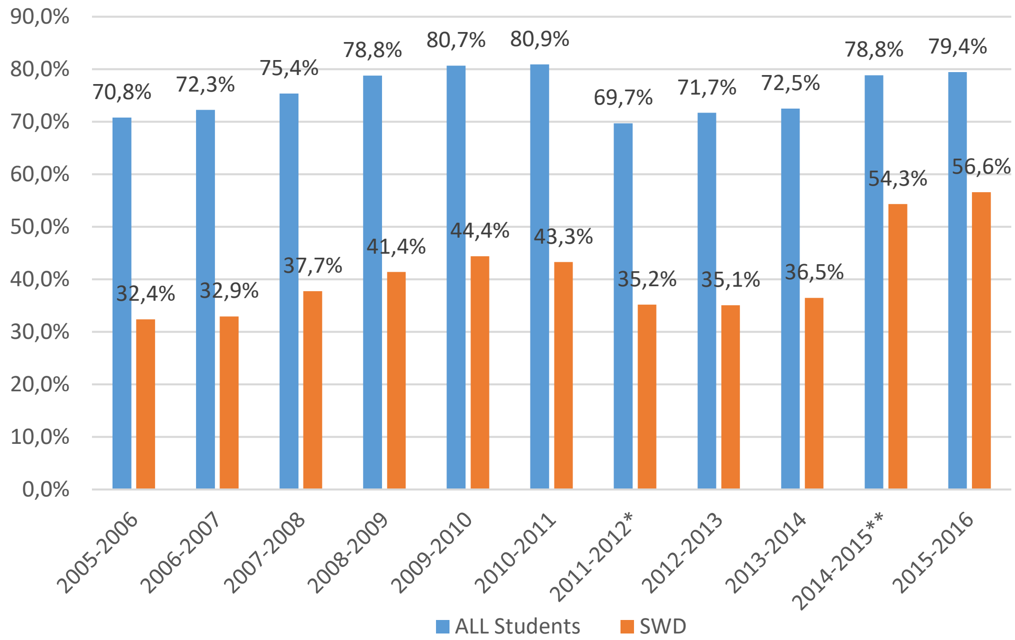
Year	All Students				Students with Disabilities					
	College Prep	**Tech Prep**	**Dual**	**Total**	**College Prep**	**Tech Prep**	**Dual**	**SPED**	**Cert of Attend**	**Total**
2008	49%	23%	21%	90,789	13%	35%	4%	39%	9.1%	8,028
2009	49%	23%	22%	93,790	14%	37%	6%	35.6%	8%	8,116
2010	51%	21%	22%	96,871	15%	38%	6%	33%	7.8%	8,215
2011	52%	19%	22%	98,823	17%	34%	6%	31.4%	11.4%	8,226

Most recently, President Trump signed an Executive Order titled, *Buy American and Hire American*. When the President spoke to a crowd in Kenosha, Wisconsin on April 18, 2017, he announced that Education Secretary Betsy DeVos "is working to ensure that our workers are trained for the skilled technical jobs that will, in the future, power our country" and told the American people that vocational education would play a prominent role in his administration (Trump, April 18, 2017). With this call for vocational education to be brought back to the forefront, it is possible for educational reforms to come full circle and once again face adjustments based on the current economic needs of our nation.

LIMITATIONS

This research presents graduation rates spanning from 2004-2016 and it cannot be ignored that the state utilized two different graduation rate calculation methods during that span of time (<1993-2011 AFGR, 2012-2016 ACGR), which makes comparisons between the two methods difficult. As a secondary method for examining graduation outcomes, diploma counts (number of diplomas issued) were also considered when attempting to formulate an answer to the research questions. Figure 2 is a visual representation of graduation rates in the state of Georgia students with and without disabilities for the years 2005-2015. The noticeable drop in 2011-2012 is likely due to the switch from the lever proxy rate to the cohort method to calculate graduation rates. This new method reflected a more accurate portrayal of the overall students in each cohort (total number of students graduating in four years) by considering transfers, deaths, and emigrations into the calculation. This drop can also be seen in Table 2 under the *all* column below the Georgia heading for the year 2012. The 6.3% increase in the graduation rate from 2013-3014 to 2014-2015 was likely due to the state's decision to remove the assessment portion of the graduation requirements, as seen Figure 2. Beginning with the 2015 graduates (2011 cohort), students were no longer required to pass the Georgia High School Graduation Tests (GHSGT) to receive their diploma. You can also see this dramatic increase in diplomas issued on Table 3 under the certificate of attendance (CA) column and on Table 2 under the All and SPED columns under the Georgia heading for the year 2015.

Although the survey was developed based upon similar researched qualitative studies, the survey was not tested for validity and reliability. Some of the respondents noted that a few of the survey questions were confusing. Two respondents left comments questioning if the meaning of a rating of three was "do not know" or "unknown". This was not clearly defined by the researcher in the directions and Google Forms did not display descriptions of values in the entire Likert scale (1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree) which may have led to confusion. Further item development is needed to produce a valid and reliable survey. Survey questions should be recalibrated and placed through reliability and validity tests with scientific principles guiding the analysis.



*New Cohort Graduation Rate
**Elimination of GHSGT

Figure 2. Graduation Rates in Georgia 2006-2016

CONCLUSION

This research is aimed to provide policy makers and educational leaders with informed data that demonstrates the value of technical education in public schools. The current versions of CTE have far surpassed antiquated social constraints with the implementation of the broadminded Career and Clusters Pathways that are not adequately utilized in the school system and do not provide a clear and alternate education path for students. in Students with disabilities need increased support and accountability to be successful in these pathways. The assumption that all students should, and are capable, of going to a 4-year college is an out dated thought of education reform. This goes against long standing federal legislation from the Smith-Hughes Act of 1917 to IDEA which has established standards for supporting students with disabilities through education and service delivery systems in a variety of settings.

As more initiatives are released at the federal level and education reforms are adopted at the state level, such as the streamlining of diplomas and the elimination of the GHSGT, more research needs to focus on investigating associations between these reforms and changes in graduation rates among students with disabilities. With an overwhelming focus on graduation rates trending in education, the reflection process of any newly implemented initiative demands attention. Research that examines the intended and unintended results of education reforms could lead to the caliber of effective and responsive policy changes required by such a dynamic and evolving economy, like the one in the United States of America.

REFERENCES

Aliaga, O., Kotamraju, P., & Stone, J. (2014). Understanding participation in secondary career and technical education in the 21st century: Implications for policy and practice. *High School Journal, 97(3)*, 128-158.

Brand, B., Valent, A., and Browning, A. 2013, March. *How Career and Technical Education Can Help Students Be College and Career Ready: A Primer.* Retrieved from www.air.org/sites/default/files/downloads/report/College Career Readiness Primer Brief.pdf.

Carlson, S. (2016). Should everyone go to college? For poor kids, 'college for all' isn't the mantra it was meant to be. *The Chronicle of Higher Education,* (34). 22.

Cobb, B. & Johnson, D.R. (1997). The statewide systems change initiative as a federal policy mechanism for promoting education reform. *Career Development for Exceptional Individuals*, *20*(2), 179-190.

Dodson, R. (2015) Kentucky principal’s perceptions of the state’s new teacher evaluation system: a survey analysis. *Educational Research Quarterly*, *39*(2), 53-74.

Erickson, A., Kleinhammer-Trammil, J., & Thurlow, M. (2007). An analysis of the relationship between high school exit exams and diploma options and the impact on students with disabilities. *Journal of Disability Poly Studies, 18*(2), 117-128.

Friedel, J. N. (2011). Where Has Vocational Education Gone? *American Educational History Journal*, 37, 53.

Georgia Department of Education. (2009). Consolidated state application accountability workbook. Retrieved from http://archives.doe.k12.ga.us/DMGetDocument.aspx/2009%20GA%20Consolidated%20 Accountability%20Workbook%206-28-2009.pdf?p=6CC6799F8C1371F61497921 020092B72752151DF62932FD99A6AB5479C860333&Type=D

Georgia Department of Education. (2010). Georgia high school graduation requirement: preparing students for success. Retrieved from http://www.gadoe.org

Georgia Department of Education. (2012). Business and computer science programs industry certification process. Retrieved from https://www.gadoe.org/Curriculum-Instruction-and-Assessment/CTAE/Documents/2012-13-BCS-Industry-Certification-Standards.pdf

Georgia Department of Education. (2012). CTAE annual report. Retrieved from https://www.gadoe.org/Curriculum-Instruction-and-Assessment/CTAE/Documents/CTAE-Annual-Report-2012.pdf

Georgia Department of Education. (2016). Georgia end of pathway (EOPA) assessment state guidance. Retrieved from https://www.gadoe.org/Curriculum-Instruction-and-Assessment/CTAE/Documents/Assessment-EOPA-State-Guidance.pdf

Georgia Department of Education. (2017). [Data File]. Retrieved from http://www.gadoe.org/Technology-Services/Data-Collections/Pages/Data-Collections-and-Reporting.aspx

Governor's Office of Student Accountability. (2017). [Data File]. Retrieved from http://gosa.georgia.gov/state-education-data-0

Hall, C. I. (2012). The effects of reducing tracking in upper secondary School. *Journal of Human Resources*, 47(1), 237-269.

Harvey, M. (2001). Vocational-technical education: A logical approach to dropout prevention for secondary education. *Preventing School Failure, 45*(3), 108-113.

Friedel, J. (2001). Where has vocational education gone? The impact of federal legislation on the expectation, design, and function of vocational education as reflected in the reauthorization of the Carl D. Perkins career and technical education act of 2006. *American Educational History Journal, 38*(1), 37-53.

International Baccalaureate Organization. (n.d.). What is the Career Programme? Retrieved April 24, 2017, from http://www.ibo.org/programmes/career-related-programme/

Johnson, D.R., Stodden, R.A., Emanuel, E.J., Lueking, R., & Mack, M. (2002). Current challenges facing secondary education and transition services: What research tells us. Exceptional Children, 68, 519-531.

Johnson, D., Thurlow, M., & Schuelka, M. (2012). Diploma options, graduation requirements, and exit exams for youth with disabilities: 2011 national study, NCEO Technical Report 62. Retrieved from http://www.cehd.umn.edu/NCEO/OnlinePubs/Tech62/default.htm

Johnson, D., & Thurlow, M. (2004). A National study on graduation requirements and diploma options for youth with disabilities. NCEO Technical Report 36, *The National Center on Secondary Education and Transition.* Retrieved from http://www.ncset.org/publications/related/NCSETgradreport.pdf

National Collaborative on Workforce and Disability for Youth. (2011). Practice brief: Engaging youth in work experiences. Washington, DC: Author. Retrieved from http://www.ncwd-youth.info/innovative-strategies/practice-briefs/engaging-youth-in-work-experiences

National Commission of Excellence in Education (Ed.). (1983). *A Nation at Risk: The Imperative for Educational Reform*.

Neubert, D. (1997). Time to grow. The history and future of preparing youth for adult roles in society. *Teaching Exceptional Children, 29*(5), 5-17.

No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002).

Özelçi, S. Y., Çengel, M., Vural, R. A., & Gömleksiz, M. (2016). Rethinking tracking practices: what teachers say. *Universal Journal of Educational Research*, 4(10), 2341-2352.

Providing More Students, a Pathway to Success by Strengthening Career and Technical Education: Hearings before the Subcommittee on Early Childhood, Elementary, and Secondary Education, House of Representatives, 115th Cong. (2017).

Rich, J. M. (2010). Vocational education. *Handbook of Texas Online.* Retrieved April 14, 2017, from https://tshaonline.org/handbook/online/articles/kdves

Rubin, B. C. (2006). Tracking and detracking: Debates, evidence, and best practices for a heterogeneous world. *Theory into Practice, 45(1), 4-14.*

Rubin, J. (2016). Georgia's policies regarding high school special education diplomas: Are too many children left behind? *Georgia State University Law Review, 32*(3), *Article 6.*

Samuelson, R. J. (2012, May 27). It's time to drop the college-for-all crusade. *The Washington Post.* Retrieved June 21, 2017, from https://www.washingtonpost.com/opinions/its-time-to-drop-the-college-for-all-crusade/2012/05/27/gJQAzcUGvU_story.html?utm_term=.8636bfee8718

Thurlow, M. (2009). Alternative high school diploma options for students with disabilities. *Exceptionality, 17*(3), 117-118.

Thurlow, M.L., & Johnson, D.R. (2000). High-stakes testing of students with disabilities. *Journal of Teacher Education, 51*(4), 305-314.

Trodd, Z. (2007). Hemingway's camera eye: the problem of language and an interwar politics of form. *The Hemingway Review, 26(2)*, 7-21.

Trump, D. (2017). Remarks by President Trump on Buy American, Hire American Executive Order | Kenosha, WI [Transcript]. Retrieved from https://www.whitehouse.gov/the-press-office/2017/04/18/remarks-president-trump-buy-american-hire-american-executive-order

United States. National Commission on Excellence in Education. (1983). *A nation at risk: the imperative for educational reform: a report to the Nation and the Secretary of Education, United States Department of Education*. Washington, D.C.: National Commission on Excellence in Education: [Supt. of Docs., U.S. G.P.O. distributor].

U.S. Department of Labor Secretary's Commission on Achieving Necessary Skills. (1991, June). *What work requires of schools: A SCANS report for America 2000*. Washington, DC: United States Department of Labor. Available: http://wdr.doleta.gov/SCANS/whatwork/whatwork.pdf

Wagner, M., Newman, L., Cameto, R., & Levine, P. (2006). *The academic achievement and functional performance of youth with disabilities. A Report of Findings from the National Longitudinal Transition Study-2 (NLTS2).* Menlo Park, CA: SRI International. Retrieved from https://ies.ed.gov/ncser/pdf/2006300

ETHICAL ISSUES IN ENGINEERING EDUCATION CURRICULUM

Farhad Balash
Kharazmi University, Iran

Ameneh Alipour
Universiti Tecknologi Malaysia, Malaysia

Ensieh Habibi
Electric Power Distribution Company, Iran

ABSTRACT: This study aims to reveal the ethical issues in engineering education curriculum in Iran. Basically, engineering education seems to be highly impacted by different factors in universities. In this study, the researchers tried to discover those ethical issues that affect the curriculum in engineering education. The Akker's curriculum components are examined in association with ethics. The data were collected through the interviews and semi-structured Delphi questionnaire. Analytic Hierarchy Process technique was applied to prioritize the curriculum components based on ethical concerns. The samples of the study were selected from those engineers that recently they were graduated from different Iranian universities. The results show that priorities of ethical issues, which were perceived by the students, are: assessment, teacher role, and learning activity, respectively.

Keywords: ethics, engineering education, curriculum

INTRODUCTION

Ethics is defined as the study of morality and it is one of the concepts that is respected and praised in different communities. Ethics consists of a set of rights and wrongs, which are described by law, society, and traditions. It can be implied that ethics consists of some obligations, benefits, fairness, and some virtues. It is stated that ethics means the study of moral beliefs, and moral behaviors that can ensure the people and enterprises pursue reasonably well and satisfy moralities (Velasquez, 2015). Moreover, ethical codes based on some principles such as honesty, professional loyalty, and developments of professional competence fortify engineering education professionals with honor, integrity, and dignity. Social systems and enterprises can take advantage of fulfilling ethical privileges in order to introduce themselves well as prestigious and competent in local, national, and international levels. Therefore, ethics can be considered as the foundation of development for the engineering education.

Peters (2015) distinguishes that ethics as a part of philosophy that specifically argues and analyzes the answers to the practical questions about moralities. In contrast with theoretical discussions, in practical questions, the issue can be what the case is, and through the answers to these questions, the study defines the things to be settled and changed or modified. He states that to settle the educational issues it is necessarily needed to have an answer to the practical and theoretical questions. Whereas the education complies with the objectives of developing and improving, it requires some ethical values. He emphasizes that the matter and the manner of education strongly demand ethical bases.

In the challenging and growing decision-making situations in the engineering world, engineers need to rely on ethical decisions and consider morality issues as the concerns and determining matters. The fundamental ethical behavior of engineers can be built up during their academic study years and the road of morality can be paved from engineering education to engineering profession. In order to educate engineering students as to be properly prepared for their professional careers to overcome the challenges facing in developing engineering world of technology and services, engineering education needs to get improved reasonably, in accordance with the changes in relating medium of technologies, services, people expectations, and social welfare (Bhavya, 2009). In the current situation of information and communication, students expect some levels of curriculum style and educational attitude of the engineering education systems. Effectively, the contribution of engineers in changing paradigm of engineering proficiency, growing engineering technology markets, the evolvement of technological products, and increasing demanded a level of quality necessitate engineering graduates to have professional and ethical standards. Besides sufficient working abilities, which are demanded from engineering graduates, they need to have problem-solving skills and ethical decision-making capabilities.

Engineering education researchers pay special attention to curriculum improvement in order to respond the future of engineering education concerns and satisfy the growing demand for qualified and attitudinal engineers. They have come to study on instructional issues including the components of teamwork, timing and learning styles. It is said that students' behavior and consequently, their professional behavior is influenced by learning (Lawrence, 2007). For the revision and redesigning of educational systems, researchers employ psychological, sociological, communicational and other behavioral models (Svinicki, 2008). Actually, a basic model of learning framework 'How People Learn (HLP)' model is explained by Svinicki (2008). In this model, there are four well-known thrusts, which are mostly used as instructional design theories and consist of student-centered, knowledge-centered, assessment-centered, and community-centered instructions. This research aims to examine the development of the efficient education through investigating ethical concerns in the engineering curriculum.

To design the structure of the study in data gathering about ethical issues, which are observed by engineering students, researchers needed to find out, which questions could be the best suitable items to consider engineering education curriculum. Whereas the outcomes of this study and the similar works can be used for the purpose of curriculum improvement, the curriculum definitions and consisting factors should be considered effectively. It is mentioned that in curriculum improvement, different factors and components are needed to be in balance and there is some sort of components, which are defined by professionals of curriculum. One of the classified curriculum definitions is given by Walker which comprises three main parts in the curriculum as purpose, content, and organization of learning (Akker,2010). To have a more appropriate-detailed association of curriculum components and factors, later studies have progressed leading to a complete design, which is introduced by Akker (2010). He provides ten items in his elaborated curriculum design. These components are listed in Table 1. In this article, Akker's curriculum components are used as the cornerstone to examine the engineering education curriculum as to provide a classified question to enable the authors evaluating ethical concerns faced by engineering students during their educational years. It is said, there is an interest in engineering education research to work on aims and objectives of engineering education curriculum in the matter of content and organization of assessment and evaluation (Bhavya,2009).

Table 1. Akker's Curriculum Components

Rationale or Vision*	Why are they learning?
Aims and Objectives	Toward which goals are they learning?
Content	What is learning
Learning activities	How are they learning?
Teacher role	How is the teacher facilitating learning?
Materials & Resources	With what are they learning?
Grouping	With whom are they learning?
Location	Where are they learning?
Time	When are they learning
Assessment	How to measure how far learning has progressed

*: The rationale or vision is considered as the core of this classification of components and each of other components provides an aspect of the curriculum rationale (Akker, 2010).

Engineering education research can be a 'translational' study, which connects the engineering practices to knowledge (Bhavya, 2009) and feedbacks if it is attentive to applied interaction of science and practice. Several educational researches are conducted based on teachers' viewpoints (Svinicki, 2008). This study is based on students' observation and assessment. On the student-centered instructions, researchers survey the attitudes, needs, and judgment of current/ ex-students. In the assessment-centered research the frequent and informative statements, and feedbacks are evaluated (Svinicki,2008). In this study, assessment is based on views and experiences of the engineering education, a community of engineers, working in electric power utility service company in Iran (HEDC). Results and findings of the study based on the field study can help the engineering education to get improved by considering the current educational systems' weak points and going through the issues, which are needed to be redefined and re-established with deploying the kind of educational services covering the most appropriate ethical codes. Designing educational systems with a higher level of moralities and defining an effective ethical code in engineering education curriculum can provide and improve the system's professional competence, prestige, and efficiency.

METHOD

In engineering education research, there is no specific advantage for any of qualitative, quantitative, or mixed mode method (Johri, 2011). This study is conducted using the qualitative-quantitative, mixed-method. While the respondent opinions are surveyed and interviewed based on their descriptive statements, the frequency of the similar concepts explained by participants is considered to determine the main concerns in each curriculum component of engineering education. On the other hand, prioritizing the components is done using analytic hierarchy process (AHP). AHP is one of the multiple criteria methods that are used in decision makings where there are several alternatives and criteria. The consistency analysis of the rated priorities determines whether the preference ratings are consistent (Geoff, 2004).

Delphi semi-structured questionnaire is provided and includes ten explicit questions about ethical concerns observed and experienced by the study participants. The field of the study is an Electric Power Utility company of Iran (HEDC). The respondents are 27 engineers aged between 28 to 45 years old, almost 90 percent of participants are electrical engineers and most of the senior engineers have participated in engineering higher education during four recent years. The respondents' observations and experiences cover their degree study years which go to past 5 to 20 years and their postgraduate study which is pursued recent 4 years- this is because of the recent availability of postgraduate courses in the regional universities. Meanwhile based on the personnel combination of HEDC, almost 80 percent of the respondents are male engineers. The participants have studied their engineering majors in different national universities.

RESULTS AND FINDINGS

Using Akker's curriculum components, ten questions are defined to find out about the main ethical issues in engineering education from the perspective of engineering students. Respondents, professional engineers, have stated their opinions based on their experiences of whatever they think that has been an important issue during their study years. Totally 103 ethical issues are listed in 10 components of the curriculum, which after modification reduced to 91 concerns. Among different components the maximum number of ethical issues is illustrated in 'assessment' item, which is 18 ethical concerns and the least concerns is in 'location' item of curriculum with 6 concerns. After the assessment component, 'lecturers' role', and 'grouping' include higher concerns. In the whole curriculum components, the main ethical issue which more frequently is stated by participants is listed in Table 2. For the two highest ethically concerned components of assessment and lecturers’ role, the most important stated ethical issues are "theoretical assessment" and "not properly guiding students" respectively.

Table 2. The Curriculum Based Questions and the Highest Frequent Concerns

Question	The highest frequent given answer
What are the main ethical issues related to the content of engineering education curriculum	The lessons are taught theoretically
What are the main ethical issues related to learning activities?	The subjects are taught theoretically that are not practical
What are the main ethical issues related to the lecturers’ role?	Students are not appropriately guided by lecturers in the projects and dissertations
What are the main ethical issues related to material and resources?	The fixed subjects are not offered each semester
What are the main ethical issues related to grouping?	Plagiarism in doing assignments and projects
What are the main ethical concerns related to the location?	Inappropriate atmosphere in the classrooms
What are the main ethical issues related to time component?	Schedules are not properly planned based on the students’ needs
What are the main ethical issues related to assessment?	Examinations are focusing on theoretical aspects of learning rather than practical
What are the main ethical issues in aims and objectives of engineering education curriculum? *	Lack of job opportunities
What are the main ethical issues related to rationale or vision of engineering education curriculum? *	Decreasing status of education because of the market problem

*: The concerns about aims and the rationale or vision seem not to be ethical concern but the respondents judge that when normally in this society engineering education is believed as a desired field of study and is praised as remarkable success for the academic study applicant, practically facing lack of job opportunities for graduates is not fair and they think that this conflict is an ethical concern.

In the next step, to find out which components have the priority regarding ethical issues, the curriculum components are examined using AHP method. The examination is done by two representatives from the two main groups of participants, electrical, and non-electrical engineers using a primary questionnaire. For each component, the pair wise comparison matrix is developed and then it is normalized and followed by weighting for the components. Finally, consistency analysis is evaluated (Bunruamkaew, 2012). The questionnaire design of the first step of AHP is presented in Table 3 (Appendix); one part of a whole pair-wise comparison matrix is shown in Table 4 (Appendix); Table 5 (Appendix) presents the normalization of comparison matrix. Using consistency index in AHP computational model of CI which is calculated 0.31 and random index of the comparison between 10 variables, RI, which is 1.49 (Geoff, 2004), Consistency Ratio (CR) is calculated 0.21. Although the consistency ratio of blew the limit of 0.1 shows the judgments in comparison of the factors are reasonably consistent; however, Geoff (2004) states that CRs higher than 0.1 sometimes have to be accepted. He emphasizes that excess of 0.1 shouldn't be too much as he clarifies that CR =0.9 means the judgments are completely untrustworthy.

Figure1 shows the judged ratings of curriculum components regarding ethical issues. Most ethically concerned components of the engineering education curriculum are Assessment, Lecturer role, and learning activities. It seems that the importance of assessment and lecturer role is well-known and established as they exist in the list of 14 items in the code of ethics of American Society for Engineering Education, as fair evaluation and treating fairly (ASEE, 2012). Figures 2 and 3 present the details of ethical issues stated by the participants for assessment and lecturer role, respectively.

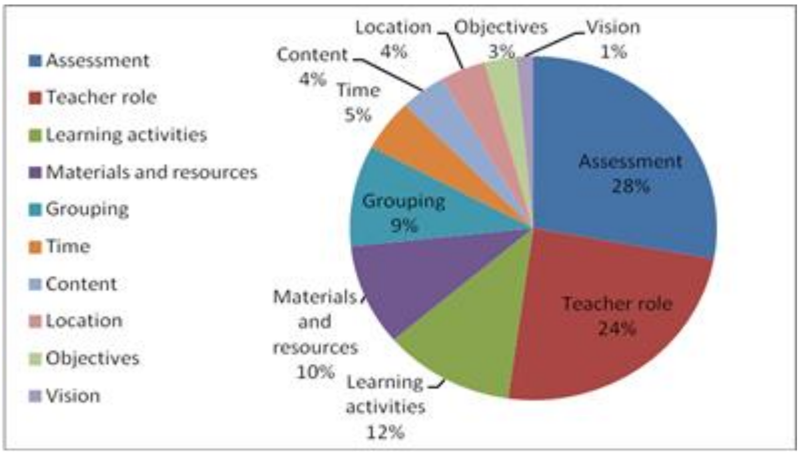


Figure 1. Priority Ratings of Ethically Involvement of Akker's Curriculum Components

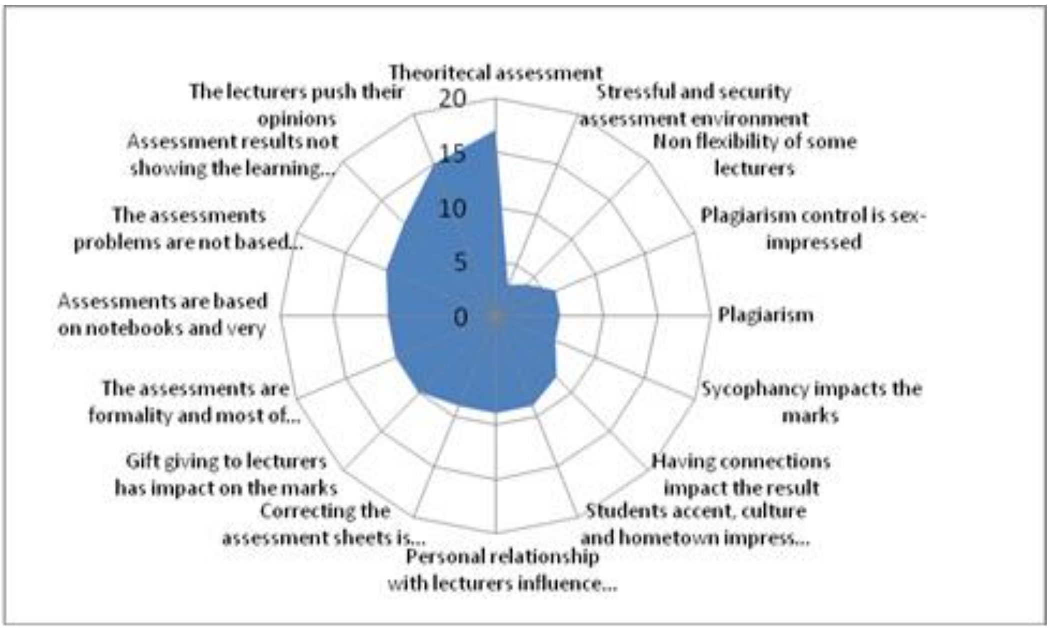


Figure 2. Main Ethical İssues Related to Assessment in Engineering Education Curriculum

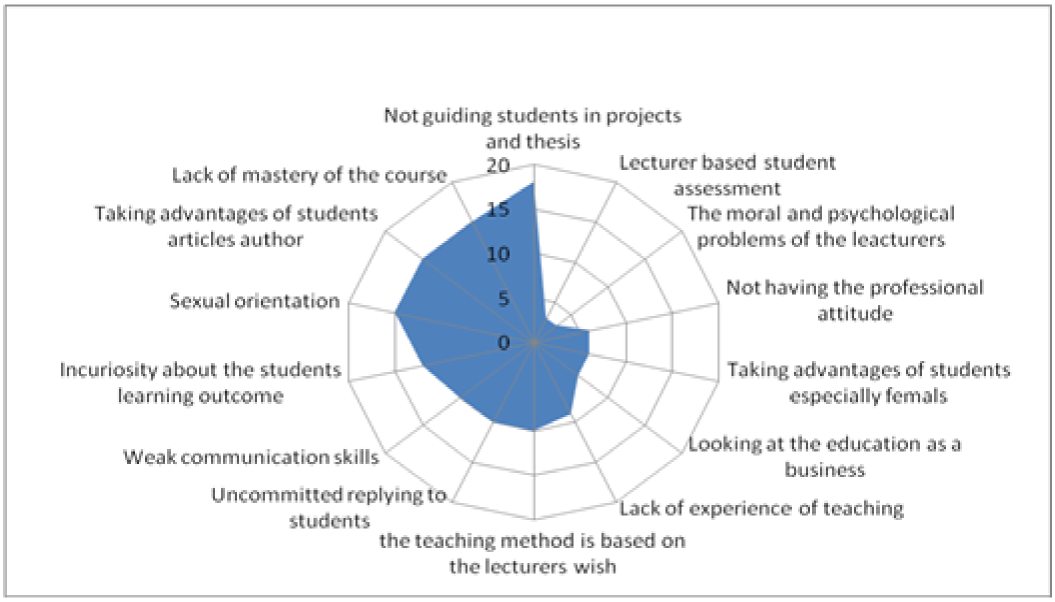


Figure 3. Main Ethical İssues Related to Lecturers' Role in Engineering Education Curriculum

In the ethical concerns, some issues are stated in more than one component such as gender orientation, which is considered as one of the issues both in lecturer's role and assessment. These kinds of duplicated concerns are taken into consideration and are counted while some statements, which give the same concept in different explanations, are modified to a central phrase. The listed ethical issues, which are surveyed, include some concerns that do not fit in curriculum component categories. Some of these concerns are religious autarchy and inconsiderate curriculum scheduling in the matter of the students, welfare, and requests.

CONCLUSION

Engineering education systems need to be monitored and evaluated precisely from different perspectives to meet the growing expectations of engineering world and humanities. One of these aspects is ethical issues, which is investigated in this article. The student-centered evaluation is conducted specifically on the aspect of ethical concerns. The study framework is based on Akker's curriculum components. Research-based findings can be employed to guide the individual actions, establish efficient ethical codes, and revise education system actions. This article clarifies that assessment, lecturer role, and learning activities are the three top curriculum components, which involve highest priorities in students' ethical concerns. The most important ethical issues stated in these components are "theoretical assessment" and "not properly guiding students".

RECOMMENDATIONS

Further study is recommended to survey the ethical concerns of engineering education curriculum from the students’ viewpoint in different regions, which can lead to define curriculum standardized ethical codes. However, the authors are supposed to redesign this study to improve the current consistency ratio of 0.2 in AHP technique to less than 0.1.

REFERENCES

Akker Jan van den. (2010). Building bridges: how research may improve curriculum policies and classroom practices.

ASEE. (2012). American Society for Engineering Education Code of Ethics. This is an online document from: https://www.asee.org/member-resources/resources/Code_of_Ethics.pdf, Approved by the ASEE Board of Directors, (PDF).

Bhavya Lal. (2009). Task Leader, Strategies for Evaluating Engineering Education Research. IDA, Washington.

Geoff Coyle. (2004). Practical Strategy. Open Access Material, AHP. THE ANALYTIC HIERARCHY PROCESS, Pearson Education Limited.

Johri Aditya, M. Olds Barbara. (2011). Situated Engineering Learning: Bridging Engineering Education Research and the Learning Sciences. The Research Journal of Engineering Education.

Khwanruthai Bunruamkaew. (2012). How to do AHP analysis in Excel, Division of Spatial Information Science, Graduate School of Life and Environmental Sciences, University of Tsukuba.

Lawrence Whitman, Zulma Toro-Ramos, and Steven Skinner. (2007). Educating the Engineer of 2020: A Practical Implementation, College of Engineering Wichita State University, Proceedings of the 2007 Midwest Section Conference of the American Society for Engineering Education rev5.

Peters R. S. (2015). Ethics and Education, Routledge Revivals Press, Edition 2015, ISBN 13: 978-1-138-89041-1 (bbk) pages17,91

Svinicki Marilla D. (2008). A guidebook on conceptual frameworks for research in engineering education.

Velasquez Manuel, Andre Claire, Shanks Thomas, S.J., and Meyer Michael J. (2015). Markkula Center for Applied Ethics.

GEOGRAPHICAL THINKING APPROACH IN GEOGRAPHY EDUCATION

Abdullah Balciogullari
Çukurova University, Turkey

ABSTRACT: Studies carried out in teaching geography mainly aim at determining the encountered problems. One of the main objectives of geography education is to improve geographical thinking skills. Every work in this field will help students to identify themselves and the entire universe; and use the information in their daily lives. The studies about geography teaching in Turkey mostly focus on topics such as course book, concepts and encountered problems. With the acquisition of geographical thinking skills, students can have the opportunity to think, synthesize, analyze and evaluate geographic information. Location and how it affects relationships with other phenomena are the basis of geographical thinking. This is also possible in other research methods, such as reaching information, explaining, analyzing and thinking on it. The geographic skills required of a geographically informed person consist of five sets of skills adapted from the Guidelines for Geographic Education: Elementary and Secondary Schools, prepared by the Joint Committee on Geographic Education by the Association of American Geographers and the National Council for Geographic Education. This study tries to answer questions such as; "What is geographic thinking approach? What are the main features of the geographical thinking process? How the geographical thinking learning process should be organized in terms of geography education in middle schools?" For this purpose, we developed an implementation of a lesson plan for geographical thinking skills.

Keywords: geography, geographical thinking, thinking

INTRODUCTION

Every environment in which people live is geography and therefore geography is the area of life of a person. The environment in which the person lives is not different from the people, and the two are not independent of each other. In fact, we always live with our geography in our everyday life, because we are a part of the geography. Geography has an effect on every area that we can imagine from what we eat in our lives to what we wear, from talking to clothes, from the exterior to the houses we live in.

Geography (local environment) has a powerful influence on the perception of the natural world by those living in that environment. It is difficult to say when and where the geography, which is as old as human history or, more precisely, and the geographical thought first emerged. Perhaps the first geographer was the first person to climb a river or to pass a stream to see what was on the other side. Maybe that person asked questions that what the geographers still ask: Where is it and what is there? Geography is basically the product of old and irreversible curiosity about "places" other than their own, located in the structure of man himself (Tümertekin & Özgüç, 2002).

Geography is actually our natural environment and the relationship between natural environment and people. While this is the reality of geography, geography cannot be passed on to schools in the process of imprisonment with classes. In addition, they are not only confined to class, but they are trying to overload information and memorize information.

Geography is basically a positive science. However, some research subjects are closer to science and some are closer to social science. Geographers interpret the system of thought that they apply by shaping it with principles. Thus, it aims to solve the social, economic and technical problems of the society. For this reason, geography must have a special place in our education system (Harvey, 1969).

Geography seems to consist of memorizing place names in society. However, knowing place names is only one of the tools of geography (Tümertekin and Özgüç, 2002). Learning only the context, as an end in itself, makes relatively little contribution to thinking geographically (Graves, 1980). The way we develop geographical thinking, which has the applicability to the environment we live in, goes far beyond the practicality of the information taught in everyday life. In this respect, the most important task in the realization of geographical thinking depends on the teachers.

Downs (1994) notes that geography teaching should focus on conceptual, effective learning and psychomotor skills of students. He also asserts that students need to understand the information they are acquainted and that their knowledge should include their ability to use it in different situations. It should also be clarified what kind of learning-teaching process should be organized in order to make geographical subjects more permanent and usable.

In fact, the development of geographical thinking skills in students is one of the main objectives of geography teaching. Therefore, the ability to establish relationships between geographical incidents, to bring students own interpretation into the events by taking advantage of different information and to evaluate them must be required from the students. These skills are also geographical thinking skills. In their research, Gersmehl and Gersmehl (2007) found that students with geographical thinking skills did not have any difficulty in solving any problems they had not encountered before. Geographical thinking provides a unique and powerful way of observing the world and establishing links from the local to the global scale (Jackson, 2006).

A full and healthy geography education enables us to better understand our connection with other people around the world, our relationship with the environment, and skills, knowledge, concepts and foundations that help us understand ourselves. Geography leads us in thinking, critical thinking and problem solving in the decision-making phase (Barth and Demirtas, 1997). Geography must be the center of life in order to have geographical thinking skills and to be able to direct human life (Thomas, 2011). Geographical thinking skills provide students with information processing, reasoning, interrogation and evaluation. All of these lead students to think and develop lifelong learning (Fisher and Binns, 2016). With geographical thinking, students can think about how and why places have changed over time (Newman and O-Neill-Jones, 2016).

Application of Geographical Thinking Skills Approach in Geography Education

One of the main objectives of teaching geography of education system today is to use geographical skills rather than memorizing geographical information. It is therefore possible through an educational environment that establishes the causality relationship between reading and understanding by reading geographical realities, evaluating different aspects of events and improving their own interpretations and views. One of these ways is the use of geographical thinking skills. It is closely related to the students' ability to adapt to life, their environment and their observations and, as far as possible, to learn and use ways to achieve results by establishing cause-effect relationships between events. For this reason, students should acquire the habit of thinking objectively and making correct decisions in case of events and situations by examining their environment with scientific methods in geography lessons. From the above general statement, it is clear that the geography lessons should include selection, investigation, accessing knowledge, choosing among the many knowledge that can be used. In geography lessons, geographical thinking skills come at the forefront of the methods that students can use to transfer their knowledge and skills to daily life and cope with the problems they encounter in everyday life. It is thought that many problems related to teaching this area can be solved by bringing geographical thinking skills that are so important in geography teaching in class environment.

As it can be understood from the above general explanations, geography lessons are at first place in educating individuals who can think, understand and inquire. Geographical thinking skills are take place near the top methods that students can use to cope with the problems they encounter. Geographic skills provide the necessary tools and techniques for us to think geographically. They are central to geography’s distinctive approach to understanding physical Earth, human patterns and processes. Geographic skills are used in making decisions important to everyday life. The geographic skills required of a geographically informed person consist of five sets of skills adapted from the Guidelines for Geographic Education: Elementary and Secondary Schools, prepared by the Joint Committee on Geographic Education by the Association of American Geographers and the National Council for Geographic Education. These stages are also known as geographic inquiry (ESRI, 2003). These are;

1. Asking Geographic Questions
2. Acquiring Geographic Information
3. Organizing Geographic Information
4. Analysing Geographic Information
5. Answering Geographic Questions

Steps for Geography Thinking Skills

1. Geographical Thinking Skills Preparation Step:

This step ensures that students have an overall view of the given text. During the preparation phase students are provided with information on the text, maps, charts and pictures of the students and the general structure of the subject. They are asked to write one or two sentences about what the subject of the text is and what information it contains.

2. Geographical Questioning Step:

This step is the step for students to prepare effective geographical questions about the text. For this, they use the words of the question by performing the necessary studies on the paper given first. Later, questions are asked to text, maps, tables and graphics with the help of the teacher. The students are asked to write these prepared questions under the text. Successful geographical surveys involve asking and thinking about geographical facts and causes of events, where and how they have come to fruition. Geographical questions can be such questions; Where is this (geographical phenomenon) located? Why is it there? What is it about? What does it look like? Questions should be in the framework of such as.

1. Where is this place?
2. What does this place look like? What does it look like?
3. Why is this place similar to this?
4. How is this place linked to other places?
5. Does this change location? How?
6. How is it to live in this place?
7. How does this place look or differ from another place?

These questions are important for the development of students' geographical inquiry skills. In addition, geographical and non-geographical questions should be given together so that students are asked to distinguish them from each other, so students are prepared to ask themselves geographical questions by distinguishing geographical from non-geographical questions. At a later stage, students can also propose solutions for problems by identifying geographical problems. For example, in students' lessons, "why does this piece of land, region or country look like this? Why are these mountains here? Why is the shape of these mountains like this? Why do people like them around?

Regarding geographical questions, students should be able to plan and organize a geographical research project, a problem, a research question or hypothesis, and identify the source of information.

1. Prepare geographical questions by examining a map of a region and examining the map. For example, the division of countries, the relationship between the distribution of dwellings and population, topography, and questions about the effectiveness of cities.
2. Prepare geographical questions by working with many charts and write information to answer them.

3. Step of Obtaining Geographical Information:

It directs students to determine ways to obtain information. To do this, students are first asked to identify the sources and sources of information related to each question and write them once. The resources that provide information to the question are determined by discussing each question and firstly students do these operations to their notebooks as to what these resources are. Then, these processes should be printed next to the problem on the board.

Students should be able to read and interpret maps of all kinds. So, using a map, they should be able to generate information for a place that they know nothing about. They should also use quantitative and qualitative methods to compile primary and secondary sources and benefit from them. Students can obtain information through surveys, fieldwork, use of various materials, and library surveys. The skills of obtaining geographical knowledge include; interviewing, systematizing the information, interpreting and reading maps and other graphics, observation and statistics. The primary sources of knowledge, particularly the field work done by students, are very important in terms of geographical research. Fieldwork includes activities such as surveying, taking photos, making observations, interviewing with people and collecting samples. Field work ensures that geographical work becomes more fun and understandable. Fieldwork is a very important activity that allows students to establish relations between physical features and human activities and to establish a connection between the outside world and the part of the school geographical knowledge they live in (Bednarz, 2003).

Secondary sources of information are written documents such as texts, maps, graphics, photographs (satellite photographs, aerial photographs, three-dimensional photographs, professional or amateur photographs), multimedia tools, newspapers, telephone directories and government publications. They bring secondary resources to the scene and a part of the geographical information is obtained from these sources.

Tertiary sources are mostly encyclopedic sources. Encyclopedic information is information that others have benefited from primary and secondary sources. But there is information available here that student cannot reach personally.

4. Step of Arranging Geographical Information:

To be able to analyze and interpret compiled geographical information, it needs to be arranged. Information should be systematized and different types and forms of information should be classified. The information and data obtained from various sources should be organized using graphics, photographs, climate graphics, diagrams, tables, and maps.

It is a step that helps to reorganize the information obtained about the text. For this, students prepare information in the form of tables, graphs and maps or compositions of the information obtained through different sources. These studies can be made by Microsoft Excel program in table formats. The tabulated data is then translated into various graphic formats with the support of the researcher. The information should first be processed on a dumb map.

There are several ways to organize geographical information. Because of maps are the basis of geography, they are first in the arrangement of geographical information. Apart from this, using various types of graphics can make the geographic information regular. Creativity and skill have a very important place in the effective interpretation of geographical information. Creativity and skill are also influential in designing and coloring graphics, and scaling and shaping maps.

5. Analysis of Geographical Information Step:

It is the step that students respond to the questions prepared in the first step by using the information that is handled and organized in various sources. Analyzing the information obtained through various sources and researches involves finding examples and establishing relationships and links. Students analyze and interpret information about meaningful examples. Students should be able to synthesize the information that they have gained via observations. They should add new information by adding information from maps, charts, diagrams, tables and other researches. They should also be able to connect with simple statistics and be able to draw conclusions.

The analysis of geographical information includes researching and relating facts, events and occurrences. Students analyze and comment on events and problems. Students can then synthesize their own observations. By using simple statistics, they can show trends, associations, and frequencies and have information about them. Sometimes it is difficult to separate the activities of organizing and analyzing geographic information from each other. But, it is possible to master knowledge of raw information by analyzing the information. Additionally, students need to carefully examine the maps to understand and compare spatial concepts and relationships (MacBeath 1997).

6. Steps to Answering Geographical Questions:

A successful geographical survey should be based on compiled, organized, and analyzed knowledge and should result in a development of generalization skill. Geographical skills should be used to be able to respond to geographical questions and information should be graphically presented, based on organized information, orally or written. Firstly, interpretations, tables, graphics and maps should be interpreted to separate the necessary and non-essential information for answering. Then, the answers are prepared for the questions in the light of the information.

Geographic generalization can also be done through thinking or deduction. Thinking enhances students' ability to synthesize geographical knowledge, answer questions and enrich the debate. It includes geographic generalization, induction and deduction processes. Students use the induction approach to synthesize geographical knowledge, answer questions and arrive at results. Thinking through deductive reasoning is about identifying questions, evaluating and collecting evidence about the topic, and using them again outside the school world.

A Lesson Plan for Geographical Thinking Skills Approaches in Geography Courses

1. Purpose of Lesson

Provide knowledge about distribution of population

2. What do learners know at the end of the course?

1. Distribution of population
2. Asking geographical questions about the distribution of population
3. Knowing to obtain information about population
4. Organizing geographic information
5. Analyzing the information about the distribution of the population and answer the geographical questions

Preparation / First Step: Students are required to ask geographical questions. For this, students need to

1. Read the text
2. Review the table
3. Review the chart
4. Review the title of the map and determine the theme of the map

Second Step:

The teacher leads the students to ask geographic questions. For this, teacher says, “Now let's try to work together to prepare a geographical question about Population in the World. Firstly, we will write question sentences about "Population in the World". Let's write some sample questions brawly together.” Students use question words and they brawly prepare question. Questions that are agreed upon are written on the board. Students’ questions are expected to be similar to the following:

1. Where are the densely populated areas in the world?
2. What is the population?
3. Where are the sparsely populated areas in the world?
4. What is the relationship between population distribution and climate characteristics?
5. How is the historical development of the world population? Why is population censuses carried out?
6. What could be the negative aspects of living in densely populated areas?

Third step:

The teacher leads the students to determine ways of acquiring geographic information. For this, the teacher says, “We learned how to create geographical questions about a subject and now we will obtain information to answer these questions. We will find out the sources that provide us with information besides books. Where can we get information about a topic? Is there information only in books or else that can we constitute our own information?” And then, teacher says; “Except books, there are also different sources of information. We can find ways to answer questions which we have created.” The teacher asks, "Where can we get information about geography?" With the brainstorm technique, students should be able to share their thoughts on the sources of information. The teacher guides the students to discuss ways of gathering information about a topic. At tte end of the discussion, writing the way of gathering information and grouping them take place. The teacher leads the students to classify information sources as primary and secondary sources. The groupings that made are written on the board.

The teacher explains the primary and secondary sources of information to the students with examples. Students prepare a few interview questions. Then, at the end of the discussion they write the interview questions and group them.

Fourth step:

The teacher helps students to sort questions according to the way they collect information and organize them according to each source of information. For this, the teacher says that “now we will classify the sources of information for the questions we have prepared and let's think about the sources of information with a question and write alongside it.” Firstly, students do this individually in their notebooks. Geographical questions and knowledge sources include the followings;

1. Where are the densely populated areas in the world? (*Map, book, internet*)
2. What is the population? (*Book, internet*)
3. Where are the sparsely populated areas in the world? (*Map, book, internet, table*)

4. What is the relationship between population distribution and climate characteristics? (*Map, book, encyclopaedia*)
5. How is the historical development of the world population? (*Book, internet, encyclopaedia, table*)
6. Why is population censuses carried out? (*Book, internet, graph, table*)
7. What could be the negative aspects of living in densely populated areas? (*Book, internet, encyclopaedia, interview, observation*)

Fifth step:

Providing students with information about geographical questions and ways of obtaining information. The teacher says, "Let's examine the Population Map of World Countries and try to explain the information by looking at the legend. This map gives us some numerical information. The legend on the lower left corner of the map will help you to obtain information from the map. What do these colors mean? What do you say? Let's guess the population of each country now by matching the numbers mentioned with these colors to the countries." And then, students use the map to write the population of countries and comparing the estimates of the countries' population by looking at maps.

Teacher says, "now let's examine World Physical Map, World Rainfall Dispersion Map and World Climate Map. Let's try to relate these three maps; is there a relationship between the distribution of the population, the forms of the earth and the distribution of the rainfall? What do you say about it?" Students direct questions to texts, maps, tables and graphs and write a brief summary of information.

Sixth Step:

The teacher helps organize the information that the students get from different sources. The teacher says the students that "we will organize the information we gathered together the information we have gained in the last few lessons. First, we will learn the ways to show numerical information with tables and graphs." For this, the teacher asks each student to open a Microsoft Excel spreadsheet on the computer. Numerical data is entered in the Excel sheet. It is expected from the students that they should create the table.

The teacher helps students transform the information they have gained from the tables into a column chart. Students summarize the collected information that is obtained from internet, books and other written sources. Students are asked to organize all the information as composition.

Seventh Step:

The teacher leads the students to analyze the geographical information and to answer the geographical questions. For this, the teacher says, "We will now examine the information which we gained from different sources and use that information to develop relationships. Then, we will try to give answers to the questions that we created initially". Students firstly examine the information individually.

The geographical questions which are created in the first step are written on the board. The teacher uses the discussion method and students are provided with the opportunity to find answers to each question.

Eighth Step:

Students should be able to provide the answers for a map and text. The teacher leads the students to check the answers whether it is correct or not. Students map the information that organized by them. There are two ways to do this. By using a paint program on computer or using an empty World Map. The teacher leads the students to analyze the geographical information and to answer the geographical questions.

CONCLUSION

A qualified geography education is only possible if the purposes of the lesson are achieved. In achieving these goals which the skills gained in the school should be linked to their daily lives by the students.

Geographical thinking skills approach can be used to improve academic success in geography courses and to ensure the permanence of the learners. As it can be clearly understood from the nature of geography, in lessons more emphasis should be given on the ways in which students will be able to question and think about events.

This study was developed as a lesson plan which is an example of the application of geographical thinking skills in geography lessons. In this study, it is explained which routes to follow at each step in detail. New plans can be developed at each class level by using this plan. It is important that students at all levels of the geography course be actively involved in learning activities at various levels. By using these activities in geography lessons, geography can be a practical course. Thus, geography classes can get out of from the classroom environment and take the place of real life.

Students can be able to create their own knowledge with the application of the five-step geographical thinking skills. Geographical thinking skills are a versatile approach that can be used in conjunction with other teaching and learning approaches.

REFERENCES

Downs, M. R. (1994). The need for research in geography education: It would be nice to have some data. *Journal of Geography*, 93 (1), 57-60.

Barth, J. and Demirtas, A. (1997). Ilkogretim Sosyal Bilgiler Oğretimi. Ankara: YOK Dunya Bankasi Milli Egitimi Gelistirme Projesi.

ESRI, (2003). Geographic Inquiry: Thinking Geographically. Retrieved November 3, 2016 from http://www.esri.com/industries/k-12/education/~/media/files/pdfs/industries/k-12/pdfs/geoginquiry.pdf

Fisher, C., & Binns, T. (Eds.). (2016). Issues in geography teaching. Routledge.

Harvey, D. (1969). Explanation in geography, Londra. Retrieved February 14, 2017 from http://www.enchantedlearning.com/geography/mapreading/1.shtml.

Geography Education Standards Project. 1994. *Geography for Life: National Geography Standards 1994.*, Washington: National Geographic Research and Exploration.

Gersmehl, C. A; Gersmehl, P. J. (2007). Spatial thinking by young children: neurologic evidence for early development and educability. *Journal of Geography*, Retrieved February 10, 2017 from http://www.informaworld.com/smpp/title~content=t770943818~db=all~tab=issueslist~branches=106 - v106.

Jackson, P. (2006). Thinking Geographically, *Geography*, 91, 3, pp 199-204.

Graves NJ (1980). Geography in Education (2nd Edition), London: Heinemann Educational Books

Thomas, P. G. (2001). An Analysis of The Geographic Knowledge of Preservice Teachers at Selected Midwestern Universities. (unpublished phd thesis). Kansas State University. Kansas.

Tümertekin, E. and Özgüç, N. (2002), Beşeri Coğrafya İnsan, Kültür, Mekan, Çantay Kitabevi, İstanbul.

Newman, M. an. O-Neill-Jones, P. (2016). Integrating historical and geographical thinking. *The TPS Journal,* Vol. 8, No. 1, Spring.

CONTENT ANALYSIS OF THE TURKISH COURSEBOOKS FOR PRE-SCHOOL CHILDREN (50-74 MONTHS-OLD)

Banu Uslu
Selcuk University, Turkey

Aysel Cagdas
Selcuk University, Turkey

ABSTRACT: In the present study, the content of the vocabularies chosen for 50-74 months-old children were determined. In this context, 3 sets of Turkish coursebooks used in private schools were chosen depending on expert opinions and examined in terms of word distribution. In these three sets, criteria were formed for content scanning based on native word categories such as; nouns, verbs, pronouns, adverbs, adjectives, conjunctions, prepositions, spoken actions/ idiomatic verbs, question words, numbers, quantifiers/ quantifiers, interjections, colors, speech phrases and reduplication. In this way, the kind of the words used in the coursebooks and their frequency were determined. The words were determined via word counting program considering their categories, and the most frequent words were determined according to the relevant age group. The results of the 50-74 months-old children's foreign language concept table and its descriptive analysis conducted by the word counting program were examined by 3 academicians from child development department and 3 teachers working with this age group. According to the analysis, it is seen that most of the coursebooks in Turkish have respectively "Nouns", "Verbs", "Pronouns" and "Adverbs". The words that are least frequent were "Quantifiers", "Interjections", "Colors", "Reduplications" and "Speech phrases".

Keywords: pre-school period, Turkish, coursebook

INTRODUCTION

The preschool period is one of the fastest periods of children's mental, physical and language development. This period covering the 0-6 years is a period in which the child acquires basic knowledge and skills, prepared for life in the very best way and learns to adjust to his or her current situation (Oktay, 1999). For this reason, it is only possible for children to be able to learn social values such as belief, culture and citizenship and apply these in their lives via internalizing, carrying to future generations, possessing the living environment and national values through eligible and qualified education (MNE, 2013).

The goals of preschool education are as follows; to develop a common educational environment to disadvantaged children, to develop skills such as communication, creativeness and critical thinking, to help children speak their mother language properly and beautifully and to prepare them for primary education (MNE, 2014).

It is a common belief that children learn a language better when they encounter with it at an early age. However, this is not accepted by all researchers. The children are very successful in learning a language but there are disagreements over whether they are better at it or not. Considering the speed of learning a language, there is no evidence in favor of children. On the contrary, it is mentioned that adults and youngsters learn faster. In numerous researches, it is mentioned that adults are disadvantaged in speaking a second language like the first one since they are not exposed to it at a very young age. In this context, it is stated that the age of adolescence is determinant, and those who acquire the language before adolescence are evaluated as better than the ones who acquire it after adolescence. At least it is obvious that children are more successful than adults in foreign language learning but you cannot come to a conclusion that adults can not learn a foreign language or will never be successful at it (Gass & Selinker, 1994).

Everything that will facilitate and provide foreign language learning is material (in addition to original materials such as newspapers, promotional brochures prepared for tourists, magazines and posters; the real objects and flash cards). There is no specific technique or activity for content-based instruction, which is considered more as an approach than a method. The most important thing that can be said for these materials and activities is that they vary according to program and everything that provides learning is called a material, and every way to fulfill learning process is called a technique (Yaprak, 2015).

While learning the mother tongue, children learn the words they need. In the school environment, teaching vocabulary considering such need is unfortunately out of question. For this reason, it is not surprising that foreign language learning can not be as successful as first language learning. Teachers have a great task in this regard.

They need to make vocabulary learning a necessity with appropriate activities. For preschool children' learning vocabulary is about learning how to pronounce the word and understand what it means. Since preschool children cannot read and write, they are not expected to do it (Bekleyen, 2016). In Life-Focused Foreign Language Acquisition Program, the child learned "to listen to" first, and after that he related what he heard and what remained in his mind to people and objects. Here, the language teacher was careful to have a clear and fluent pronunciation. The teacher made a point of drawing children's attention and gaining their appreciation with his pronunciation which sounded like a perfect melody. The effort given has been recognized by children and this effort of the teacher has returned to him as children's effort to learn something.

According to Hymes (1972), while the child is learning his native language in a natural environment he uses the language as a tool. For example, he uses the tool to ask for something or to control others' behaviors, to interact with others or to express feelings, to learn or discover something and to exchange information. When the same natural goals are set while teaching a foreign language, language acquisition will be accomplished naturally (Cited in Richards & Rodgers, 2001).

For teachers, selecting the words to be taught in language teaching is always the first and the biggest problem. Various criteria have been established in the choice of words, but the activity that is dominant throughout the process of systematic teaching of the English has always been the word choice. Vocabulary frequency is important in planning vocabulary lists for language teaching. However, frequency is not necessarily the same as usability as the frequency of words depends on the type of language samples that are analyzed. Basically, selected language samples or texts should be relevant to the needs of the students and words should be found frequently in a wide range of different language samples. Yet, it has quickly been understood that frequency and range are not basically sufficient to develop a vocabulary list, because the words in the written text often and in a wide range are not the most teachable words in the introductory language lessons. For example; words such as book, pencil, desk and teacher are not frequent but may be needed in the very beginning in language classes such as the word "class" brings to mind desk, chair and teacher so these words can therefore be referred earlier. Since 1920s-word frequency studies are popular and active in the field of language development as the vocabulary frequency and vocabulary distribution design are easy to handle on the computer. One of the most important lexical lesson programs in language teaching has been Michael West's General-Purpose English Words List, which includes a list of 2,000 general words that are considered as basically suitable for learning English as a foreign language. The General-Purpose Word List has been a standard reference for decades for deciding which words to use in textbooks, in step-by-step reading books and in other teaching materials. Hindmarsh is another important word list and contains 4,500 words grouped in 7 levels (Richards, 2001).

Language teaching is being able to understand the structure of the language, recognizing its rules behind it and using it correctly. For this reason, language teaching is possible with a well-planned teaching program, equipped with rich materials and with teachers who can use and conduct them in the very best way. Instead of considering the foreign language as a barrier to mother tongue, we should focus on its benefits and keep on mind that learning a foreign language helps us not only to understand our native language better but also increases our awareness of our mother tongue while acquiring. The sound basis and structure of native language and the rich vocabulary support learning another language. It is difficult, even impossible, to learn something in another language if the learner does not know it in his native language (Gass and Selinker, 1994).

In general, within the researches carried out up to now, three different variables were used to measure the content of a native language book. These are; the number of syllables (averages), the number of words and sentences (averages). Among these variables, many different proportional values were determined by the researchers. Goldbort (2001) used the following variables in a text; the number of sentences, words and syllables.

There are two important principles in native language books regarding content:

a. Grammatical principles: Includes principles such as the choice and the type of words used in children's books, the numbers of the letters and syllables and the length of the sentences used.
b. Educational principles: The choice of content, to be interesting to learners, to give educational messages, to be appropriate to student's level, etc.

The present study is more of a linguistic knowledge one. The type, number and length of the words used are discussed extensively.

Native (Turkish) language textbooks should be studied very carefully in terms of both the language used and the narrative features. Books that are written correctly and properly and according to the developmental characteristics of the children are very important in acquiring native language consciousness. The concepts and rules used are important in conveying and acquiring the richness of the native language to the students. For this reason, the present study will contribute to those who are writing children books and those who are teaching young learners with a criterion-based approach. Within this scope, answers to the following questions were sought:

1. What is the distribution of the “Words” in 50-74 moths-old children’s Turkish language books?
2. What is the distribution of “Nouns” in the books by age?
3. What is the distribution of the “Verbs” in the books by age?
4. What is the distribution of the “Adjectives” in the books by age?
5. What is the distribution of the “Adverbs” in the books by age?

METHOD

In the present study, the content analysis of 50-74 months-old children’s native language course books in Turkey was done and for this reason, the research was carried out in descriptive survey model. Document review method from qualitative research approach was used. "Survey models are research approaches that aim to describe an existing situation in the past or at present in the way it existed or exists. The event, the individual or the object that is subject to the research is tried to be defined in its own conditions" (Karasar, 2011). Methods such as observation, interview and document analysis are used in qualitative researches in data gathering; perceptions and events are examined and revealed in a natural and realistic manner (Yıldırım and Şimşek, 2011). Document analysis includes analysis of written materials that contains information about the facts or events to be examined (Yıldırım and Şimşek, 2011). "It can be done in five major stages: 1. Accessing the documents, 2. Controlling the originality, 3. Understanding the documents, 4. Analyzing the data and 5. Using the data" (Foster, 1995, qtd. Yıldırım ve Şimşek, 2011: 193).

In this context, the books used were examined in terms of word distribution. Based on expert opinions, for 4-year-olds 12 books, for 5-year-olds 25 books and for 6-year-olds 23 books were determined. The books include also the publications of Ministery of National Education for this age group. In the sets, criteria were drawn based on expert opinions for content scanning. These criteria are based on the main word categories. These are; nouns, verbs, pronouns, adverbs, adjectives, conjunctions, prepositions, spoken actions, question words, numbers, quantifiers, interjections, colors. In this way, it has been tried to be determined which words are used in the books regarding the categories and how often these words are used. Considering the categories, the words were loaded on the word counting program and the most relevant and frequent words have been identified for each age group. The documents were analyzed in the following four steps, which were specified by Yıldırım and Şimşek (2011) Selecting the verbal sample to be analyzed, 2) Developing the categories, 3) Determining the analysis unit and 4) Digitizing.

The results of the 50-74 months-old children’s foreign language concept table and descriptive analysis conducted by the word counting program were examined by 3 academicians from preschool and child development departments and 3 preschool teachers working in these age groups. In the evaluation of the expert opinions, the rate of the content validity of each book was calculated. Then, the content validity index was determined by taking the average of the calculated content validity ratios (Başol et al 2008, Çepni et al., 2009; Yurdagül, 2005). The content validity of the results obtained in the descriptive analyzes was found to be 0.79.

FINDINGS

Table 1. The Range of the Words in 50-74 Months-old Children’s Course books

Word range	Total Word Number	F	The Number of Books	Average Word Number
NOUNS	3274	21340	60	355.6
VERBS	1060	12361	60	206.1
ADJECTIVES	553	3489	60	58.2
ADVERBS	343	1403	60	23.4

When the books are examined in whole, the average number of nouns per book was found as 355.6. This number was 206.1 for verbs, 58.2 for the adjectives and 23.4 for the adverbs. Besides, it is also seen that 3274 nouns were repeated 21340 times, 1060 verbs were repeated 12361 times, 553 adjectives were repeated 3489 times, and 343 adverbs were repeated 1403. It has been observed that about 90% of the words are composed of noun and verb constructions.

Table 2. The Range of the Nouns in 50-74 Months-old Children's Course books by Age Group

NOUNS	Word Type	Total Word Number	The number of Books	Average Word Number
AGE 4	518	2590	12	215.83
AGE 5	1206	7230	25	289.2
AGE 6	1550	11520	23	500.87

In Table 2, the range of nouns in the books are examined according to children's age groups. According to this, there is an average of 215.83 nouns in the 4-year-old group, 289.2 nouns in the 5-year-old group and a 500.87 noun in the 6-year-old group. In the books of age groups 4 and 5, the number of the nouns was close, but in age 6 the number of the nouns is doubled.

Table 3. The Most Frequet Nouns Used in The Books by Age Groups

AGE 4	F	%	AGE 5	F	%	AGE 6	F	%
Benekli	135	5.21%	Circle	181	2.50%	Picture	607	5.27%
Child	71	2.74%	Picture	159	2.20%	Color	419	3.64%
Page	63	2.43%	Sound	153	2.11%	Circle	261	2.26%
Picture	59	2.28%	Line	147	2.03%	Number	255	2.21%
Book	55	2.12%	Animal	146	2.02%	Line	191	1.66%
Piece	54	2.08%	Page	129	1.78%	Piece	189	1.64%
Color	51	1.97%	Child	129	1.78%	Digit	187	1.62%
Sticker	45	1.74%	Number	115	1.59%	Name	163	1.41%
Activity	42	1.62%	Box	113	1.56%	Being	155	1.35%
Ali	40	1.54%	There's/There're	110	1.52%	Box	151	1.31%

The 10 most frequently repeated nouns in the books examined are described in Table 3 by age groups. According to the document analysis, the most repetitive noun in the 4-year-old group was dotted, in 5-year-old it was circle and in 6-year-old it was picture. In all three age groups, the concepts of color and picture were the most repeated names.

Table 4. The Range of Verbs in the Books in terms of Age Group

VERBS	Word Type	Total Word Number	The Number of Books	Average Word Number
AGE 4	219	1367	12	113.92
AGE 5	423	4372	25	174.88
AGE 6	418	6622	23	287.91

In Table 4, the range of the verbs in the books was examined according to children's age groups. According to this, there were 113.92 verbs words per book in group age 4, 174.88 in 5-year-old group and 287.91 verbs in 6-year-old group. There are two important situations that stand out in table 4. The number of verbs is two times more in age group 6 compared to age group 4.

Table 5. The Range of Verbs in the Books in terms of Age Group

AGE 4	F	%	AGE 5	F	%	AGE 6	F	%
To say	95	6.95%	To be	337	7.71%	To color	642	9.69%
To draw	73	5.34%	To get	254	5.81%	To be	503	7.60%
To color	72	5.27%	To color	215	4.92%	To say	462	6.98%
To be	62	4.54%	To say	183	4.19%	To look	322	4.86%

To stick	47	3.44%	To circle	180	4.12%	To draw	320	4.83%
To do/make	46	3.37%	To put together	169	3.87%	To complete	225	3.40%
To love	41	3.00%	To draw	142	3.25%	To put together	200	3.02%
To see	41	3.00%	To complete	123	2.81%	To get	195	2.94%
To want	39	2.85%	To count	110	2.52%	To find	190	2.87%
To show	37	2.71%	To do/make	102	2.33%	To do/make	177	2.67%

The 10 most frequent verbs found in the books that were examined are described by age groups in Table 5. According to analyzes carried out, the most repetitive verb in the 4-year-old group was the verb "say", in 5-year-old group it was "to be" and in 6-year-old group it was "to color". In all three age groups, similar verbs were found to be intense. However, the verb "love" found in the 4-year-old group was not found in the other age groups. On the other hand, among the first ten words in age groups 5 and 6, such as "get/take", "complete" and "combine" were not very common in 4-year-old group.

Table 6. The Range of Adjectives in the Books in terms of Age Group

ADJECTIVES	Word Type	Total Word Number	The Number of Books	Average Word Number
AGE 4	116	393	12	32,75
AGE 5	196	1283	25	51,32
AGE 6	241	1813	23	78,83

The range of adjectives in the books that are examined according to age groups are given in Table 6. It is seen that age group 4 had 32.75 adjectives per book, age group 5 had 51.92 and age group 6 had 79.83. When age groups 4 and 6 are compared, the number of words in the upper age group was twice more.

Table 7. The Range of Adjectives in the Books in terms of Age Group

AGE 4	F	%	AGE 5	F	%	AGE 6	F	%
Tiny	42	10.69%	One	119	9.28%	One	148	8.16%
This	28	7.12%	Related	112	8.73%	This	70	3.86%
Empty	24	6.11%	This	69	5.38%	Off	70	3.86%
One	18	4.58%	Off	69	5.38%	Same	64	3.53%
Big	16	4.07%	Every	61	4.75%	Empty	64	3.53%
Very	14	3.56%	Upper	41	3.20%	Very	61	3.36%
Beautiful	11	2.80%	Same	34	2.65%	Suitable	60	3.31%
Colorful	11	2.80%	Different	33	2.57%	True/correct	52	2.87%
Little	10	2.54%	Big	32	2.49%	Every	52	2.87%
Short	9	2.29%	Small	32	2.49%	Related	39	2.15%

The 10 most frequent adjectives found in the books were analyzed by age groups in Table 7. According to analyzes, the most repetitive adjective in age group 4 was "tiny" and in age groups 5 and 6 it was "one". Similar adjectives were found in all age groups. However, the adjectives seen in 4-year-old group such as beautiful, colorful and short were not among the first ten adjectives in other age groups. On the other hand, the first ten words found in age group 5 and 6 were "cut" and "related". These adjectives were not among the first ten adjectives in age group 4.

Table 8. The Range of Adverbs in the Books in terms of Age Group

ADVERBS	Word Type	Total Word Number	The Number of Books	Average Word Number
AGE 4	43	135	12	11.25
AGE 5	142	534	25	21.36
AGE 6	158	734	23	31.91

The range of the adverbs in the books that were examined according to age groups are given in Table 8. According to this, the books in the age group 4 have an average of 11.25 adverbs, age group 5 had 21.36 and age group 6 had 31.91. When age groups are compared it is seen that the number of words found in the age group 6 is almost 3 times more.

Table 9. The Range of Adverbs in the Books in terms of Age Group

AGE 4	F	%	AGE 5	F	%	AGE 6	F	%
Many/much	27	20.15%	Very	64	11.99%	In	90	12.26%
Now	14	10.45%	Many/much	54	10.11%	Very	66	8.99%
After	9	6.72%	More	37	6.93%	More	51	6.95%
Very	8	5.97%	After	34	6.37%	Many/much	33	4.50%
More	8	5.97%	Above	18	3.37%	Into	32	4.36%
First	7	5.22%	First	17	3.18%	Together	28	3.81%
Together	6	4.48%	Sometimes	16	3.00%	After	26	3.54%
Towards	4	2.99%	Together	15	2.81%	About	25	3.41%
No longer	4	2.99%	Now	11	2.06%	Above	19	2.59%
Afterwards	4	2.99%	Never	10	1.87%	Along with	17	2.32%

The 10 most frequently repeated adverbs found in the books that are analyzed by age groups are examined in Table 9. According to analyzes, the most repetitive adverb in age group 4 was the “much/many” for age group 5 “most” and for age group 6 it was “into”. It is seen that similar adjectives were found in all three age groups. However, the quality and quantity of the adverbs found in age groups 5 and 6 were more similar.

CONCLUSION AND SUGGESTIONS

According to the analysis performed via word counting program, it is seen that in Turkish books for preschool children "Nouns" are the most frequent words, then comes the "verbs", "pronouns" and "adverbs”. The words that were least frequent were "Quantifiers", "Interjections", "Colors", "Reduplications" and "Speech phrases". Repetition of words is an important factor in vocabulary teaching and also in its development. Anılan and Genç (2011) stated in their research that there should be frequent repetitions in vocabulary teaching but this was not taken into consideration in the books. From this point of view, similar nouns, verbs, adjectives and adverbs were used intensively in all three age groups in the pre-school period. Based on the findings, the suggestions given are as follows;

1) Recognition of the words to be given during preschool period should be accepted as a general principle, and the textbooks and curricula can be prepared accordingly.
2) Determination of words based on expert opinions in mother tongue will bring positive contributions to children’s learning process.
3) A list of vocabulary, which should be taught according to age groups or classes can be specified. Course books in the preschool period may consist of the words in this list.
4) No matter which age group it is, the books on language teaching should aim to acquire a certain vocabulary, and to do this first of all, by taking into consideration the child's needs, immediate and the cultural environment effective vocabulary must be determined correctly.
5) In the follow-up studies, it is possible to examine whether the words in the course books are appropriate with children's readiness or not, especially in preschool period.
6) The opinions of the teachers and experts on the appropriateness of the words can be examined.

7) Experimental studies may be conducted to test the effectiveness of curriculums based on children's everyday words.

ACKNOWLEDGEMENTS

The present article is derived from the first author's PhD thesis with the title "The Study of the Effects of Life-Focused Language Acquisition Program on 50-74 Months Old Turkish Children's English Learning"

The present study is financially supported by Selçuk University Coordinatorship of Scientific Research Projects (BAP) with the Project number 16102002.

This paper was presented orally at the International Conference on Research in Education and Science (ICRES) which was held in Ephesus Kusadası, Turkey between 18th – 21st May, 2017.

REFERENCES

Anılan, H. ve Genç, B. (2011). Usage of New words learned in Turkish classes in written narratives. *Ahi Evran University Faculty of Education Journal,* 12(1), 111-132.

Bekleyen, N. (2016). *Teaching Foreign language to children.* Ankara: Anı Publishing.

Felsch, Rudolf (2001). *How To Write English: Let's Start with the Formula*. www.mang.canterbury.ac.nz/courseinfo/AcademicWriting/Flesch .htm

Fry, Edward B.(1988) Writeability: The Prenciples of Writing for Increased Comprehension, Editors: B.Zakaluk, S Jay Samuels. International Reading Assocation Inc.

Gass, S. M., Selinker, L. (1994). *Second language acquisition: An introductory course*. Lawrence Erlbaum Associates, Inc. USA.

Goldbord, Robert. (2001). Readable Writing By Scientists and Researchers. Journal of Environmental Healty, Vol.63, Issue 8, P.40-42

MEB. (2013). *Pre-school education program.* Ankara: MNE Publications.

MEB. (2014). *Pre-school education program*. Ankara: MNE Publications.

Richards, J. C. (2001). *Curriculum development in language teaching*. Cambridge University Press, USA.

Richards, J. C., Rodgers, T. S. (2001). *Approaches and methods in language teaching* (2nd edition). Cambridge University Press.

Temur, T. (2003). Readability concept. *TÜBAR Journal*, XIII, 170-180.

Yaprak, Z. (2015). *Language teaching. Content based instruction / content and language integrated learning.* (Editor: Nilüfer Bekleyen). PEGEM Academy: Ankara.

LANGUAGE TEACHING CURRICULUM OF TURKEY AND SINGAPORE IN THE CONTEXT OF READING-WRITING ACQUISITIONS

Esra Ay Karacuha
Ministiry of National Education, Turkey

Ahmet Cebi
Ondokuz Mayıs University, Turkey

ABSTRACT: When examining the results of PISA of 2015 published by the OECD late in 2016, the average point of 72 participanting countries in reading performance is seen to be 493. Out of 72 participant countries, Turkey ranked 50th in reading skills with 428 points, 65 points below the average point 493, and Singapore ranked 1st in reading skills with 535 points, 42 points above the average point 493. Between Turkey on the 50th rank in reading skills out of 72 countries and Singapore on the 1st rank, there is a 107-point difference, a very big difference not possible to overlook. Undoubtedly, there are many factors for emergence of this situation. One of the primary ones, which are frequently repeated by the mass media in many places, is selecting and training the preservice teachers of these two countries, and the positions of their teachers. A factor, which is not emphasized much, more precisely, is not emphasized at all, the properties which language educational programs of both countries have within the context of reading-writing achievements. It can be understood by considering the results of PISA of 2012 that this factor not emphasized at all is as important as the factor widely emphasized. When examining the results of PISA of 2012, it is seen that the average point of 65 participant countries is 496 in reading performance. Out of 65 participant countries, Turkey ranked 42nd in reading performance with 475 points and Singapore ranked 3rd in reading skills with 542 points. There is a 67-point difference between Turkey on the 42nd rank and Singapore on the 3rd rank in reading skills. When it comes to 2015 from 2012; while Singapore held more or less its rank in reading skills, a very big decrease occurred in reading skills of Turkey. One primary reason for this is that the language educational program, which was put into practice in Turkey in 2005, requires an early reading-writing method called "Sound Based Sentence Method" within the context of synthesis approach. In the present study here, the language educational programs of both countries should be compared within the context of reading-writing achievements and it should be tried to interpret the PISA results in this regard.

Keywords: Reading Achievements, Writing Achievements, PISA of 2012 Reading Performance, PISA of 2015 Reading Performance, Language Educational Programs

INTRODUCTION

The Singapore education system draws attention due to Singapore's achievements in PISA examinations that OECD prepared and applied over the last years. From Singapore's first years of independence, intensive studies have been conducted on extending basic education between 1959 and 1978. Schools were built rapidly and teachers were appointed on a large scale. A bi-lingual education system that is single and national and that teaches English and native language (Chinese, Malay and Tamil) to students was established instead of schools previously established for ethnic origins (OECD, 2016).

In Singapore, Principals Handbook that is a comprehensive reference book on situations such as the operation of schools, guidance services and so on was published by the Ministry of Education in 1981 (Wee and Chong, 1990). Furthermore, the Ministry of Education was reorganized to improve educational policies in schools and to better coordinate standardized practice. In addition to these, Curriculum Development Institute of Singapore (CDIS) was established to provide teachers with developed locally and standardized curriculum materials (Pak Tee Ng, 2008).

In 1991, Primary Education Improvement Report (MOE, 1991) recommended that all children should be educated for at least ten years. Primary School Leaving Examination (PSLE) was changed to a form of placement rather than an examination to direct children to appropriate fields at secondary level. In the same year, it was decided that expenditures on education within Edusave Program for every child between 6 and 16 years of age would be covered (Pak Tee Ng, 2008).

In Singapore, a new educational philosophy called "Thinking Schools, Learning Nation" (TSLN) was developed in 1997; it is aimed to develop creative and critical thinking skills and passion for lifelong learning instead of only giving information to students with the philosophy of "Thinking Schools" (Koh, 2004). In order to achieve these goals, curriculum was organized to make more space for research-based activities. It was tried to ensure that teachers spend more time with students in planning active learning activities collaboratively. Furthermore, significant investment in information and communication technology (ICT) facilitated the emergence of new learning styles. All these efforts accelerated the formation of an open and cooperative school environment in the context of a culture of continuous development (OECD, 2016).

The momentum gained from the vision of TSLN, led to the development of a framework for 21st Century Competencies and Student Outcomes. This framework expresses the basic competencies and values that enable young Singaporeans to develop in the 21st century (MOE, 2014). 21st Century Competencies framework guided the development of course content and teaching materials. Schools also use this framework to design programs that will help students improve their competencies (OECD, 2016).

Today, all children in Singapore start primary school education at the age of 7 (at least 84 months old). However, at the end of primary school 6, students took an examination, Primary School Leaving Examination (PSLE), to go to a secondary school that matches their learning speeds, competencies and tendencies (OECD, 2016).

In 1924, an *Elifba Congress* (Alphabet Congress) was held in Istanbul in order to address the first *reading and writing* problem, with the initiative of Istanbul Ministry of Education Director Saffet Bey. In the Congress, the *word method* within the analysis *approach* was focused on the suggestion of Sadrettin Celal, the teacher of Daru'l-fünun (Ottoman University). On the other hand, Satı Bey defended the method of sound "usul-i savti". Discussion of the *word method-sound method* in the congress continued (Çebi, 2011).

In 1924 First Schools Curriculum Program, which have characteristics of being the first Curriculum specific to Republic, the teachers are given freedom to make a choice between *the word method* within the context of *the analysis method* and *the sound method* within the context of *synthesis approach* and to apply them in the light of discussions in Elifba Congress (Cebi, 2011).

Synthesis approach and methods were excluded from the curriculum in 1926 *First Schools Curriculum Program*. 1926 Curriculum left teachers the choice between *the word method* and *mixed method.* In 1928, New Turkish letters that meet the phonetic characteristics of Turkish were accepted instead of the Arabic letters (Çebi, 2011).

In the section on the first reading and writing of 1936 curriculum, *synthetic analysis method* is included. *1936 Primary School Program* left teachers the choice by offering *the word method* and *the sentence method* options within the context of *synthetic analysis approach* (Çebi, 2011).

Synthetic analysis approach was made clear with the clarification made in 1948 *Primary School Program*. "The first reading and writing will begin with simple sentence and words. Over time, these sentences will be divided into words, words into syllables and syllables into letters; New sentences and words will be formed with the word, syllables obtained at the end of these analyses (MEB, 1948: 114). This approach in 1948 Curriculum was continued in 1962 *Primary School Program Draft* and 1968 *Primary School Program*. However, it is stated that reading and writing should start with absolute sentences instead of simple sentences and words as in 1948 Curriculum. With this narrative, 1968 curriculum blocked teacher to choice method. 1982 Elementary Schools Turkish Education Program requires the sentence method as curriculum dated 1968 (Çebi, 2011).

Singapore firstly attended to PISA examinations in 2009. Considering 2015 PISA results published and explained by OECD towards the end of 2016, it is seen that the average score of OECD countries in the field of reading skills is 493. Turkey is ranked 50th among 72 participating countries with 428 scores, 65 scores lower than the average of 493 in reading skills; Singapore is ranked 1st among 72 participating countries with 535 scores, 42 scores more than 493 of OECD average in reading skills.

In the field of reading skills, there is a non-negligible difference of 107 scores between Turkey ranked 50th and Singapore ranked first among 72 countries. There are, of course, many factors in the occurrence of this situation. One of the most prominent of these, which is repeated frequently in many places through the mass media, is the election of the teacher candidates of these two countries, their training and their teachers' positions. An unregarded factor is the features of language education curriculum in the context of reading-writing acquisitions of both countries.

It is understandable that unregarded factor is also important in the extent of very common factor, considering the results of 2012 PISA. Considering 2012 PISA results, it is seen that the average score of 65 participating countries is 496 in the field of reading skills. Turkey is ranked 42nd among 65 participating countries with 475 scores in reading skills; Singapore is ranked 3rd among 65 participating countries with 542 scores in reading skills. There is a difference of 67 scores between Turkey ranked 42nd and Singapore ranked 3rd among 65 countries in reading skills.

From 2012 to 2015, while Singapore maintains its place in reading skills; Turkey's reading skills showed a great decline. The most prominent reason for this is the necessity for reading and writing method such as "phonovisual method", which is named "sound based method" in the first reading and writing field of language curriculum implemented in Turkey, in 2005.

In the acquisition of first reading-writing skills for students, teaching approach and the choice of the method in the context of that approach are recognized as "great debate" (Shapiro & Riley, 1989) and "reading wars" (Kim, 2008) in many important sources referred to historical process in relation to the subject, and it is focused on differentiation from "parts to the whole" and "the whole to parts", the former was sometimes defended and brought into the forefront (Dehaene, 2009), and sometimes it was developed an attitude towards the latter. However, a very serious recent scientific study (Glezer and other, 2015) revealed new findings in favor of the latter.

Competences dealt in PISA in reading skills range from simple analysis of a word to vocabulary knowledge, grammar, knowing linguistic and textual structure and properties, having knowledge of the world we live. In PISA 2009, reading skills are defined as acquiring personal targets, increasing knowledge and potential that a person has in a particular context, being a participant in society and understanding written texts, using, reflecting on and engaging with written texts (OECD, 2010).

The General Characteristics of PISA 2009 Reading Skill Assessment Framework were formulated in the OECD report as follows:

TEXT →	TEXT PRESENTATION: Text how is it written? →	- Written - Electronic
	TEXT RESTRICTIONS →	- Single Writer - Message-Focused
	TEXT TYPE: How is the text presented? →	- Recipient Text (Sentence) - Independent Text (List) - Mixed Text (Both) -Multiple Text (Bringing together multiple sources)
	TEXT TYPE: What is literary structure? →	- Description (usually responds to ''what'' question) -The story (usually responds to ''what'' question) -Explanation (usually responds to ''how" question) -Discussion (usually responds to ''why "question) -Directives (includes instructions)

READER'S APPROACH TO TEXT: What is the reader's purpose of reading the text and what is his/her approach? →	REACHING INFORMATION AND REMINDING INFORMATION BRINGING INFORMATION TOGETHER AND INTERPRETING REFLECTION HIS/HER OWN THOUGHTS AND ASSESSMENT: Independent of the text association of the text with

		personal experience
INTENDED USES:	→	PERSONAL: To meet his/her own interests
According to the writer's point of view,		PUBLIC: What is the text addressed to large masses
written for?		TRAINER: Used in the guidelines
		PROFESSIONAL: On the business world (EARGED,2010)

In this study, Singapore and Turkey's language teaching curriculum were compared in terms of reading-writing acquisitions, and PISA reading acquisition (performance) was tried to be revealed in detail by considering evaluation criteria.

Purpose

The purpose of this study is to compare 1981, 2005, 2015 Turkey's Turkish curriculum (MEB, 1981, 2005, 2015) and 2001, 2010 Singapore's English curriculum (MOE 2001, 2010) by correlating PISA results in the context of the five variables related to reading-writing acquisitions. These variables are: (1) Reading-Writing Approach and Method, (2) Font Type Used to Learn Writing, (3) Using Reading-Writing Tools, (4) Reading-Writing Preparation and (5) Acquiring Reading-Writing during the Process For the above purpose, the answers to the following questions were searched, respectively:

1. What kind of view do 1981, 2005, 2015 Turkey's Turkish Curriculum and 2001, 2010 Singapore's English Curriculum reveal in terms of Reading-Writing Approach and Method variables?
2. What kind of view do 1981, 2005, 2015 Turkey's Turkish Curriculum and 2001, 2010 Singapore's English Curriculum reveal in terms of Reading-Writing Approach and Method variables?
3. What kind of view do 1981, 2005, 2015 Turkey's Turkish Curriculum and 2001, 2010 Singapore's English Curriculum reveal in terms of Reading-Writing Using variables?
4. What kind of view do 1981, 2005, 2015 Turkey's Turkish Curriculum and 2001, 2010 Singapore's English Curriculum reveal in terms of Reading-Writing Preparation variables?
5. What kind of view do 1981, 2005, 2015 Turkey's Turkish Curriculum and 2001, 2010 Singapore's English Curriculum reveal in terms of Reading-Writing Acquisition variables during Process?

The questions for which the answers were searched, based on three sub-variable of fifth variable:

5.1. What kind of view do 1981, 2005, 2015 Turkey's Turkish Curriculum and 2001, 2010 Singapore's English Curriculum reveal in terms of sub-variable for Correlating Reading-Writing Process with Life?
5.2. What kind of view do 1981, 2005, 2015 Turkey's Turkish Curriculum and 2001, 2010 Singapore's English Curriculum reveal in terms of sub-variable for Improving Vocabulary During Reading-Writing Process?
5.3. What kind of view do 1981, 2005, 2015 Turkey's Turkish Curriculum and 2001, 2010 Singapore's English Curriculum reveal in terms of sub-variable for Performing Reading-Writing Process in the context of Interaction?

METHOD

Curriculum in studies of education, are of particular importance because they are official public records and it removes a scientific concern that has emerged as a very important problematic for the qualitative researcher and a concern whether the documents were acquired from the primary source (Meriam, 2009).

In this study, document review method that is one of the three basic methods of collecting information was used for qualitative research. Documents can be classified in a variety of formats. The documents subject to this study, as mentioned, are official public records. The curriculum in the research are the documents prepared by the Ministries of Education in Singapore and Turkey.

In this study, it was applied to a document review method which includes Reading and Writing Approach and Method determined as a result of the screening of some basic application sources (Cheek and others, 1989; Durkin, 1989; Heilman and others, 1990; Spache & Spache, 1986;) about the first reading and writing teaching literature, The Type of Writing Used to Learn to Write, Using Reading-Writing Tools, Reading-Writing Preparation, the descriptive properties of five basic variable in the form of Acquiring Reading-Writing during the Process and the descriptive properties of a sub-variable within the scope of basic variables determined in the form of Acquiring Reading-Writing during the Process.

Sub-variables of the Variable for Acquiring Reading-Writing during the Process were formed as a result of measuring some key concepts obtained by scanning the literature on the first reading and writing teaching process (Beck, 1960; Çebi, 2011; Çebi ve Karaçuha, 2015, 2016; D'archy, 1973; Herrick and other, 1962); related sub-variables are listed in the study under the following names: Associating Reading-Writing Process with the Life, Developing Vocabulary During Reading-Writing Process, Performing Reading-Writing Process in the Context of Interaction

Reading-Writing Approach and Method determined in this research, Type of Writing Used to Learn Writing, Using Reading-Writing Tools, Reading-Writing Preparation, five basic variables in the form of Acquiring Reading-Writing Process were formed. These five basic variables formed by variable for Acquiring Reading-Writing During Process, Variable for Acquiring Reading-Writing During Process formed by Associating Reading-Writing Process to Life, Developing Vocabulary During Reading-Writing Process, Sub-variables for Performing Reading-Writing Process in the Context of Interaction.

Turkey's 1981, 2005, 2015 Turkish Curriculum and Singapore's 2001, 2010 English Curriculum obtained in the context of the five basic variables determined and the three sub-variables based on a basic variable other than these, were discussed in detail in the context of variables and sub-variables, and the similarities and the differences of the aforementioned Curriculum were shown by materializing with charts.

FINDINGS AND COMMENT

The following chart (Chart 1) includes the criteria of Reading-Writing Approach and Method variable for Turkey's 1981, 2005, 2015 Turkish Curriculum and Singapore's 2001, 2010 English Curriculum.

Table 1. Acquisitions of Curriculum Based on Reading-Writing Approach and Methods Variable

Reading-Writing Approach and Method			
1981 Turkey's Turkish Curriculum	**2005 2015 Turkey's Turkish Curriculum**	**2001 Singapore's English Curriculum**	**2010 Singapore's English Curriculum**
Class 1: Starts firstly reading and writing with short sentences that can be understood. -In the first reading and writing, short sentences are divided into words, words into syllable over time. - In the first reading and writing, the sounds of the letters in the syllable are detected over time. -New sentences and words are formed by the words, syllables and letters obtained at the end of analysis	**Class 1:** Reads by forming syllables from sounds, words from syllables, sentences from words. **Class 1:** Syllables, words and phrases are read fluently (2015). **Class 1:** Writes by forming syllables from sounds, words from syllables, sentences from words. **Class 1:** Forms syllables from sounds, words from syllables, sentences from words.	**Class 1:** Blend sounds of consonants and vowels to make words **Class 1:** Understand that as letters of words change, so do the sounds.	**Class 1:** Identify and differentiate among common sounds in words **Class 1:** Differentiate sounds through letter blends, segmentation, substitution and deletion Decoding through Phonics

The approach and method of the first reading and writing teaching in 1981 Turkey's Turkish curriculum was explicitly stated and the teacher was prevented from choosing the approach and method in the first reading and writing teaching. The first reading and writing approach, which is mandatory in the curriculum, is the *analysis* approach, and the method is the *sentence* method. The method and approach of the first reading and writing teaching in 2005 Turkey's Turkish Curriculum, was clearly stated as in 1981 Turkey's Turkish curriculum and the teacher was not authorized in choosing the method and approach in the same way. In 2005 Turkey's Turkish curriculum, the approach and method in 1981 Turkey's Turkish curriculum was abandoned and *synthesis approach* and "sound-based method with the own expression of the curriculum, *"phonovisual method"* in the literature was required. 2015 Turkey's Turkish curriculum is in the nature of both consecutive of 2005 Turkey's Turkish curriculum and sustainer. In 2015 Turkey's Turkish curriculum, synthesis approach and sound-based method was required.

Three of Turkey's Turkish Curriculum does not consider the teacher as competent in choosing the approach and method of the first reading and writing teaching. Furthermore, there is a base-line opposition between 1981 Turkey's Turkish Curriculum and 2005 Turkey's Turkish Curriculum in determining the approach and method of the first reading and writing teaching. The former imposed and required analysis approach and the sentence method within its scope; the latter imposed and required synthesis approach and ound method within its scope.
The children selected from the sample of Turkey for 2015 PISA applications prepared by OECD, are the children who participated in the education activities with 2005 Turkey Turkish for the first time starting from the first class. In this case, the students who participated in 2015 PISA applications in Turkey are the children who learn to read and write by using analysis method applied for the first reading and writing teaching in 2005 and the sound-based method included in this approach.

In Singapore 2001 and 2010 English curriculum, there is no such thing as any approach and method determination, approach and method enforcement in the acquisition of curriculum of approach and method to be used in the first reading and writing teaching. However, the impression we gained from the acquisitions in both curriculum as below: It is apparent that *synthesis analysis* approach and *word method* involved in this approach were suggested in the first reading and writing teaching in Singapore's curriculum. Students who participated from Singapore sample in 2009, 2012, 2015 PISA applications prepared by OECD, are the first reading and writing learners with the 2001 Singapore's English curriculum. 2001 Singapore's English curriculum has great importance in successes that Singapore achieved in these examinations.

View of *Font Type Variable Used to Learn to Write*

The following chart (Chart 2) includes the teaching criteria of Font Type Variable Used in Learning to Write for Turkey's 1981, 2005 Turkish Curriculum and Singapore's 2001, 2010 English Curriculum.

Table 2. Acquisitions of Curriculum Based on Font Type Variable Used to Learn to Write

Font Type Used to Learn to Write			
1981 Turkey's Turkish Curriculum	**2005 2015 Turkey's Turkish Curriculum**	**2001 Singapore's English Curriculum**	**2010 Singapore's English Curriculum**
Class 1: Learns upper and lower case letters in accordance with the writing principles determined by the program at the beginning of reading and writing. *[Curriculum requires font type with basic vertical letter.]*	**Class 1:** Writes adjacent italic letters according to their rules. **Class 1:** Writes all papers with adjacent italic letters. *[Curriculum requires font type with adjacent italic letter.]*	**Class 1:** Space letters, words and sentences appropriately. *[Curriculum requires font type with basic vertical letter.]*	**Class 1:** Use regular and appropriate spacing between letters, words, sentences and/ or paragraphs. *[Curriculum requires font type with basic vertical letter.]*

In 1981 Turkey's Turkish Curriculum, as can be understood from the acquisitions, basic vertical lettering was required from the font types used in learning to write. 2005 Turkey's Turkish Curriculum was separated sharply from 1981 Turkey's Turkish curriculum in this respect, adjacent italic lettering font type among font type used in learning to write. The discussions about the font type used in learning to write in Turkey since 2005 has been ongoing. In a comment made by Turkey's Minister of Education recently on Twitter, it is stated that the basic vertical lettering will be used while the writing being taught during the first reading-writing phase starting from 2017-2018 academic year. The children selected from the sample of Turkey for 2015 PISA applications prepared by OECD learned the writing by adjacent italic lettering as a mandatory.

In both Singapore 2001 and 2010 English curriculum, as understood from acquisitions, it was mandatory for basic vertical lettering for learning to write. The children selected from the sample of Turkey for 2015 PISA applications prepared by OECD learned the writing by basic vertical lettering as a mandatory. Because 2001 Singapore English curriculum, as it was clearly understood from the relevant acquisition, required the basic vertical lettering.

View of *Reading-Writing Tools Using Variable*

The following chart (Chart 3) includes the teaching criteria of Reading-Writing Tools Using Variable for Turkey's 1981, 2005, 2015 Turkish Curriculum and Singapore's 2001, 2010 English Curriculum.

Table 3. Acquisitions of Curriculum Based on Using Variable of Using Reading-Writing

Using Reading-Writing Tools			
1981 Turkey's Turkish Curriculum	**2005 2015 Turkey's Turkish Curriculum**	**2001 Singapore's English Curriculum**	**2010 Singapore's English Curriculum**
Class 1: Uses the tools and equipment necessary for reading and writing. Learns how to keep the pencil. Learns how to keep the book and notebook and how to turn the pages. Learns the techniques of how to write on the notebook with the pencil and how to delete the wrongs from the notebook.	**Class 1:** Use the book with care. **Class 1:** Pay attention to page layout and cleanliness. **Class 1:** Performs various coloring/stroking exercises using the writing materials appropriately (2015).	**Classes 1-2:** Understand and use appropriately terms relating to: - books: cover, title, author, illustrator, page number -text types e.g. fairy tale: hero, character, beginning / ending of a story -electronic books: arrows, icons -" Instructions e.g. recipes, instructions from craft books and computer programmes -" Lists e.g. shopping Narratives e.g. fairy tales, rhymes, riddles *Personal recounts e.g. oral anecdotes, diary entries -Scrapbooks	**Class 1:** Read and view a variety of reading-age-appropriate and high-interest books and texts from print and non-print sources: Poetry (e.g., rhymes, cinquains, haiku) - Personal recounts (e.g., diary entries, biographies) -Narratives (e.g., fables, historical fiction, pourquoi tales) - Procedures (e.g., recipes, directions, instruction manuals) -Information reports (e.g., project reports, fact sheets) - Factual recounts (e.g., eye-witness accounts, news bulletins) -Explanations (e.g., how something works) ° Expositions (e.g., reviews, arguments) **Class 1:** Use appropriate writing instruments (e.g., first, a pencil and then a pen)

In 1981 Turkey's Turkish Curriculum, *notebook, book, pencil, eraser* were defined as reading-writing tools in acquiring reading-writing during the process. In 2005 and 2015 Turkey's Turkish Curriculum, *notebook, book, pencil, eraser* were defined as reading-writing tools in acquiring reading-writing during the process.

2001 Singapore's English curriculum *books, stories and features (For example, Fairy tale: protagonist, characters, start/end of story etc.), electronic books, directives (For example, food definitions, directives, books on handicrafts, computer softwares, personal narratives (For example, verbal narratives, diaries, personal recordings)* were defined as reading-writing tools in acquiring reading-writing. In 2010 Singapore's English Curriculum, books and visual aids supporting them, texts in printed and unprinted sources, poems, personal records (diaries, biographies), narratives, directives, information reports, explanations, etc., pencil, pen were defined as reading-writing tools in acquiring reading-writing.

Considering the determinations in the framework of ISA reading skill assessment, we see that features such as *text presentation, text writing form, bing electronic or written, font type, literary structure of the text* are described as criteria. 2001 Singapore's English curriculum, which defines *books, stories and features*, *electronic books,* *directives, computer softwares, personal narratives* as reading-writing tools in acquiring reading-writing, is in full compliance with PISA reading skills assessment criteria in this context starting from the first class. 2015 Singapore's English curriculum defines texts as a tool and in full compliance with PISA reading skills starting from the first class, and Acquisitions in 2001 Singapore's English curriculum is more detailed than 2010 English curriculum. The text was described as a tool for reading- writing in Turkey's Turkish curriculum.

View of *Preparation Variable for Reading-Writing*

The following chart (Chart 4) includes the teaching criteria of Preparation Variable for Reading-Writing for Turkey's 1981, 2005, 2015 Turkish Curriculum and Singapore's 2001, 2010 English Curriculum.

Table 4. Acquisitions Based on Curriculum's Preparation Variable for Writing

Preparation for Reading-Writing			
1981 Turkey's Turkish Curriculum	**2005 Turkey's Turkish Curriculum**	**2001 Singapore's English Curriculum**	**2010 Singapore's English Curriculum**
1. Class: Prepares to read. Keeps understanding area of the eye wide (leaping motion) from left to right in the reading. Gets habit of passing to the bottom line at the end of the line in the reading. Grasps that writing is a way of narration. Participates in the development study of vocabulary before moving on to reading and writing. **Class 1:** Prepares to write. Draws freehand line and scratches on the page with pencil. Gets the idea of reading and writing the text on the page from top to bottom, left to right. Italic and rounded lines from top to bottom, left to right. Draws rounded lines from top to bottom, left to right.	**Class 1:** Prepares to read. (Explanation) The text to be read and a suitable seating format are determined. The distance between the book and the eye and the light level are adjusted. **Class 1:** Prepares to write. (Explanation) Seating, holding pen, bookkeeping, hand preference, line and painting exercises, free and canonical lines, tools, preparation of equipment.	**Classes 1-2:** Understand concepts about print: print is written from left to right and top to bottom, capitalisation, spacing between words, differences between letters, words and sentences.	**Class 1:** - Recognise and name the letters of the alphabet -Identify upper and lower case letters - Develop knowledge of the concepts of print: - Identify common terms relating to books (e.g., title page, author, illustrator, front/ back cover, table of contents) - Adjust directionality (e.g., from left to right, foreground to background) in accordance with the reading/ viewing text - Identify word spacing - Distinguish between letters, words and sentences on a printed page - Recognise the grammatical features of a sentence (i.e., capital letters, punctuation marks) **Class 1:** - Recognise and name the letters of the alphabet - Match letters to their corresponding sounds (i.e., the alphabetic principle) - Know the concepts of print (e.g., directionality: left to right, top to bottom of the page) - Adopt appropriate writing posture and hand grip - Position paper appropriately - Position print on a line

			-W rite from left to right and top to bottom of the page -Use regular and appropriate spacing between letters, words, sentences and/ or Paragraphs.

In 1981 Turkey's Turkish Curriculum, the direction of reading writing and the study of lines as well as the development of vocabulary were described as a preparation for reading writing in acquisitions of preparation for reading-writing. In 2005, 2015 Turkey's Turkish Curriculum, acquisitions of preparation for reading-writing are related to the physical and physiological aspects of the preparation dimension.

In acquisitions of 2001 Singapore's English curriculum, it was focused on preparation for reading-writing including acquisitions such as the direction of writing and recognizing the spacing between letters, words, and sentences, and acquisitions related to preparation for writing are not included. 2010 Singapore's English Curriculum, included acquisitions for reading writing in more detail than 2001 Curriculum by adding preparation for reading.

View on *Variable of Acquiring Reading Writing during Process*

Variable of *Acquiring Reading-Writing During Process* includes three sub-variables including (1) associating the reading-writing process with life, (2) developing the vocabulary during the reading-writing process, and (3) performing the reading-writing process in the context of interaction.

View on *Sub-Variable of Associating Reading-Writing Process with Life*

The following chart (Table 5) includes the teaching criteria *on Sub-Variable of Associating Reading-Writing Process with Life* for Turkey's 1981, 2005, 2015 Turkish native language curriculum and 1997, 2010 English Language Arts of the United States State of California.

Table 5. Acquisitions Based on Curriculum's *Sub-Variable of Associating Reading-Writing Process with Life*

Associating Reading-Writing Process with Life			
1981 Turkey's Turkish Curriculum	**2005 2015 Turkey's Turkish Curriculum**	**2001 Singapore's English Curriculum**	**2010 Singapore's English Curriculum**
Class 1: Acquires reading and writing skills in the process. Understands that first-class reading and writing activities are an integral part of the activities of this class. Realizes classroom and school life that social studies topics created natural opportunities for reading and writing.	**Classes 1-5:** Gives examples from his own life and daily life in writings. **Class 1:** Tells the people he knows, his place, the events he knows and express his thoughts and feelings about them (2015).	**Classes 1-2:** Make predictions about storyline, characters using their own experience and contextual clues.	**Class 1:** Make connections between a text and personal experiences/ real life.

1981 Turkey's Turkish Curriculum, associated reading-writing process with life by stating that Social Studies topics and the life in classroom will create natural opportunities for reading writing in Associating Reading-Writing Process with Life. 2005 Turkey's Turkish Curriculum associated language activities with life in the context of giving examples from daily life in writing; 2015 Turkey's Turkish Curriculum associated language activities with life in the context of talking about known people in narrative, known places and events.

In Singapore 2001 and 2010 English Curriculum, reading-writing process was associated with the life by including acquisitions creating associations between personal experience and texts. In reflecting and evaluating their own thoughts among PISA reading skills assessment criteria, it is mentioned the performance of association criteria of the text with the personal experiences independently from the text. Considering these evaluation criteria, it is seen that acquisitions of 2001 and 2010 Singapore's English Curriculum include the assessment criteria.

View on Sub-Variable of *Developing Vocabulary during Reading-Writing Process*

The following chart (Table 6) contains learning criteria related to Sub-Variable of Developing Vocabulary During Reading-Writing Process for Turkey's 1981, 2005, 2015 Turkish Curriculum and Singapore's 2001, 2010 English Curriculum.

Table 6. Acquisitions Based on Curriculum's Sub-Variable of Developing Vocabulary During Reading-Writing Process

Developing Vocabulary during Reading-Writing Process			
1981 Turkey's Turkish Curriculum	**2005 2015 Turkey's Turkish Curriculum**	**2001 Singapore's English Curriculum**	**2010 Singapore's English Curriculum**
Class 1: The words and sentences that are emphasized are known in stories, tales, and rhymes. **Class 1:** Writes sentences and words that they have yet learned at the same time.	**Class 1:** Uses words that they have yet learned in speeches. **Class 1:** Learns words that they do not know (2015).	**Classes 1-2:** Use grammar, punctuation and vocabulary appropriately. **Classes 1-2:** Use prior knowledge: familiar words, word association.	**Class 1:** -Age-/ year level-appropriate high-frequency words, including non-decodable words, function words and high-interest words -Frequently misspelled words (e.g., 'their', 'they're', 'there') looking up words in a dictionary (e.g., an online dictionary or the spell-check function in a word processing software)

In 1981 Turkey's Turkish Curriculum, the development of vocabulary was dealt with in the context of a whole (sentence, story, fairy tale, rhyme, etc.) in accordance with the first reading and writing teaching approach. 2005 Turkey's Turkish Curriculum includes an acquisition for using the words that the student newly learned, while 2015 Turkey's Turkish Curriculum includes an acquisition for learning a new word.

2001 Singapore's English Curriculum includes an acquisition for using preliminary knowledge in both using words and establishing a relationship between words, 2010 Singapore's English Curriculum includes acquisitions for recognizing frequently used words and using dictionary for word recognition.

"Understanding" having an important place among the assessment criteria of PISA reading skills, is a determinant that is particularly relevant to the relationship between words within the whole and the words. In this context, it is seen that one of the two most suitable curriculum for PISA reading skills assessment criteria is 1981 Turkey's Turkish curriculum and the other is 2001 Singapore English curriculum.

View on *Sub-Variable of Performing Reading-Writing Process in the context of Interaction*

The following chart (Table 7) contains learning criteria related to *Sub-Variable of Performing Reading-Writing Process in the context of Interaction* for Turkey's 1981, 2005, 2015 Turkish Curriculum and Singapore's 2001, 2010 English Curriculum.

Table 7. Acquisitions Based on Curriculum's Sub-Variable of Performing Reading-Writing Process in the Context of Interaction

Performing Reading-Writing Process in the Context of Interaction			
1981 Turkey's Turkish Curriculum	**2005 2015 Turkey's Turkish Curriculum**	**2001 Singapore's English Curriculum**	**2010 Singapore's English Curriculum**
Class 1: The teacher, along with corrections and explanations, allows children to examine their own	**Class 1:** Writes in cooperation. **Class 1:** Share what they read with others. **Class 1:** Share what they wrote (2015).	**Classes 1-2:** -Ask / talk about people, places, things -Participate in discussion - Agree / disagree at appropriate	**Class 1:** Discuss collaboratively to achieve the objective of a task, e.g., - Generate ideas (e.g., brainstorming, listing)

writings in groups of four people, to find their wrong and successful aspects and to help them.	**Class 1:** Read plain text and poems and actively participate in group reading (2015).	times - Speak in turn Learn and contribute Follow agreed upon rules for group work

1981 Turkey's Turkish Curriculum included acquisitions of group work for performing Reading-Writing Process in the Context of Interaction. 2005 and 2015 Turkey's Turkish Curriculum has acquisitions that includes cooperation and sharing, but there is no indication of how cooperation and sharing shall be performed.

2001 Singapore's English Curriculum included acquisitions of group work in detail. Singapore's 2010 English Curriculum included acquisitions required cooperative work and brainstorming.

In PISA 2009, the reading skills are emphasized that it is possible to develop potential the people has in certain areas by being a participant in society (OECD, 2010). In this context, it can be seen that 1981 Turkey's Turkish Curriculum and 2001 and 2010 Singapore's English Curriculum are compatible with this emphasis of PISA 2009.

CONCLUSION

1981 Turkey's Turkish Curriculum required the analysis approach and the sentence method within the scope of the analysis approach in the first teaching of reading and writing. 2005 and 2015 Turkey's Turkish Curriculum required the synthesis method within the scope of the synthesis method in the first reading and writing teaching. The last two and the first on, as you can see, is basically opposite to each other for the first reading and writing approach and method. However, in terms of the approach and method used in the teaching of the first reading and writing, one common feature of the three curriculum examined is to require "one approach, one method" in Turkey.

In 2001, 2010 In Singapore's English Curriculum, there is no obligation to impose "one approach, one method" in the teaching of first reading and writing. The choice of approach and method in the first reading and writing teaching is left to the teacher. However, when it is read between the lines, it is seen that both Singapore's English Curriculum proposed indirect synthesis analysis approach and the word method within the scope of the approach in the first teaching of reading and writing.

We are witnessing that 1981 Turkey's Turkish Curriculum suggests the basic vertical lettered writing in the performance of the first reading and writing teaching; 2005 and 2015 Turkey's Turkish Curriculum suggests cursive italic lettered writing. However, the Ministry of Education stated that the basic vertical lettered writing, not cursive italic lettered writing, would be used in the first reading and writing teaching during the 2017-2018 academic year.

2001, 2010 Singapore's English Curriculum suggests the basic vertical lettered writing in the first reading and writing teaching.

1981, 2005, 2015 Turkey's Turkish Curriculum list pencil, notebook, eraser, writing board etc. As the first reading and writing instruments. Although some technological instruments are addressed in curriculum, it is witnessed that ICT creates the focal point of reading and writing activities.

In 2001, 2010 Singapore's English curriculum, especially in 2001 curriculum, it is witnessed that technology is addressed in a very detailed manner in terms of tools and instruments, beyond that, ICT was made the focal point. 1981 Turkey's Turkish Curriculum discussed the preparation for writing and the preparation for reading in a very detailed way; 2005-2015 Turkey's Turkish Curriculum generally addressed the preparation for reading and writing.

In 2001 Singapore's English Curriculum, there is preparation for writing, but the preparation for reading is not mentioned. 2010 Singapore's English Curriculum, detailed both preparation for writing and the preparation for reading.

In 1981 Turkey's Turkish Curriculum, acquisition variable of reading-writing during the process are consistent with association of reading-writing with life, developing vocabulary in the reading-writing process, sub-variables of performing reading-writing process in the context of interaction and the recommendations related to PISA reading skills. In 2005-2015 Turkey's Turkish Curriculum, the same sub-variables of the same variable can hardly be mentioned in terms of their consistency with PISA reading skills.

Considering 2001-2010 Singapore's English Curriculum, it is seen that acquisition variable of reading-writing during the process are consistent with association of reading-writing with life, developing vocabulary in the reading-writing process, sub-variables of performing reading-writing process in the context of interaction and the recommendations related to PISA reading skills.

The 15-year-old students selected from the sample of Turkey for PISA in 2015, are the children who learn the first reading-writing in 2005 Turkey's Turkish Curriculum and the 15-year-old students selected from the sample of Singapore are the children who learn the first reading-writing in 2001 Singapore's English Curriculum.

REFERENCES

Beck, R. H., Walter, W. C., Kearney, N. C. (1960). *Curriculum in the modern elementary school*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Cheek, E. H., Filippo, R. F., Lindsley, J. D. (1989). *Reading for success in elementary schools*. Fort Worth, Orlando: Holt Rinehart and Winston, Inc.

Çebi, A. (2011). Tarihsel bağlamıyla Türkiye'de ilk okuma-yazma öğretimi sorunsalı. S. Sever ve diğerleri (Yay. haz.). *Cahit Kavcar Türkçe eğitimi çalıştayı* içinde (ss. 439-458). Ankara: Ankara Üniversitesi Yayınları.

Çebi, A. ve Karaçuha, E. A. (2015). Türkiye ile ABD Kaliforniya Eyaleti anadili eğitim izlencelerinde ilk okuma ve yazma öğretimi. International Journal of Languages' Education and Teaching, UDES 2015, Special issue: 28-46.

Çebi, A. ve Karaçuha, E. A. (2016). Türkiye ile ABD Teksas Eyaleti anadili eğitim izlencelerinde ilk okuma ve yazma öğretimi. in Kuram ve uygulama bağlamında Türkçe öğretimi. S. Dilidüzgün (ed.). Ankara: Anı Yayıncılık.

D'arcy, P. (1973). *Reading for meaning: Learning to read* (Vol. 1). London: Hutchinson Educational Ltd.

Dehaene, S. (2009). *Reading in the brain.* New York: Penguin Books.

Durkin, D. (1989). *Teaching them the read* (Fifth edition). Boston: Allyn and Bacon, Inc.

EARGED (2010). PISA 2009 ulusal ön raporu. Ankara: MEB Eğitim Araştırma ve Geliştirme Dairesi Başkanlığı.

Glezer, L. S., Kim, J., Rule, Josh, J., Jiang, X., and Riesenhuber, M. (2015). Adding words to the brain's visual dictionary: Novel word learning selectively sharpens orthographic representations in the VWFA.*The Journal of Neuroscience*. 35 (12): 4965-4972.

Heilman, A. W., Blair, T. R., Rupley, H. (1990). *Principles and practices of teaching reading* (Seventh edition). Columbus: Merill Publishing Company.

Herrick, V. E., Goodlad, J. I., Estvan, F. J., Eberman, P. W. (1962). *The elementary school*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Kim, J. S. (2008). Research and the reading wars, *Phi Delta Kappan*. 89 (5): 372-375.

Koh, A. (2004). Singapore education in "New Times": Global / local imperatives. *Discourse: Studies in the Cultural Politics of Education*. 25(3): 335-349.

MEB (1982). *Temeleğitim okulları Türkçe eğitim programı*. İstanbul: Milli Eğitim Basımevi.

MEB (2005). *İlköğretim Türkçe dersi öğretim programı ve kılavuzu (1-5. sınıflar)*. Ankara: Devlet Kitapları Müdürlüğü Basımevi.

MEB (2015). *Türkçe dersi (1-8. sınıflar) öğretim programı*. Ankara: Devlet Kitapları Müdürlüğü Basımevi.

Meriam, S. B. (2009). *Qualitative research: A Guide to design and implementation*. Third edition. San Fransisco, CA: John Wiley & Sons, Inc.

MOE [Ministry of Education] (1991). Primary education improvement report. Singapore: Report of the National Commission. See: www.moe.gov.np/assets/uploads/files/2049_English.pdf

MOE (2014). Information sheet of 21st century competencies. https://www.moe.gov.sg/education/education-system/21st-century-competencies

OECD (2010). PISA 2009 results: Executive summary. https://www.oecd.org/pisa/pisaproducts/46619703.pdf

OECD (2016). Country note: Singapore /PISA 2015 high performers. Paris: OECD publishing. See: https://www.oecd.org/countries/singapore/46581101.pdf

Pak Tee Ng (2008). The phases and paradoxes of educational quality assurance: The case of the Singapore education system. *Quality Assurance in Education*. 16 (2): 112-125.

Piaget, J. (1960). *The child's conception of the world*. Translated from the French by J. and A. Tomlinson. Littlefield, NJ: Adams & Co.

Piaget, J. (1970). *Science of education and the psychology of the child*, Translated from the French by D. Coltman. New York: Orion Press.

Piaget, J. (1972). *Judgment and reasoning in the child*. Translated from the French by M. Warden. Littlefield, NJ: Adams & Co.

Piaget, J. (1978). *The language and thought of the child,* Translated from the French by M. and R. Gabain, London: Routledge & Kegan Paul.

Shapiro, J. and Riley, J. (1989). Ending the great debate in reading instruction. *Reading Horizons.* 30 (1): 67-78.

Wee, H. T. and Chong, K.C. (1990). 25 years of school management. in J. Yip and W. K. Sim (Eds.). *Evolution of educational excellence: 25 years of education in Republic of Singapore*. Singapore: Longman. pp. 31-58.

PSYCHOSOCIAL VARIABLES THAT AFFECT STUDENTS' EFFORT IN MATHEMATICS

Wajeeh Daher
An-Najah National University, Palestine

Fakher Al-Khalili
An-Najah National University, Palestine

Yasmin Abu-Kayyas
An-Najah National University, Palestine

ABSTRACT: What does affect students' effort in mathematics? What is the relationship of variables such as math-level, anxiety, teacher support, self-concept and motivation with students' effort to learn mathematics? The relationships of the five variables with students' effort in mathematics are complex, which made us use a correlation cross-sectional design to study them. Doing so, we conducted a Structural Equation Modeling (SEM), using self-report measures of the various variables, to examine the relationships of the five variables with effort, for eighth, ninth and tenth grade students. We assumed that teacher support, which is a social variable, is one variable that needs to be an independent variable in the model. To account for the individual variable, we chose once student math-level and once student self-concept. Seven hundred and twenty eighth, ninth and tenth grade students completed the questionnaires. There were 381 males and 339 females. All participants were from northern West Bank in Palestine, at upper primary governmental schools. The research results show that there are two models that can explain the relationships between the variables and that could affect student effort to learn mathematics. The two models differ in the consideration of self-concept. One of them considers self-concept a dependent variable, while the other considers it an independent variable.

Keywords: Effort in mathematics, self-concept, math anxiety, teacher support, math level, motivation

INTRODUCTION

What does influence students' effort in mathematics? Some researchers attempted to find the influence of effort as an independent variable, finding that increasing one’s effort results in more ability (Resnick & Hall, 1998). This role of effort in increasing students' abilities in mathematics makes it necessary to try to influence it in several ways. Fiore (1999) says that reinforcing effort in math begins with helping students to develop positive self-concepts. To do so, Shinn et al. (2003) suggested different; one of which is teaching keeping in mind that students have understanding of mathematics, which lessens their anxiety (Reyes, 1980). So, anxiety is related to effort. The other methods are related to teacher role and support, as creating a comfortable class environment that emphasizes learning through participation, where students ask questions (Tobias & Weissbrod, 1980). These methods emphasize teacher role and support as a factor which affects student effort. These researches encouraged us to study the factors that affect student effort to engage in mathematical activities. We included teacher support, self-concept and anxiety, for they have been mentioned, as described before, as variables that affect student effort to do mathematics. As to motivation, some researchers connected effort to motivation, saying that the extent of effort affects student motivation to learn, as they could be unmotivated to learn if the effort needed to do so is so great (Wright, 2012). On the other hand, researchers pointed at motivation as a factor that could affect student effort (Usher & Kober, 2012). In more detail, Usher and Kober (2012) consider rewards (an external motivation component) a variable that encourages students to spend effort in their learning. In the present research, we examine how motivation can affect paths to effort.

The variables that affect student effort could be categorized as social and individual variables, or as environmental and personal variables, where the environmental variable is mostly represented by teacher support.

Teacher Support

Do teachers influence students' learning and classroom behavior, including effort? And if they indeed do, what kind of influence do they have on student learning? The question of how or whether teachers impact student learning has preoccupied educational researchers for a long time. This issue is especially important in light of Coleman Report (Coleman, 1990), released in 1966 (Coleman, 1990). The Coleman report used aggregated measures of school inputs in terms of facilities, teacher characteristics (average educational level of the teachers' families, average years of experience, on average whether teachers were local to the area, the teachers' average level of education, the teachers' average scores on a self-administered vocabulary test, the teachers' preference for teaching middle-class, white-collar students, the proportion of teachers in the school who were white), and student characteristics to study the effect of the school on students' achievement. The report showed that student characteristics, such as student socio-economic status [SES], parental educational attainment, poverty and student attitude towards schooling, influenced student achievement more than teachers and schools (e.g., Meyer, 1996; Porter & Smithson, 2000). Moreover, teachers become influential on student achievement when the previous variables are controlled for (e.g., Darling-Hammond, 2000; Haycock, 1998).

On the other hand, some researches found that teachers, when certain conditions are satisfied, contribute positively to students’ learning. Wenglinsky (2001) mentions two conditions that ensure the improvement of student performance. First, the rigor of the academic standards and the alignment of curriculum and assessments to those standards, and, second that teachers possess the skills to teach according to the standards. Moreover, Rimm-Kaufman and Sandolis (2011) claim that improving students' relationships with teachers has positive influence on students' academic and social development. This is not done solely by improving students' relationships with teachers, but by ensuring that teachers provide close, positive and supportive assistance for their students.

The literature described above shows that the teacher's role in influencing achievement is disputed but his/her assistance in supporting learning is more acknowledged when the teacher provides appropriate support for students. This claim is affirmed by Usher and Pajares (2009) who say that the social persuasions that students receive from parents, teachers, and peers whom students trust serve as a source of self-efficacy. This is because the social persuasions can boost students’ confidence in their academic capabilities. This is true particularly when accompanied by instruction that help the students reach their academic goals. Moreover, this is especially true when teachers work on teaching specific behaviors such as decoding tasks, perseverance, seeing difficulties as opportunities, and learning from mistakes (Dweck, 2000).

The previous claim of the teacher mediating role in motivating students to learn and thus affecting positively their effort is also supported by Russell (1999) and Fast et al. (2010). Russell (1999), as reported in Shinn et al. (2003), claims that teacher can provide reinforcement and recognition for students' effort. Fast et al. (2010) argue that the degree to which a classroom environment is perceived as challenging also influences self-efficacy. This challenge is especially necessary in the case of high ability students who, if not challenged or engaged with lessons that fit their abilities, would lose motivation in their learning (Davis, 2012). This need for challenge in student learning is supported by brain research which suggests that the brain will continue to develop only when a student is challenged (McAllister & Plourde, 2008). In addition, one way to make this environment challenging is through providing students with progressively difficult tasks as their proficiency increases. This can be provided by the teacher whose support guarantees to a greater degree the success of students in the challenge. It can be concluded from the previous argument that teacher support, if managed rightly, can help students to overcome their math anxiety (Beilock, & Willingham, 2014).

The present research intends to examine the role of teacher support in paths of variables, in order to explain how different variables, affect student effort. Here teaches support is considered an independent variable. Another variable that we want to consider as independent one is student math-level.

Student Math-Level

Another variable that we expected to influence students' learning is student math-level. Pajares and Miller (1994) found that the level of high school mathematics and number of credits earned provide a strong measure of students' prior experience with mathematics. So, we hypothesized that math level, together with teacher support are expected to affect different variables of students' learning. This effect would be in light of their math anxiety.

Math Anxiety

Dowker, Sarkar and Looi (2016) say that the construct of mathematics anxiety has been an important topic of study at least since the concept of “number anxiety” was introduced by Dreger and Aiken (1957), and has received attention since then, but increased attention in recent years.

Hembree (1990) found that in the population of school pupils, mathematics anxiety showed a mean correlation of −0.73 with enjoyment of mathematics and −0.82 with confidence in mathematics. In the population of college students, the equivalent mean correlations were a little lower than in schoolchildren, but still very high: −0.47 between mathematics anxiety and enjoyment of mathematics, and −0.65 between mathematics anxiety and confidence in mathematics. In addition to these findings of Hembree (1990), Dowker et al. (2016) argue that mathematics anxiety seems to be particularly related to self-rating, where students who think that they are bad at mathematics are more likely to be anxious. This is in line with studies that indicate a negative relationship between mathematics self-concept and mathematics anxiety (Hembree, 1990; Jain & Dowson, 2009; Hoffman, 2010). Mathematics anxiety is related to effort too. Ashcraft and Kirk (2001) reported that, across several studies, they have found substantial evidence for performance differences as a function of math anxiety. They described these differences as not observed on the basic whole-number facts of simple addition or multiplication but observed on more difficult arithmetic problems. In a more recent research, Ashcraft and Krause (2007) emphasize that math anxiety influences cognitive processing in a straightforward way, where working memory resources are compromised whenever the anxiety is aroused. Moreover, math anxiety leads to a global avoidance pattern. This is presented in the finding that, whenever possible, students avoid taking math courses and avoid situations in which math will be necessary. This avoidance pattern could explain students' unwillingness to spend effort when they are mathematically anxious.

Bandalos, Yates and Thorndike-Christ (1995) studied what factors influence math anxiety of university students. Categorizing it as general test anxiety and statistical test anxiety, they found that students' attributions for failure and success influenced both categories of anxiety for both male and female students. In more detail, women who attributed success to behavioral causes had a higher level of math self-concept than women attributing success to external causes. For men, those who attributed failure to external causes had a higher level of the worry component of statistical test anxiety. Moreover, math self-concept was negatively related to both general test anxiety and statistics test anxiety, whereas perceived self-efficacy had a negative relationship with the worry component of statistics anxiety.

Student Self-Concept in Doing Mathematics

Researchers defined self-concept as one's perception of his/her strength, weakness, state of mind, and value (Huitt, 2004; Marsh & Craven, 1997). Moreover, self-concept is influenced by our sense of identity, by our perception of social interaction and by the judgments made of us by others (Purkey & Novak, 1996, as reported by Tang, 2011). In addition, Marsh and Craven (1997) argue that enhancing a child’s academic self-concept is a desirable goal that could result in improved academic achievement. This improvement in academic achievement could be a result of academic effort, where students who perceive their academic skills positively tend to participate in more effort-oriented activities such as engaging in class activities, finishing homework, and studying for exams (Valentine, DuBois, & Cooper, 2004). Marsh, Trautwein, Ludtke, Koller and Baumert (2005) argue that the possible improvement of student performance is based on a reciprocal relationship between self-concept and academic achievement. We claim that this argument also holds for the relationship between self-concept and effort. One reason for this similarity is the reciprocal relationship between effort and achievement, where effort leads to achievement, on one hand, and on the other hand achievement encourages effort.

Wang (2007) draws our attention that professional organizations of mathematics education, as well as mathematics education researchers, have considered affective factors that self-concept is one of, as an important aspect of mathematics education. Moreover, students’ mathematics self-concept is an important outcome of education and is related to successful mathematics learning (Marsh and O’Mara, 2008). Furthermore, students who have a low level of mathematics self-concept perform worse in mathematics than students who have a higher level of mathematics self-concept.

In addition to the relationships above, Liu (2010) examined the relation between academic self-concept and motivation in foreign language learning, finding that all of the academic self-concept related variables and the motivation components are positively and significantly correlated.

Student Motivation to Learn Mathematics

Wæge (2009) argues that there has not been done much work in mathematics education on students’ motivation. Trying to define student motivation, Wæge (2009) attracts the attention to five sets of motivational factors used by Stipek et al. (1998) and that constitutes the components of achievement motivation. These five motivational factors are (1) students’ focus on learning and understanding mathematics concepts as well as on getting right answers; (2) students' enjoyment in engaging in mathematics activities; (3) students' related positive (or negative) feelings about mathematics; (4) students' willingness to take risks and to approach challenging tasks; and (5) students' self-concept as mathematics learners. In the present research, we used different questionnaires for motivation, anxiety and self-concept, where motivation was considered a construct that has external motivation and internal motivation as components. Doing so, we intend to study the associations with motivation, when the paths start from teacher support together with an individual factors, and ends in student effort.

Student Effort to Learn Mathematics

Effort is a construct that can explain differences in students' learning, including achievement. Sorensen and Hallinan (1977) categorized the factors that can explain differences in achievement among students as: learning opportunities, effort, and ability. Carbonaro (2005) commented that by focusing on learning opportunities and effort, Sorensen and Hallinan highlighted the importance of both social structure and human agency in explaining differences in learning.

Carbonaro (2005) examined the relationships among students' effort, tracking (assigning students to different classes on the basis of their achievement levels), and students' achievement. Doing so, different factors that influence student' effort were taken care of, as well as consequences of these efforts. The results indicated that students in higher tracks exerted substantially more effort than students in lower tracks. Moreover, those results indicated that differences in effort were largely explained by differences in prior effort and achievement, as well as students' experiences in their classes. Furthermore, students' effort was strongly related to students' learning.

Sullivan, McDonough and Harrison (2004) studied students' perceptions of the contribution of their effort to their success in mathematics. In more detail, they studied students' perceptions of the extent to which student' own efforts contributed to their success in mathematics and their life opportunities. They found that even students who were confident, successful and persistent in their learning exhibited short-term goals. They also found that classroom culture may be an important determinant of under participation in schooling. Furthermore, the authors concluded that the participating students seemed to have the necessary self-confidence and appreciation of the contribution of effort and persistence, but may under contributed due to characteristics of the classroom culture. Here too, we see the importance of teachers' role in the mathematics classroom, where their support is a decisive factor in the classroom culture that influences student effort.

Research Goals and Rationale

The present research intends to find possible models that consitute paths leading to student effort. Thus, the present research is about the sources of effort in mathematics learning and how these sources advance in paths that lead to student effort. Usher and Pajares (2009) studied sources of self-efficacy in mathematics. Here, we do that for effort. Usher and Pajares (2009) considered four starting points: Mastery experience, vicarious experience, social persuasions and physiological state. We too take into account the social aspect, with other individual factors. Specifically, our present research assumes that two variables start the path to performance; math level and teacher support, or self-concept and teacher support. The models also assume that additional variables are involved, as anxiety and motivation. Still there is deficit in researches that study the effect of both social and individual factors on one construct related to student learning. At the same time, few researches take into consideration both cognitive and affective factors as affecting students' effort in learning mathematics. The present research attempts to do so.

Research Question

Which Good-Fitting models can explain the effect of teacher support, math-level, anxiety, motivation and self-concept on student effort in learning mathematics?

METHOD

Participants

Seven hundred and twenty eighth, ninth and tenth students' grades completed the questionnaires. There were 381 males and 339 females. All participants were from northern West Bank in Palestine, at upper primary governmental schools.

Data Collecting Tools

The data was collected using a questionnaire that had two parts. The first part collected background information about the respondent; namely grade and gender. The second part of the questionnaire requested the respondent to choose the extent to which he/she agrees with a statement. The statements were related to 5 variables: teacher support, student self-concept, student anxiety, student motivation and student effort.

Math level was assigned according to the math grade of the teacher. Mathematics anxiety scale was taken from Morony, Kleitman, Lee and Stankow (2013). Teacher support scale was taken from Johnson, Johnson, Buckman, and Richards (1985). Mathematics self-concept scale was taken from Vandecandelaere, Speybroeck, Vanlaar, De Fraine and Van Damme, (2012). Mathematics motivation scale was taken from two categories of the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia & McKeachie, 1993): Intrinsic Goal Orientation and Extrinsic Goal Orientation. Furthermore, student effort scale was adapted from Engagement and Effort Scale (SEES) from Vallerand, Fortier and Guay (1997).

Each of the variables was represented by 8 items. Examples on the items are: the mathematics teacher spends enough time to help me when I ask him to (teacher support), I get anxious when I solve mathematical problems (anxiety), sometimes when I don't understand a mathematical topic at the beginning, I know that I will not understand it (self-concept), I try my best to get a good grade in mathematics at the end of the trimester (motivation), I study very hard to learn mathematics (effort).

Statistical Analysis

Path analysis, a type of structural equation modeling, was used to analyze the models and to evaluate their ability to fit the data. The SEM with ML procedure was used. The fitting between the hypothetical models and observed data were assessed by examining the following indexes; relative chi-square [CMIN/df], Bentler-Bonnett normed fit index [NFI], non-normed (Tucker-Lewis) fit index [TLI], comparative fit index [CFI], goodness of fit index [GFI], adjusted goodness of fit index [AGFI], and the classical root mean square error of approximation (RMSEA). (Browne & Cudeck, 1993; Byrne, 2010; Hu & Bentler, 1998; MacCallum & Austin, 2000); RMSEA is one of the most important indicators showing the degree to which estimated parameters of an SEM model are representative for the whole population from which the sample was drawn. Since RMSEA is sensitive to misspecifications of relationship among variables and it is accompanied by a confidence interval, which provides an indication of precision of estimation, its use in applied research is strongly encouraged (MacCallum& Austin, 2000). CMIN/df is also called the normed chi-square. This value equals the chi-square index divided by the degrees of freedom. This index might be less sensitive to sample size. The criterion for acceptance of the model, according to chi-square varies across researchers, ranging from more than 2 (Ullman, 2006) to less than 5 (Schumacker & Lomax, 2010). Values greater than 0.95 for GFI, AGFI, NFI, TLI and CFI, and RMSEA and value lower than 0.05 indicate a good fit of the hypothetical model to the observed data (Byrne, 2010). Following suggestions from the literature, it was considered that a value of RMSEA as high as 0.08 indicates an acceptable fit of the SEM model (Browne & Cudeck, 1993). In addition, TLI and CFI values ranging from 0.90 to 0.95 indicate an acceptable model fit (Hu & Bentler, 1998). Furthermore, some authors such as Bagozzi and Yi (2012) have used a more liberal cutoff NFI value of 0.80.

RESULTS

A correlational cross-sectional design was performed, using self-report measures, to examinine the associations among teacher support, student math-level, anxiety, motivation, self-concept, and effort in mathematics for eighth, ninth and tenth grades' students. Follwoing this design, we used Structural Equation Modeling (SEM) technique to compute each hypothesized model's fit.

Based on the literature review, the present study intended to investigate how the six psychological, individual and social variables (teacher support, math level, mathematical anxiety, mathematical motivation, self-concept, and effort) constitute a model that explains student effort in learning mathematics. Doing so, we assumed that teacher support (the social variable) would probably be an independent variable. As a second indpendent variable, we chose an individual variable. Once, we took math-level and another time we took self-concept.

Based on the previous research findings, the first model hypothesizes paths from teacher support and math-level to anxiety, motivation, and mathematical effort. It hypothesizes two paths from anxiety to mathematical effort and self-concept. It hypothesizes one path from motivation to self-concept and one path from self-concept to mathematical effort. Finally, it hypothesizes covariance between teacher support and math level. Figure 1 shows this model.

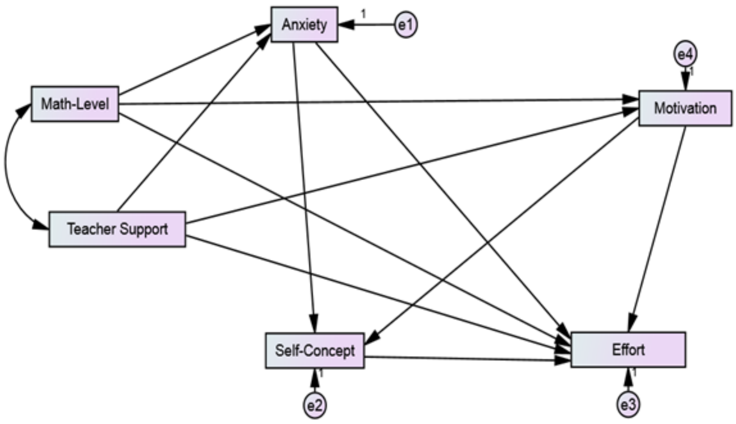


Figure 1. The first model relationships with self-concept are indirect and all paths end in effort

It could be seen that the first model hypothesizes that relationships with self-concept are not direct, where anxiety and motivation mediate them. On contrast, the second model hypothesizes that the relationships with self-concept is direct; i.e. teacher support, math level and math anxiety have direct paths with self-concept. At the same time, anxiety has a direct path with self-concept and effort, and self-concept has a direct path with effort. This model is represented in Figure 2.

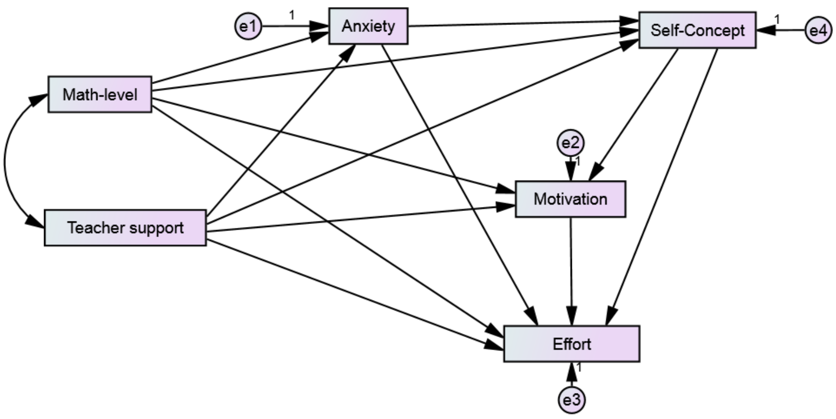


Figure1. The second model relationships with self-concept are direct and all paths end in effort

Note that the first two models assume that the five variables (teacher support, math-level, anxiety, self-concept and motivation) have direct paths to effort. Furthermore, the first model assumes a direct path from motivation to self-concept, while the second model assumes that the path is otherwise, i.e. from self-concept to motivation.

The third model hypothesizes paths from four variables, not five, to effort, where no direct path goes from self-concept to effort. A path is hypothesized to go otherwise; i.e. from effort to self-concept. This model is represented in Figure 3.

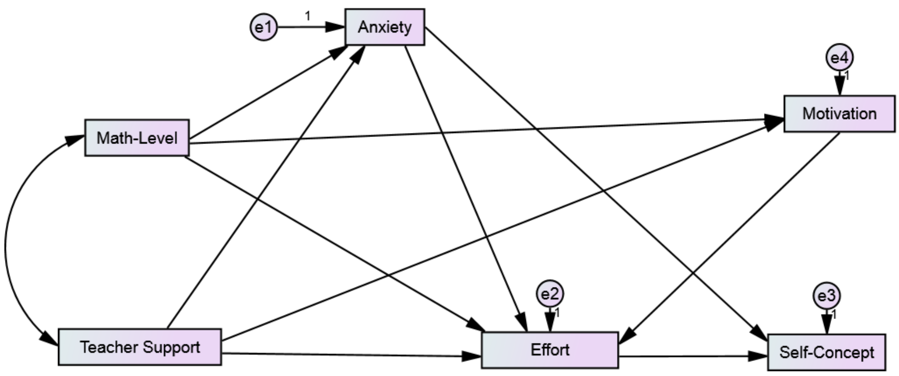


Figure 2. The third model relationships with self-concept are not direct and all paths end in self-concept

The fourth model again hypothesizes paths from four variables to effort, but the difference from the first three models is that it starts from teacher support and self-concept, where self-concept replaces math-level in the first three models. The fourth model is represented in Figure 4.

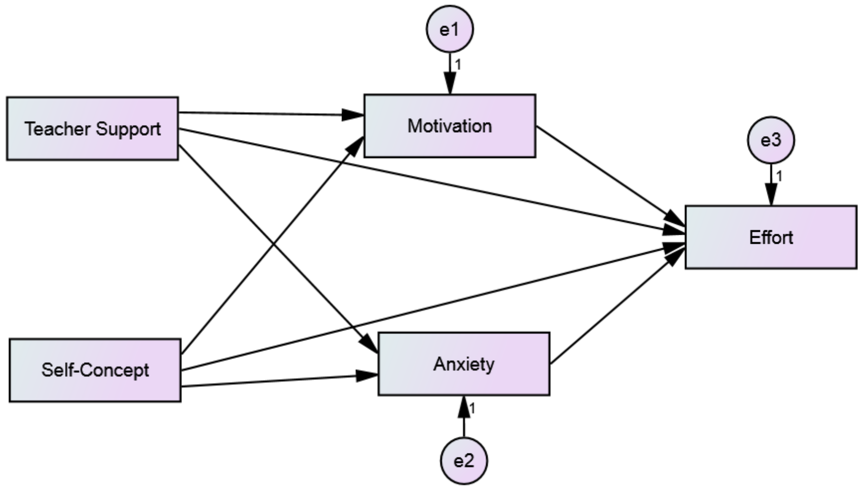


Figure 4. Self-concept is at the beginning of the model

SEM Analysis for the First Model

Statistics were performed to compute the model fit for the hypothesized first model, standardized paths coefficients, and the estimate of the variance explained (R^2). The computations showed that the χ^2 value for the hypothesized model was 10.70 (d.f. = 3, p = 0.013). So, the relative χ^2 was (CMIN/df = 3.567). Moreover, the RMSEA estimate of 0.06 (90% CI = 0.024; 0.100) succeeded in providing support for the model. Bentler's CFI was 0.993, which means the proposed model fit the data according to this index. For NFI, TLI, GFI, and AGFI, they were 0.991, 0.967, 0.995, and 0.966 respectively, so all of these values indicated the proposed model fit the data.

In the first model, $R^2 = 0.296$ for anxiety, 0.257 for motivation, 0.097 for self-concept and 0.544 for effort (See Figure 5 for seeing the paths for each of them). These values explain the variances explained by the first model.

According to results in table 1, all paths coefficients were significant except the path from math level to effort. In addition, the covariance coefficient between teacher support and mathematical level was significant (p = 0.273).

Table 1. Results of SEM analysis for the First Model

Parameter Description	S.E.	St. est.	P-value
Motivation from Teacher Support	0.023	0.384	0.000
Anxiety from Teacher Support	0.032	-0.18	0.000
Anxiety from Math Level	0.025	-0.466	0.000
Motivation from Math Level	0.018	0.243	0.000
Self-concept from Anxiety	0.019	0.257	0.000
Self-concept from Motivation	0.027	0.25	0.000
Effort from Motivation	0.036	0.469	0.000
Effort from Teacher Support	0.025	0.263	0.000
Effort from Anxiety	0.026	-0.146	0.000
Effort from Self-concept	0.044	0.115	0.000
Effort from Math Level	0.02	0.056	0.068
Teacher Support and Math Level	0.034	0.273	0.000

Note. S.E. – standard error; St. est. – standardized estimate.

The observed paths of the first model are presented in Figure 4.

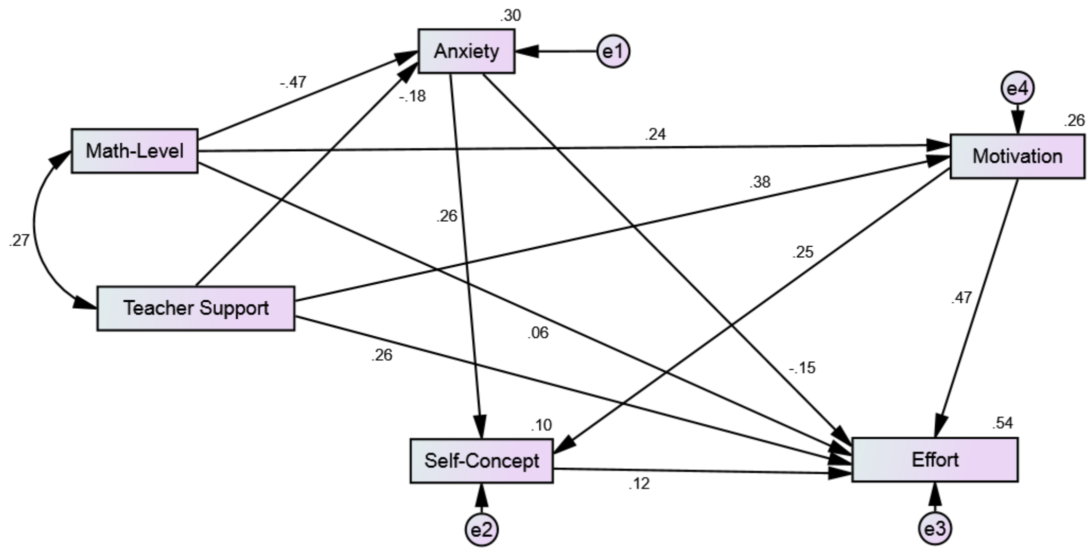


Figure 5. Observed paths of the first model

SEM Analysis for the Second Model

Statistics were performed to compute the model fit for the hypothesized second model, standardized paths coefficients, and the estimate of the variance explained (R^2). The χ^2 value for the hypothesized model was 0.615 (d.f. = 1, p = 0.433). So, the relative χ^2 was (CMIN/df = 0.615). Moreover, the RMSEA estimate of 0.03 (90% CI = 0.012; 0.053) succeeded in providing support for the model. Bentler's CFI was 0.999, which means the proposed model fit the data according to this index. For NFI, TLI, GFI, and AGFI, they were 0.999, 0.998, 0.999, and 0.978 respectively, so all of these values indicated the proposed model fit the data.

In the second model, R^2 = 0.296 for anxiety, 0.08 for self-concept, 0.287 for motivation, and 0.543 for effort (see Figure 6 for seeing the paths for each of them). These values explain the variances explained by the second model.

According to results in table 2, all paths coefficients were significant except the path from math level to effort.

Table 2. Results of SEM analysis for the second model

Parameter Description	S.E.	St. est.	P-value
Anxiety from Teacher Support	0.032	-0.18	0.000
Anxiety from Math Level	0.025	-0.466	0.000
Self-concept from Anxiety	0.022	0.326	0.000
Self-concept from Teacher Support	0.02	0.133	0.000
Self-concept from Math Level	0.017	0.146	0.000
Motivation from Teacher Support	0.023	0.371	0.000
Motivation from Self-concept	0.043	0.172	0.000
Motivation from Math Level	0.018	0.244	0.000
Effort from Teacher Support	0.025	0.263	0.000
Effort from Anxiety	0.027	-0.146	0.000
Effort from Self-concept	0.044	0.116	0.000
Effort from Motivation	0.036	0.469	0.000
Effort from Math Level	0.021	0.056	0.070
Teacher Support and Math Level	0.034	0.273	0.000

Note. S.E. – standard error; St. est. – standardized estimate.

The observed paths of the second model are presented in Figure 6.

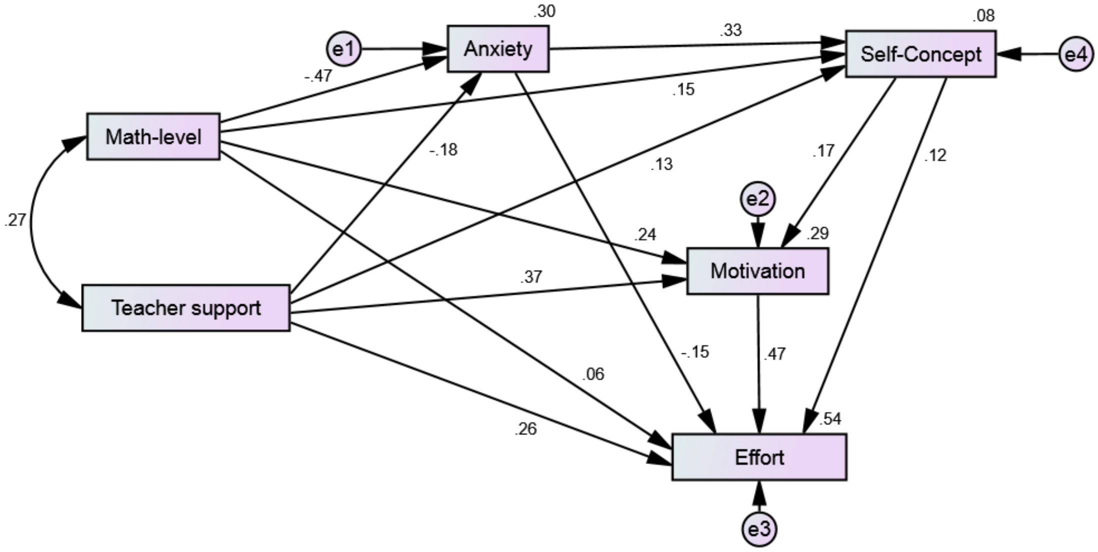


Figure 6. Observed paths of the second model

SEM Analysis for the Third Model

Statistics were performed to compute the model fit for the hypothesized third model, standardized paths coefficients, and the estimate of the variance explained (R^2). The χ^2 value for the hypothesized model was 13.617 (d.f. = 4, p = 0.009). So, the relative χ^2 was (CMIN/df = 3.404). Moreover, the RMSEA estimate of 0.058 (90% CI = 0.013; 0.003) succeeded in providing support for the model. Bentler's CFI was 0.992, which means the proposed model fit the data according to this index. For NFI, TLI, GFI, and AGFI, they were 0.988, 0.969, 0.994, and 0.967 respectively, so all of these values indicated the proposed model fit the data.

R^2 for anxiety = 0.296, for motivation = 0.257, for self-concept = 0.119 and for effort = 0.533 (see Figure 7 for seeing the paths for each of them). These values explain the variances explained by the third model.

According to results in table 3, all paths coefficients were significantexcept the path from math level to effort.

Table 3. Results of SEM analysis for The Third Model

Parameter Description	**S.E.**	**St. est.**	**P-value**
Motivation from Teacher support	0.023	0.384	***
Anxiety from Teacher support	0.032	-0.18	***
Anxiety from Math Level	0.025	-0.466	***
Motivation from Math Level	0.018	0.243	***
Effort from Motivation	0.036	0.492	***
Effort from Teacher support	0.025	0.269	***
Effort from Anxiety	0.026	-0.11	***
Effort from Math Level	0.021	0.066	0.033
Self-concept from Anxiety	0.02	0.305	***
Self-concept from Effort	0.023	0.299	***
Teacher support and Math Level	0.034	0.273	0.000

The observed paths of the third model are presented in Figure 7.

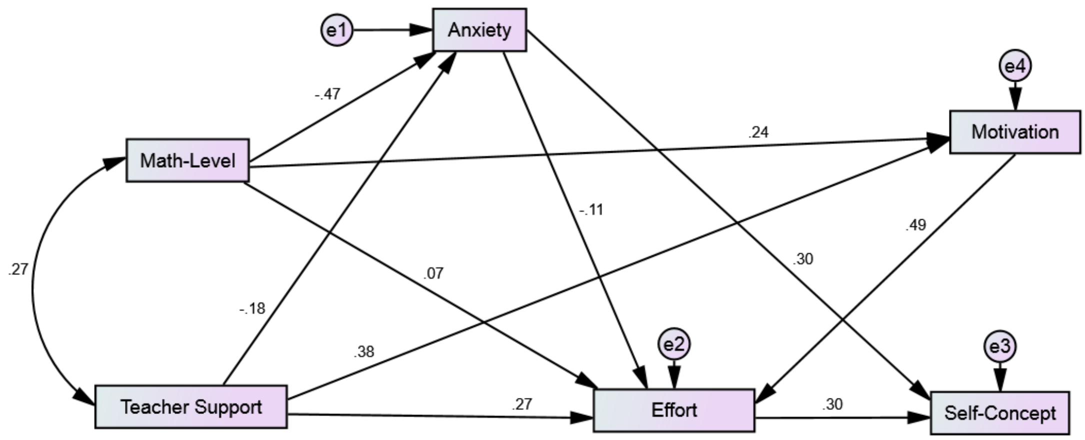


Figure 7. Observed paths of the third model

SEM Analysis for the Fourth Model

Statistics were performed to compute the model fit for the hypothesized fourth model, standardized paths coefficients, and the estimate of the variance explained (R^2). The $\chi 2$ value for the hypothesized model was 3.848 (d.f. = 1, p = 0.05). So, the relative $\chi 2$ was (CMIN/df = 3.848). Moreover, the RMSEA estimate of 0.063 (90% CI = 0.002; 0.135) succeeded in providing support for the model. Bentler's CFI was 0.997 for the present model, which means the proposed model fit the data according to this index. For NFI, TLI, GFI, and AGFI, they were 0.996, 0.967, 0.998, and 0.968 respectively, so all of these values indicated the proposed model fit the data.

R^2 for anxiety = 0.16, for motivation = 0.22 and 0.53 for effort (see Figure 8 for seeing the paths for each of them). These values explain the variances explained by the fourth model.

According to results in table 5, all paths coefficients were significant.

Table 1. Results of SEM analysis for the fourth Model

Parameter Description	S.E.	St. est.	P-value
motivation from teacher support	0.023	0.44	0.000
Anxiety from self-concept	0.066	0.23	0.000
Anxiety from teacher support	0.034	-0.32	0.000
motivation from self-concept	0.044	0.17	0.000
effort from motivation	0.035	0.48	0.000
effort from anxiety	0.024	-0.18	0.000
effort from teacher support	0.025	0.27	0.000
effort from confidence	0.044	0.12	0.000
Correlation between e1 and e2	0.015	-0.11	0.005

Note. S.E. – standard error; St. est. – standardized estimate.

The observed paths of the fourth model are presented in Figure 8.

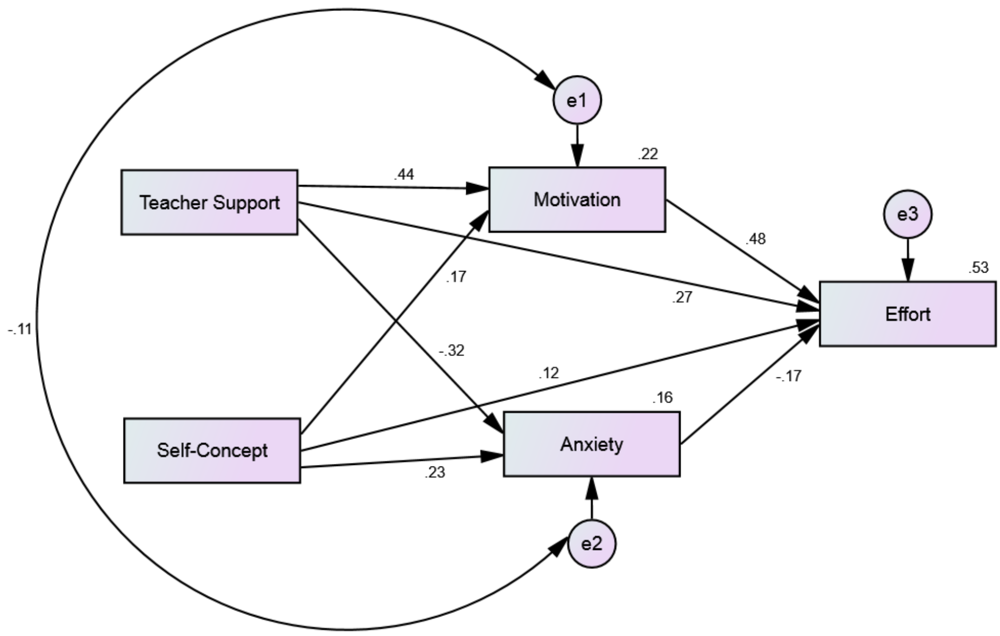


Figure 8. Observed β-s of the fourth model

DISCUSSION

The present research intended to study the factors that affect student effort to learn mathematics. To do so it examined five variables as factors that could affect this student effort: teacher support, student math level, anxiety, motivation, self-concept. Different models were hypothesized for the paths between the six variables of the present research. The models were hypothesized based on two starting conditions: teacher support is one of the variables that start the paths, and student effort is the variable that ends the paths.

Path analysis served as structural equation modeling for analyzing the models and to evaluate their ability to fit the data. The first model assumed that teacher support and math-level affect directly and indirectly (through motivation, anxiety and self-concept) student effort in learning mathematics. This model explained 0.544 for effort scores, with the limitation that math-level did not have a significant direct path with student effort. The insignificant path could be explained by the possibility that students attempt to perform in mathematics regardless of their math level. This attempt could be encouraged by the teacher support. This role of the teacher depends on his/her expectations, caring, and support, where these functions to set the tone for student behavior (Baker, 1999; Noddings, 1992). This role of the teacher is represented in the first model through the significant paths from teacher support to student motivation, and at the same time, from student motivation to student effort. Thus, it could be argued that teacher support sets the tone for student motivation, which leads to his/her greater effort in learning mathematics. In addition, it could be claimed that math-level affected student effort indirectly through anxiety and self-concept, where the appropriate paths were significant.

The second model has two differences with the first model; the paths from teacher support and math-level to self-concept are direct and self-concept leads to motivation and not otherwise. These two differenced did not make the model better. The model explained 0.543 of the variance for effort scores, and the direct path from math-level to effort was still insignificant. Still, it could be argued that math-level affected significantly student effort indirectly as could be seen from the significant the following significant paths: math-level to anxiety and anxiety to effort, math-level to motivation and motivation to effort, math-level to self-concept and self-concept to effort. In addition, the previous research results of the insignificant path between math level and effort should be looked at in light of other researches results that mathematics ability had a direct effect on mathematics performance (e.g., Zarch & Kadivar, 2006). Zarch and Kadivar (2006) also found that math level had an indirect effect on performance via mathematics self-efficacy judgments. This indirect effect, of math-level on effort, was also found in the present research, where the mediating variables were anxiety, motivation and self-concept.

The third model, in light of the limitations of the first two models, examined what happens if self-concept replaces effort. This model explained 0.533 of the variance of effort, but the more important result was that all the paths between the variables turned to be significant, including the path from math-level to effort. This could mean that the model that neglects self-concept as a mediating factor that leads to effort could be sounder than other models that try to explain effort. This does not contradict past studies that found that self-concept leads to effort (Fiore, 1999), for the present research findings describe a model and not a simple relationship. The third model's Fit-computations made us examine a model in which self-concept is an independent variable, together with teacher support. This was our fourth model. Fit computations of the fourth model resulted in significant paths of the model, where it explained 0.53 of the variance of student effort.

Based on the results, the most appropriate models to explain the data were the third and fourth models, where all paths in these two models were significant. Furthermore, they explained moderately the variance of effort, where $0.30 < R$ squared < 0.60 is considered moderate (Sanchez, 2013). These models are most appropriate though they considered self-concept differently, where the third model considered self-concept a dependent variable, at the end of the model, while the fourth model considered it an independent variable, at the beginning of the model. These results show the importance of the configuration of the model. They also show the centeredness of self-concept as a construct that affects learning in the mathematics classroom, where in certain setting it affects learning as an independent variable, and in other setting, it affects learning as a dependent variable through affecting the configuration that leads to student effort.

CONCLUSIOLNS

The present research results show that educational phenomena are compound, so we need to examine how the variables of these phenomena impact each other. In the present research, we used Path analysis, a type of structural equation modeling, to verify the factors that influence student effort in the mathematics classroom. Results showed that paths leading from teacher support, as a social variable, and math-level of self-concept as an individual variable, to student effort could constitute different models. Specifically, self-concept has a special role in such model, where it could be considered an independent or dependent variable. These results constitute important findings in the field for previous reason; i.e. the impact of self-concept on students' learning of mathematics, where this impact varies among different educational configurations. We, as educators, should pay attention to what educational variables we are attending and encouraging first, for our choice of the educational constructs that we attend to first will impact the outcome of the actors' processes in the educational setting.

REFERENCES

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General, 130*, 224–237.

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review, 14*, 243–248.

Bagozzi, R. P. & Yi, Y. 2012. Specification, Evaluation, and Interpretation of Structural Equation Models. *Journal of the Academy of Marketing Science, 40*(1), 8-34.

Baker, J.A. (1999). Teacher-Student interaction in urban at-risk classrooms: differential behavior, relationship quality, and student satisfaction with school. *The Elementary School journal, 100*(1), 57- 70.

Bandalos, D. L., Yates, K., & Thorndike-Christ, T. (1995). Effects of math self-concept, perceived self-efficacy, and attributions for failure and success on test anxiety. *Journal of Educational Psychology, 87*, 611–623.

Beilock S. L., & Willingham, D. T. (2014). Math anxiety: Can teachers help students reduce it? *American Educator, 38*(2), 28-32.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In: K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136-162). Beverly Hills, CA: Sage.

Byrne, B. M. (2010). *Structural equation modeling with AMOS: basic concepts, applications, and programming*. New York, NY: Routledge

Carbonaro, W. (2005). Tracking student’s effort, and academic achievement. *Sociology of Education, 78*(1), 27-49.

Coleman, J. S. (1990). *Equality and achievement in education*. Boulder: Westview Press.

Davis, K. (2012). *The effect of homogeneous ability grouping in math class on student achievement and attitudes about math* (Master of Science thesis). Montana State University, Bozeman, Montana.

Darling-Hammond, L. (2000). Teacher Quality and Student Achievement: A Review of State Policy Evidence. *Education Policy Analysis Archives, 8*(1), 50.

Dowker, A., Sarkar, A., &Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? *Frontiers in Psychology, 7*, 1–16.

Dreger R. M., Aiken L. R. (1957). The identification of number anxiety in a college population. *Journal of Educational Psychology, 48*, 344–351.

Dweck, C.S. (2000). *Self theories: Their role in motivation, personality, and development*. Philadelphia: Psychology Press.

Fast, L. A., Lewis, J. L., Bryant, M. J., Bocian, K. A., Cardullo, R. A., Rettig, M., & Hammond, K. A. (2010). Does math self-efficacy mediate the effect of the perceived classroom environment on standardized math test performance? *Journal of Educational Psychology, 102*(3), 729-740.

Fiore, G. (1999). Math-abused students: Are we prepared to teach them? *The Mathematics Teacher, 92*(5), 403-406.

Haycock, K. (1998). Good Teaching Matters: How Well-Qualified Teachers Can Close the Gap. *Thinking K-16, 3*(2), 1-14.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*, 33–46.

Hoffman B. (2010). ‘I think I can, but I'm afraid to try’: the role of self-efficacy beliefs and mathematics anxiety in mathematics problem solving efficiency. *Learning and Individual Differences, 20* (3), 276–283.

Hu, L.-T., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to under-parameterized model misspecification. *Psychological Methods, 3*, 424-453.

Huitt, W. (2004). *Becoming a brilliant star: An introduction*. Presentation at the Forum for Integrated Education and Educational Reform sponsored by the Council for Global Integrative Education, Santa Cruz, CA.

Liu, H-G. (2010). The relation of academic self-concept to motivation among university EFL students. *Feng Chia Journal of Humanities and Social Sciences, 20*, 207-225.

Jain S., Dowson M. (2009). Mathematics anxiety as a function of multi-dimensional regulation and self-efficacy. *Contemporary Educational Psychology, 34*, 240–248.

Johnson, D. W., Johnson, R. T., Buckman, L. A., & Richards, P. S. (1985). The effect of prolonged implementation of cooperative learning on social support within the classroom. *Journal of Psychology, 119*, 405-411.

MacCallum, R. C., & Austin, J. T. (2000). Applications of structural equation modeling in psychological research. *Annual Review of Psychology, 51*, 201–226.

Marsh, H. W., & Craven, R. (1997). Academic self-concept: Beyond the dustbowl. In G. Phye (Ed.), *Handbook of classroom assessment: Learning, achievement, and adjustment* (pp. 131-198). Orlando, FL: Academic Press.

Marsh, H.W. and A.J. O’Mara (2008), “Self-concept is as multidisciplinary as it is multidimensional: A review of theory, measurement, and practice in self-concept research”, in H.W. Marsh, R.G. Craven and D.M. McInerney (eds.), *Self-Processes, Learning, and Enabling Human Potential: Dynamic New Approaches* (Vol. 3, pp. 87-115). Charlotte, North Carolina: Information Age Publishing.

Marsh, H. W., Trautwein, U., Ludtke, O., Koller, O., & Baumert, J. (2005). Academic selfconcept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*(2), 397-416.

McAllister, B., & Plourde, L. A. (2008). Enrichment curriculum: Essential for mathematically gifted students. *Education, 129*(1), 40-49.

Meyer, R. H. (1996). Value-added indicators of school performance. In E. A. Hanushek& D. W. Jorgenson (Eds.), *Improving America's Schools: The Role of Incentives* (pp. 197-123). Washington, D.C.: National Academy Press.

Morony, S., Kleitman, S., Lee, Y.P., Stankow, L. (2013). Predicting achievement: Confidence vs self-efficacy, anxiety, and self-concept in Confucian and European countries. *International Journal of Educational Research, 58*, 79-96.

Noddings, N. (1992). *The challenge to care in schools: an alternative approach to education*. New York: Teachers College Press.

Pajares, F. and Miller, M.D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem-solving: A path analysis. *Journal of Educational Psychology, 86*(2), 193-203.

Pintrich, P., Smith, D., Garcia, T., & McKeachie, W. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement, 53*. 801-813.

Porter, A. C., & Smithson, J. L. (2000, April, 2000). *Alignment of state testing programs, NAEP and reports of teacher practice in mathematics and science in grades 4 and 8*. Paper presented at the American Educational Research Association, New Orleans, LA.

Purkey, W., & Novak, J. (1996). *Inviting school success: A self-concept approach to teaching and learning (3rd ed.)*. Belmont, CA: Wadsworth.

Reyes, L. (1980). Attitudes and mathematics. In M. Montgomery Lindquist (Eds.), *Selected Issues in Mathematics Education* (pp. 161-182). Berkley, CA: McCutchan Publishing Corporation.

Rimm-Kaufman, S., &Sandolis, L. (2011*). Improving students’ relationships with teachers to provide essential supports for learning*. http://www.apa.org/education/K12/relationships.aspx

Resnick, L., & Hall, M. (1998). Learning Organizations for Sustainable Education Reform. *Daedalus, 127*, 89-118.

Sanchez, G. (2013). *PLS Path Modeling with R*. Berkeley: Trowchez Editions. http://gastonsanchez.com/PLS_Path_Modeling_with_R.pdf

Shinn, G. C., Briers, G. E., Christiansen, J. E., Edwards, M. C., Harlin, J. F., Lawver, D. E., Lindner, J. R., Murphy, T. H., and Parr, B.A. (2003). Improving student achievement in mathematics: An important role for secondary agricultural education in the 21st Century. Unpublished manuscript. Texas A&M University. College Station, TX.

Schumacker, R. E., & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling (3rd ed.)*. New York: Routledge.

Sorensen, A., & Hallinan, M. (1977). A Reconceptualization of School Effects. *Sociology of Education 50*, 273-289.

Stipek, D., Salmon, J. M., Givvin, K. B., Kazemi, E., Saxe, G., & MacGyvers, V. L. (1998). The Value (and Convergence) of Practices Suggested by Motivation Research and Promoted by Mathematics Education Reformers. *Journal for Research in Mathematics Education, 29*(4), 465-488.

Sullivan, P., McDonough, A. M., & Harrison, R. T. (2004). Students' perceptions of factors contributing to successful participation in mathematics. In M. J. Hoines & A. B. Fugelstad (eds.), *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 289-296). Bergen, Norway: Bergen University College.

Tang, S-F. (2011). The relationships of self-concept, academic achievement and future pathway of first year business studies diploma students. *International Journal of Psychological Studies*, *3*(2), 123-134.

Tobias, S. & Weissbrod, C. (1980). Anxiety and mathematics: An update. *Harvard Educational Review. 50*, 95-104.

Ullman, J. B. (2006). Structural equation modeling. In B. G. Tabachnick & L. S. Fidell (Eds.), *Using multivariate statistics* (5th ed.; pp. 653–771). Boston: Allyn & Bacon.

Usher, A., & Kober, N. (2012). *Student motivation: An overlooked piece of school reform*. Washington, D.C: Center on Education Policy.

Usher, E. L., & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology*, *34*, 89–101.

Valentine, J. C., DuBois, D. L., & Cooper, H. (2004). The relation between self-beliefs and academic achievement: A meta-analytic review. *Educational Psychologist, 39*, 111–133.

Vallerand, R. J., Fortier, M. S. & Guay, F. (1997). Self-determination and persistence in a real-life setting: toward a motivational model of high school dropout. *Journal of Personality and Social Psychology, 72*(5), 1161–1176.

Vandecandelaere, M., Speybroeck, S., Vanlaar, G., De Fraine B., & Van Damme, J. (2012). Learning environment and students' mathematics attitude. *Studies in Educational Evaluation, 38* (3–4), 107–120.

Wæge, K. (2009). Motivation for learning mathematics in terms of needs and goals. In V. Durand-Guerier, S. Soury-Lavergne, & F. Arzarello (Eds.), *Proceedings of the Sixth Congress of the European Society for Research in Mathematics Education* (pp. 84-93). Lyon: ERME.

Wang, J. (2007). A trend study of self-concept and mathematics achievement in a cross-cultural context. *Mathematics Education Research Journal, 19*(3), 33–47.

Wenglinsky, H. (2001). *Teacher classroom practices and student performance: How schools can make a difference* (Report Number RR-01-19). Princeton, NJ: Educational Testing Service.

Wright, J. (2012). *Six reasons why students are unmotivated (and what teachers can do)*. Paper presented at the Technical Assistance Meeting for CSE Chairpersons Lake Placid, NY, 15 March 2012.

Zarch, M. K., & Kadivar, P. (2006). The role of mathematics self-efficacy and mathematics ability in the structural model of mathematics performance. *WSEAS Transactions on Mathematics, 6*, 713–720.

Section 2: Science Education

THE INVESTIGATION OF THE EFFECTS OF ROBOTIC-ASSISTED PRACTICES IN THE TEACHING OF RENEWABLE ENERGY SOURCES TO SCIENCE TEACHERS CANDITATES

Sibel Acisli
Artvin Coruh University, Turkey

ABSTRACT: It is aimed to investigate the effect of robotic-assisted practices in the teaching of renewable energy sources to science teacher candidates. Research was carried out with 20 volunteer teacher candidates who study at Artvin Çoruh University Faculty of Education in third grade of Science Teacher Education Program. A single group pre-test, post-test model was used in the study. The subject of renewable energy sources was tried to be taught to teacher candidates using the Lego® Mindstorms EV3 Training Kit and the Lego® Renewable Energy Kit. The practice lasted total of 20 hours in 3 stages. At the first stage, Lego® Mindstorms EV3 Training Kit and Lego® Renewable Energy Kit were introduced to teacher candidates. At the second stage of the practice, solar energy related materials and at the final stage of the practice, materials related to wind energy were ensured to be designed by them, and it was made them to do activities. In the research, as a mean of collecting data, "Attitude Test for Renewable Energy Sources" developed by Güneş, Alat and Gözüm (2013) in order to determine the attitudes of teacher candidates about renewable energy sources, "Renewable Energy Awareness Scale" developed by Morgil et al. (2006) and was translated into Turkish by Tiftikçi (2014) in order to measure the attitudes of teacher candidates about renewable energy sources and semi-structured interview form were used in order to determine the opinions and suggestions of the teacher candidates about the robotically assisted practice. The data obtained in the study were evaluated through the SPSS package program. In the light of this study, attitudes and awareness of teacher candidates concerning the renewable energy sources and how they perceive education with legos as a method were determined.

Keywords: robotic, renewable energy resources, lego® mindstorms EV3 educatin kit, lego® renewable energy kit, teacher candidates

INTRODUCTION

Increase in world population and increased use of technology along with developments in technology and use of more energy to sustain a convenient life standard give rise to energy need so that energy problems become a global issue. Quality of the training is crucial in order to make decisions for delivering right and effective use of energy resources that have been a bigger problem day by day (Güneş, Alat and Gözüm, 2013).

It is very important for the future of the communities that individuals adapt to these rapid developments in science and technology and benefit from the developments for their own interests (Aydınlı, 2007). According to Akkoyunlu (1998), teachers of the future should be educated as individuals who comprehend the importance of technology, are able to reach information by using technology effectively and productively, can produce and use new information and can share this information with various communication environments, can build effective communication with students, can adapt the ever-changing learning environments and can solve problems that might be encountered during learning processes (Silik, 2016). In this scope, use of robots particularly in science and technology courses and in various teaching programs, which students actively participate in, draw attention (Özdoğru, 2013). According to Wood (2003), providing teachers with a robotic teaching program that is integrated with science and technology in robotic technology area education field, and organizing advanced technology implementations on robots within learning environments ensure more meaningful and permanent learning, and the information and abilities that are acquired by learners can be used to create practical and corporate products that will ease the daily life (Silik, 2016).

It is very important to have a social sensitivity for recyclable energy resources that are crucial for our future. To ensure this must be among responsibilities of teachers who educate the future generations (Mutlu, 2016). In the most comprehensive manner, recyclable energy subject is taught with Science and Technology course. Therefore, during their undergraduate studies, Science and Technology teachers' own attitudes toward creating attitudes in their students related to energy resources are important (Güneş, Alat and Gözüm, 2013). Recyclable energy resource is a field that has been constantly developed and renewed as an interesting area. Therefore, it is very important that teachers should have an increased level of awareness and obtain a sufficient level of knowledge about recyclable energy subjects. Teachers' low level of knowledge or possible misinformation about recyclable energy subjects might lead students to have concept confusions or learn the concepts in the wrong manners (Mutlu, 2016). It is very important for teacher candidates to apply active learning methods as avoiding only memorizing information during higher education period and to become as individuals who obtain environmental awareness and responsibilities in terms of future generations to gain environmental awareness (Tiftikçi, 2014).

In this scope, it was aimed to analyze the effect of use of robotic supported implementations during recyclable energy resources education on science teacher candidates, and to determine teacher candidates' attitudes and awareness toward recyclable energy resources.

METHODS

This study aimed to identify science teacher candidates' knowledge levels related to recyclable energy resources and their opinions toward use of robotic supported implementations during teaching of recyclable energy resources. The study was conducted as single group pre-test post-test experimental design. The study group was composed of 20 teacher candidates. In the study, before starting the implementation, firstly, Attitudes Test toward Recyclable Energy Resources and Recyclable Energy Awareness Scale were applied, and semi-structured interview forms were used to determine teacher candidates' opinions and suggestions about robotic supported implementation. The implementation process used a total of 20 hours as organized within 3-phases. In the first phase, Lego® Recyclable Energy Set was introduced to teacher candidates with Lego® Mindstorms EV3 Training Set. Participants were requested to design materials related to solar energy and to make related activities in the second phase of the study. Moreover, they were requested to design materials related to wind energy and to make related activities in the third phase of the study.

Data Collection Tools

In the research, as data collection tools, "Attitudes Test Toward Recyclable Energy Resources" that was developed by Güneş, Alat and Gözüm (2013) was used to identify teacher candidates' attitudes toward recyclable energy resources. "Recyclable Energy Resources Awareness Scale" that was developed by Morgil, Seçken, Yücel, Özyalçın Oskay, Yavuz and Ural (2006) and adapted to Turkish by Tiftikçi (2014) was used to measure teacher candidates awareness levels related to recyclable energy resources. "Robotic Pre-Questionnaire" that was developed by Riberio (2006) and adapted to Turkish by Koç Şenol (2012), and "Robotic Satisfaction Test" that was developed by Silva (2008) and Gibbon (2007) and adapted to Turkish by Koç Şenol (2012) were used. Moreover, semi-structured interview forms were used to determine teacher candidates' opinions and suggestions about robotic supported implementations.

RESULTS AND FINDINGS

A total of 20 teacher candidates, as 12 of them were female and 8 of them were male, participated to the research. Before implementation process, "Robotic Pre-Questionnaire" was applied to participants to determine their opinions toward robotic supported implementations that were used in recyclable energy resources education, and after robotic implementation process, "Robotic Satisfaction Questionnaire" was applied to participants and semi-structured interview forms were applied to determine teacher candidates' opinions and suggestions about robotic supported implementations. Answers of teacher candidates, who participated to this study, for "Robotic Pre-Questionnaire" and "Robotic Satisfaction Questionnaire" were presented below in tables. In the research, "Attitudes Test toward Recyclable Energy Resources" was applied to determine teacher candidates' attitudes toward recyclable energy resources and "Recyclable Energy Resources Awareness Scale" was applied to teacher candidates to measure their awareness levels related to recyclable energy recourses, and obtained data was presented below.

Table 1. Frequency and percentage distributions of Robotic Pre-Questionnaire Question 1 and Question 2

	Yes		No	
	F	%	f	%
Have you ever used Lego parts?	9	45	11	55
Do you have any information about Lego Mindstorms Robotic System?	3	15	17	85

As seen in Table 1, for the question, "Have you ever used Lego parts? 45% of teacher candidates who participated to this research replied as "Yes" while 55% of them replied as "No". 15% of teacher candidates who participated to this research stated that they had information about Lego Mindstorms Robotic System while 85% of them stated that they did not know about this system.

Table 2. Frequency and percentage distributions of Robotic Pre-Questionnaire Question 3

	Yes		Undecided		No	
	f	%	f	%	f	%
Do you think that you can learn recyclable energy resources subject with the help of Legos?	10	50	10	50	0	0

As seen in Table 2, for the question, "Do you think that you can learn recyclable energy resources subject with the help of Legos?" 50% of teacher candidates who participated to this research replied as "Yes" while 50% of them replied as "No".

Table 3. Frequency and percentage distributions of Robotic Pre-Questionnaire and Robotic Satisfaction Questionnaire Question 4

	Relatively Difficult				Undecided				Easy			
	Pre-test		Post test		Pre-test		Post test		Pre-test		Post test	
	f	%	f	%	f	%	f	%	f	%	f	%
What do you think about use of Legos in the activities that you did/ you will do?	4	20	2	10	8	40	1	5	8	40	17	85

For the question, "What do you think about use of Legos in the activities that you did/ you will do?", in pre-test, 40% of teacher candidates who participated to this research replied as undecided for use of Legos in the activities that would be done, 40% of them replied as easy for use of Legos and 20% replied as relatively difficult for use of Legos. On the other hand, in post-test, 10% of teacher candidates replied as relatively difficult, 5% of them replied as undecided while 85% of them replied as easy.

Additionally, for the question, "What is your satisfaction level for the activities you did?", 10% of teacher candidates replied as satisfied while 90% of them replied as very satisfied.

For the question, "Did you get interested in use of Legos in recyclable energy resources activities", 100% of teacher candidates replied as "Yes".

Table 4. Frequency and percentage values of answers to items in Recyclable Energy Awareness Scale

	Definitely Disagree		Disagree		Undecided		Agree		Definitely Agree	
	f	%	f	%	f	%	f	%	f	%
1. Recyclable energy resources should be effectively used to meet the increased energy demand.	0	0	0	0	1	5	6	30	13	65
2. Public investments should be increased for recyclable energy, and effective and feasible use of recyclable energy resources.	0	0	0	0	1	5	8	40	11	55
3. I do not think that traditional energy production methods are harmful to environment.	4	20	9	45	4	20	3	15	0	0
4. I believe that all of the countries should use environment-friendly recyclable energy resources.	0	0	0	0	0	0	10	50	10	50
5. I do not have much information about recyclable energy and recyclable energy resources.	5	25	8	40	7	35	0	0	0	0
6. The current century's motto should be "use clean energy resources".	0	0	0	0	2	10	7	35	11	55
7. I do not find use of solar and other countless clean energy resources as realistic	11	55	7	35	2	10	0	0	0	0

8.	I believe that use of recyclable energy resources is more limited when use of recyclable energy resources is compared to traditional energy resources.	5	25	7	35	2	10	4	20	2	10
9.	Use of recyclable energy resources does not decrease use of fossil fuels.	6	30	10	50	4	20	0	0	0	0
10.	I do not believe that use of recyclable energy resources will be easier for me.	8	40	9	45	3	15	0	0	0	0
11.	I am not interested in recyclable energy resources since they require more technology.	6	30	13	65	1	5	0	0	0	0
12.	I do not prefer recyclable energy resources because their usage is not easy although it is necessary for environment.	6	30	14	70	0	0	0	0	0	0
13.	I use fossil fuels but I do not have any information about their harms.	8	40	10	50	2	10	0	0	0	0
14.	Greenhouse gases, occurred due to use of fossil fuels, enable keeping heat within atmosphere. With parallel to this occurrence, I am happy with global warming.	17	85	3	15	0	0	0	0	0	0
15.	I do not believe that global warming causes a major problem.	16	80	4	20	0	0	0	0	0	0
16.	I believe that energy resources should be recyclable for ecological balance.	0	0	0	0	2	10	8	40	10	50
17.	I do not have any information about recyclable energy resources.	6	30	12	60	1	5	0	0	1	5
18.	Efforts to find new recyclable energy resources should be increased with planned energy programs.	0	0	0	0	1	5	9	45	10	50
19.	I definitely support use of recyclable energy resources.	0	0	0	0	0	0	6	30	14	70
20.	I support the production of recyclable energy resources.	0	0	0	0	1	5	5	25	14	70
21.	The concept "recyclable energy resources" makes me nervous because I am not familiar with it.	6	30	7	35	2	10	2	10	3	15
22.	Recyclable energy resources are clean energy resources at the same time.	0	0	0	0	2	10	7	35	11	55
23.	I do not believe that the difference between recyclable energy resources and unrecyclable energy resources is very important.	10	50	10	50	0	0	0	0	0	0
24.	Wind energy is a very important type of recyclable energy resources.	0	0	0	0	0	0	6	30	14	70
25.	I do not believe the idea of generating energy from wastes.	12	60	7	35	1	5	0	0	0	0
26.	Energy generating from resources for example solar system or water is a dream.	16	80	2	10	2	10	0	0	0	0
27.	I do not believe that recyclable energy resources contribute to energy saving.	10	50	6	30	4	20	0	0	0	0
28.	I believe that education in schools about recyclable and unrecyclable energy resources are important.	0	0	0	0	2	10	7	35	11	55
29.	I am not interested whether energy resources are recyclable or unrecyclable.	10	50	6	30	4	20	0	0	0	0
30.	In globalization process, it is important that individuals are aware of recyclable energy resources consumption.	0	0	2	10	1	5	4	20	13	65
31.	I do not see a relationship between compliance to European Union, globalization processes and use of recyclable energy resources.	7	35	6	30	6	30	1	5	0	0

32. It is important that use of recyclable energy resources is among environment protection activities.	0	0	0	0	0	0	8	40	12	60
33. Use of recyclable energy resources will eliminate harmful effects of greenhouse gases.	0	0	0	0	2	10	9	45	9	45
34. Turkey has very convenient conditions for recyclable energy resources in terms of its climate conditions and geographic condition.	0	0	0	0	2	10	10	50	8	40
35. The purpose of energy policies is to ensure the sustainability of energy systems and recyclable energy resources.	1	5	2	10	4	20	8	40	5	25
36. I believe that there is not a difference between use of recyclable energy resources and unrecyclable energy resources in terms of energy saving.	10	50	7	35	3	15	0	0	0	0
37. In on-the-job training programs. I believe that teachers should focus the importance of energy saving and energy resources, and they should create an awareness in this subject.	0	0	0	0	0	0	7	35	13	65
38. I believe that media has very important role in emphasizing the importance of recyclable energy resources.	2	10	0	0	4	20	4	20	10	50
39. Fossil fuel is a type of recyclable energy resources.	13	65	6	30	1	5	0	0	0	0

The lowest score that can be obtained from Recyclable Energy Awareness Scale, used in this research as one of the data collection tools, is 39 while the highest score is 195. It was determined that the lowest score that was obtained by teacher candidates who participated to this research was 135 while the highest score was 165. Mean score that was obtained from the scale by teacher candidates was calculated as 151,1, while standard deviation was found as 7,683. This result can be interpreted as recyclable energy awareness levels of teacher candidates are medium level.

As seen in Table 4, it was determined that in the scale, teacher candidates replied as “definitely agree” or “agree” for the items of 1, 2, 4, 6, 16, 18, 19, 20, 22 24, 28, 30, 32, 33, 34, 35, 36 and 37; moreover, they replied as “disagree” or “definitely disagree” for the items of 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 21, 23, 25, 26, 27, 29, 31, 36 and 39.

Table 5: t-test results of teacher candidates’ attitudes toward recyclable energy resources

	N	$\overline{X}$	***SS***	t	df	p
Pre-test	20	2,76	0,17	0,94	19	0,36
Post test	20	2,72	0,19			

In Table 5, teacher candidates’ attitudes toward recyclable energy resources pre-test mean score was found as 2,76 while post-test mean score was found as 2,72. A statistically meaningful difference between pre and post-test scores of teacher candidates’ attitudes toward recyclable energy resources was not found since results of t-test that was conducted based on those values was found as (t_{19}=0.36; p>0.05).

100% of teacher candidates replied as “Yes” for the question “Did Lego® Recyclable Energy Set helps you learn Recyclable Energy resources subject” that was asked to teacher candidates, who participated to this research, to determine their opinions and suggestions about robotic supported implementations. Some of the answers of teacher candidates as follow;

T.C-1: *"It helped so much. We did and produced by ourselves. It was a student oriented study."*
T.C-2: *"Yes, it did; it was so enjoyable to build wind turbine by ourselves."*
T.C-3: *"Yes, it did. It engaged in a very enjoyable learning opportunity."*
T.C-4: *"I did not know about the Legos that were used in the lecture, but I learned. It was so beneficial. It requires attention. It made me so happy to see that we generated energy."*
T.C-5: *"Yes, it helped so much. I and my friend designed a car working with wind panel and solar energy. The process was so enjoyable and it was the first time that I had generated energy."*
T.C-6: *"Yes, it helped so much. We designed our own solar system supported car and also we generated our own*

electricity."
Some of the answers that teacher candidates gave for the question “Do you think of using Lego® Recyclable Energy Set while teacher recyclable energy resources when you become a teacher in the future? that was asked to teacher candidates who participated to the research, as follows;

T.C-1: *"Yes, I do. It is an activity which is very practical, enjoyable and based on self-do and self-create method. It is a very good study to teacher the course to students. Any problems do not occur if sufficient time is allocated."*
T.C-2: *"I do. Because learning can be easier while spendings enjoyable time."*
T.C-3: *"I do. Learning can be more active."*
T.C-4: *"I definitely do, I think students can learn easier."*
T.C-5: *"I would like to use it but I believe its cost can be high and every school might not be able to purchase it."*
T.C-6: *"I do. Learning can be more memorable because children learn as doing by themselves. However, we might have difficulty on costs."*
T.C-7: *"I definitely do. It, not only, enhances crafting skills but also create group study opportunities as sustaining learning for subjects as doing-experiencing method."*
T.C-8: *"Yes, I do. Because, it is very enjoyable and informative. The fact that children learn the information while they enjoy can ensure the information becomes permanent."*
T.C-9: "I do. Children are the future. A good future depends on the way they are raised. World’s livability, moreover, is associated with more level of use of recyclable energy resources."

Some of the answers that teacher candidates gave for the question “What kind of advantages can use of Legos in courses provide you? that was asked to teacher candidates who participated to the research, as follows;

T.C-1: "*It engages students more active. Students can find answers for their own questions. They generate their own electricity suing wind or solar system."*
T.C-2: *"When we omit time limitation, it ensures that the subject can be learnt more permanently."*
T.C-3: *"We can embody the subject that we teach abstractly."*
T.C-4: *"I ensure easier learning and the information that is learnt can become more permanent."*

Some of the answers for the question “What kind of advantages can a lecture that was organized with Legos provide students? that was asked to teacher candidates who participated to the research, as follows;

T.C-1: *"The lecture can be more enjoyable and practical. I think every teacher should use it in convenient lectures"*
T.C-2: *"I believe that Legos ensure more permanent learning for students and Legos also develop students' psychomotor skills."*
T.C-3: *"Children can learn as doing-experiencing and this ensures them to learn fast and efficient manners."*
T.C-4: *"My students would learn while enjoying."*
T.C-5: *"Students can learn while enjoying in class and can also develop their crafting skills."*

95% of teacher candidates replied as “Yes” for the question “Would you like to take a robotic based course during your undergraduate education period?” that was asked to teacher candidates who participated to the research. Some of the answers from teacher candidates are as follows;

T.C-1: *"Yes. I would develop myself in different subjects and can learn to use different material and teaching technics for my following academic life. I would like to a different teacher. Robotic education would contribute positively to my academic success. "*
T.C-2: *"I would. I would be a teacher who is more helpful for students as having information from many aspects."*
T.C-3: *"I would. I am sure that the learning that I took during a robotic based course becomes more permanent."*
T.C-4: *"I definitely would. I would like to learn while doing-and-experiencing as leaving monotone course teaching methods."*
T.C-5: *"I would, very much. Because I enjoyed very much in the implementation, I created a product while also learning and this made me so happy. "*
T.C-6/7: *"I would. We learnt while enjoying. I not only enjoyed but also learnt."*
T.C-8: *"Yes, I would. I would like to take that course not only because I would like to develop myself but also to give this course to my students."*

CONCLUSION

In this research, it was aimed to analyze the effect of robotic supported implementation on recyclable energy resources education to science teacher candidates. Before implementation process, “Robotic Pre-Questionnaire” was applied as pre-test to measure teacher candidates' prior knowledge about Robotic subject. According to pre-test results, 55% of teacher candidates stated that they never used Lego parts before this research study. Additionally, 85% of teacher candidates stated in pre-test that they did not have information about Lego Mindstorms Robotic System. Based on these findings, majority of the teacher candidates, who participated to this research, did not use any Lego parts and did not have any information about robotic before the implementation.

Before implementation process, half of teacher candidates thought that they could learn recyclable energy resources subject using Legos. Before implementation process, 40% of teacher candidates stated that they were undecided about use of Legos in the related activities, 40% of them stated that use of Legos would be easy and 20% of them stated that they would have difficulties on using Legos. On the other hand, in post-test, 10% of teacher candidates stated that they had difficulties on using Legos, 5% of them stated that they were undecided while 85% of them stated that use of Legos was easy. This result means that majority of the teacher candidates, who stated that they never used Lego parts before this research, enhanced self-confidence and self-reliance after the implementation process.

After implementation process, all of the teacher candidates stated that they enjoyed the activities. Additionally, all of the teacher candidates stated that they are interested in use of Legos in recyclable energy resources activities.

In the research, it was determined that teacher candidates' awareness toward recyclable energy resources are medium-level. This result is similar to some of the studies in literature (Liarakou et al., 2009; Karabulut et al., 2011; Tiftikçi, 2014). Additionally, a statistically meaningful difference was not found between teacher candidates' attitudes toward recyclable energy resources for pre and post-test.

REFERENCES

Aydınlı, E. (2007). Evaluation of Science Process Skill Study on the 6,7 and 8. Grade Students. Master's Thesis, Gazi University, Ankara.

Güneş, T., Alat, K. & Gözüm, A. İ. (2013). Renewable Energy Sources Attitude Scale for Science Teachers: Validity and Reliability Study. Journal of Educational Sciences Research International E-Journal, Vol: 3, No: 2, 269-289.

Karabulut, A., Gedik, E., Keçebaş, A., & Alkan, M. A. (2011*).* An İnvestigation on Renewable Education at University Level in Turkey. Renewable Energy*, 36*, 1293-1297.

Koç Şenol, A. (2012). Science and technology laboratory applications supported by robotic: ROBOLAB. *Master Thesis, Erciyes University, Graduate School of Education Sciences.*

Liarakou, G., Gavrilakis, C. & Flouri, E. (2009). Secondary school teachers' knowledge and attitudes towards renewable energy sources. *Journal of Science Education and Technology*, *18*(2), 120-129.

Mutlu, O. (2016). Investigation of Levels of Renewable Energy Awareness of Pre-Service Science Teachers (Physics, Chemistry and Biology) Master's Thesis, Süleyman Demirel University, Isparta.

Özdoğru, E. (2013). The Effect of Lego Programme Based Science and Technology Education on the Students' Academic Achievement, Science Process Skills and Their Attitudes Toward Science and Technology Course for Physical Facts Learning Field. Master's Thesis, Dokuz Eylül University, İzmir.

Silik, Y. (2016). Effect of Educational Robotics Applications on Problem Solving Skills of Science Teacher Candidates. Master's Thesis, Karadeniz Technical University, Trabzon.

Tiftikçi, H.İ. (2014). Awareness on Renewable Energy Sources for Last Class of University Students Who are Studying in Different Departments. Master's Thesis, Gazi University, Ankara.

CAN WE CHANGE ATTITUDE TOWARD PHYSICS? OUTCOMES OF TECHNOLOGY SUPPORTED AND LABORATORY BASED INSTRUCTIONS

Feral Ogan-Bekiroglu
Marmara University, Turkey

Onur Oymak
Marmara University, Turkey

ABSTRACT: Attitudes are inferred internal states that appear to modulate behavior. School, particularly classroom, variables such as how well students like their teachers, the science curricula, or the science classroom climate have been found to be key influences on attitudes toward science. This research was framed by activity theory model. The following research question put a light on this research: Is there a significant difference among the attitudes of students towards physics exposed to hands-on laboratory instruction, the attitudes of students exposed to technology supported instruction, and the attitudes of students exposed to curriculum-based instruction? True experimental design was carried out for this research. The participants of this study were 144 9^{th} grade students studying in an all-boys state high school. The students who were in the technology supported classroom constituted the first experimental group while the students in the laboratory based classroom comprised the second experimental group. There was also one control group whose students were taught based on the curriculum. Each group had 48 students. Teacher of three groups was the same person. Data were collected in the physics lessons. In order to determine any change in the students' attitudes towards physic, "Physics Lesson Attitude Scale" was used. Effect sizes were calculated for the changes in students' attitudes. Two conclusions can be drawn from the study. First, when students are given a chance to engage with technology supported and laboratory based instructions, they tend to develop more positive attitudes toward physics. And second, there is no difference between the technology supported instruction and laboratory based instruction in terms of their impact on students' attitudes toward physics.

Keywords: Attitude, instruction, technology, laboratory, science

INTRODUCTION

Attitudes are inferred internal states that appear to modulate behavior (Gagne, 1984). In general, attitudes are considered to include three different aspects. One is a cognitive aspect, that is, an idea or a proposition. The second is an affective aspect, the feelings that accompany the idea. The third is a behavioral aspect that pertains to the readiness or predisposition for action (Gagne, 1985, p.222). Attitude towards science is often treated as one concept, but includes many dimensions depending on different meanings of "science" and in which contexts these occur (Barmby, Kind, & Jones, 2008). Siegel and Ranney (2003) state that modest positive correlations between science attitude and science achievement have been reported in many studies; as a result, work in the realm of students' attitudes toward science has been motivated by the desire to increase interest, performance, and student retention in science (Third International Mathematics and Science Study, as cited in Siegel & Ranney, 2003). However, a concern for many countries is the falling numbers of students choosing to pursue the study of science, alongside the increasing recognition of the importance and economic utility of scientific knowledge (Barmby, et al., 2008). During the last three decades many researchers have reported declines in attitudes toward science among students of all ability levels during middle or high school (Zacharia & Barton, 2004). School, particularly classroom, variables such as how well students like their teachers, the science curricula, or the science classroom climate have been found to be key influences on attitudes toward science (Zacharia & Barton, 2004). Therefore, the purpose of this research was to examine if students' attitudes towards science would change when the instruction is changed.

THEORETICAL FRAMEWORK

This research was framed by activity theory model which represents activity as a dynamic unity of several elements which interact with each other as an activity develops (Engeström, Miettinen & Punamäki, 1999). The subject of activity can be either a teacher or a learner depending on the purposes of analysis. When considering a teacher's activity, the object of the activity can be seen as enhanced teaching using a pedagogical tool (Kaptelinin & Nardi, 2006).

According to Engeström, Miettinen and Punamäki (1999), activity is motivated by the objects to be changed and object orientedness as well as mediation by tools is one of the most distinguishing characteristics of activity. Tools are seen as having extended human ability to achieve the goals of an activity; that is, to change objects in the world. This theory treats tools as a means of meeting real needs and achieving corresponding goals (Kaptelinin & Nardi, 2006).

Correspondingly, it was assumed that students' attitudes towards physics would change when a teacher used tools, i.e. technology and laboratory experiments.

EFFECTS OF INSTRUCTIONAL STRATEGIES ON STUDENTS' ATTITUDES

The rapid growth of computing and networks offers increasing and ever-changing potentials for technology use in education. Technology simultaneously ushers the tasks of creating, evaluating, analyzing, and applying through collaboration into the classroom while generating greater enthusiasm for learning (Cicconi, 2014), which is related to attitude. Students indicate higher interests in learning strategies related to technology (La Velle, McFarlane, & Brawn, 2003). Ranging from drawings on a blackboard or interactive multimedia simulations to etchings on a clay tablet or Web-based hypertexts to the pump metaphor of the heart or the computer metaphor of the brain, technologies have constrained and afforded a range of representations, analogies, examples, explanations, and demonstrations that can help make subject matter more accessible to the learner (Koehler & Mishra, 2008).

Considerable amount of research has focused on the impact of using technology on students' attitudes. Marty (1985), for example, investigated the effects of interaction with computerized simulation game on high school students' attitudes. Analysis revealed very little difference in the change of class means on attitudes. Grimm (1995) examined the effect of technology rich educational environments on student attitude by comparing type of school (technology-rich school (TRS) and traditional school (TS)). The overall findings indicated that TRS environments contributed to students' overall attitudes for 6^{th}-grade and ll^{th}-grade students. The participants of the research done by Kenar, Balci and Gokalp (2013) were fifth grade students who were divided in two groups. The experimental group was instructed with tablet computer assisted instruction and the control group was instructed with traditional methods during science and technology courses. The results of the study showed that the tablet computer assisted instruction had both negative and positive impacts on the students' attitudes toward science.

Encouragement also continuous for implementing hands on science and laboratory activities. Hands-on approach in science education provides the student with engaging activities during the learning process (Wiggins, 2006). Research implies that when properly designed use of the laboratory and hands-on activities can influence attitude toward science in a positive way (Freedman, 1995).

Some research investigated the benefits of laboratory instruction on students' attitudes towards science. For instance, Norton (1985) compared college students in the experimental group who were told to work independently and did not get any instructional help with the students in the control group who continued with step-by-step verification laboratory exercises, working in pairs with direct supervision and instruction. Results indicated that the treatment of the independent laboratory investigation did not have a significantly different effect on the dependent measures of scientific attitude when compared to the effect of the performance of verification laboratory exercises by a control group. Freedman (1997) investigated the use of a hands-on laboratory program as a means of improving student attitude toward science. It was concluded that laboratory instruction influenced, in a positive direction, the students' attitudes toward science. Adesoji and Raimi (2004) examined the effect of supplementing laboratory instruction with problem solving strategy and or practical skills teaching on students' attitudes toward chemistry. Senior secondary class II students took part in the study. The results revealed that the use of enhanced laboratory instructional strategy significantly improved the attitudes of students toward chemistry. Wiggins (2006) concerned with the influence of hands-on science instruction versus traditional science instruction on middle school students' attitudes. A statistically significant difference was not found in the attitude scores of middle school students who were exposed to hands-on or traditional science instruction.

Some research compared the impact of technology with effects of laboratory (Azar & Sengulec, 2011; Coramik, 2012; Darrah et al., 2014; Finkelstein et al., 2005; Zacharia & Anderson, 2003). Azar and Sengulec (2011) stated that computer-assisted teaching with the participation of 50 students from high school 9th grade with simple electrical circuits might be more effective in the attitudes of the students towards the physics lesson than the laboratory assisted teaching. Coramik (2012) explored the outcomes of using computers and experiment-assisted activities in the teaching of the magnetism unit in the 11th grade physics course to the students' attitudes towards the physics course. It was seen that attitude scores of the students in the experiment-supported teaching group were higher than the scores of the students in the computer-assisted teaching group.

Research produced miscellaneous results; hence, more studies are needed to reveal which instructional strategy is more influential in changing students' attitudes. Moreover, research comparing technology supported instruction to hands-on laboratory activities with each other and to curriculum-based instruction is not ample. Thus, the following research question put a light on this research: Is there a significant difference among the attitudes of students towards physics exposed to hands-on laboratory instruction, the attitudes of students exposed to technology supported instruction, and the attitudes of students exposed to curriculum-based instruction?

METHOD

True experimental design was used for this research (Krathwohl, 1997). There were two experimental groups and one control group. The first experimental group was instructed with technology supported teaching and the second experimental group was instructed with laboratory based teaching while the control group followed the curriculum and was exposed to curriculum based teaching. The participants of the study were 144 9th grade male students. Each group had 48 students. The research was conducted in a physics class in an all-boys state high school. Teacher of all groups was the same person. The students were taking the class two hours a week. The instruction continued in the dynamics unit and lasted 8 weeks. Simulations, video recordings, smart board, tablets and z-book were used as the technology in the first experimental group. The second experimental group did hands on science by using experiment sets.

Quantitative research methods were used to gather data. In order to measure the changes in the participants' attitudes towards physics, Physics Class Attitude Scale (PCAS) developed by Geban et al. (1994) was applied to the participants before and after the treatment. This instrument consisted of 15 items with 5-point Likert scale. The scoring was between 15-75. The following factors constituted of the instrument: Liking physics, interest to physics, and necessity of physics. Descriptive statistics and t-tests were performed to analyze the data. Effect sizes were calculated for the changes both within and between the groups. Reliability measurements were made with the help of Cronbach alpha test.

RESULTS AND DISCUSSION

The application of Physics Class Attitude Scale had high reliability where Cronbach Alpha value for the pre-test was .90 while this value was .93 for the post-test. Table 1 presents that there was no significant difference among the groups' pre-test results when the attitude took into account.

Table 1. Independent t-Test Results of the Groups' Pre-Tests

Groups	**n**	$\bar{x}$	**ss**	**t**	**sd**	**p**
Technology	44	47.57	9.89			
Laboratory	43	49.09	9.70	-.726	85	.470
Total	87					
Technology	44	47.57	9.89			
Curriculum based	44	49.70	11.51	-.934	86	.353
Total	88					
Laboratory	43	49.09	9.70			
Curriculum based	44	49.70	11.51	-.268	85	.790
Total	87					

However, according to Table 2, significance differences were explored within the technology and within the laboratory groups in terms of pre- and post-test results. Technology group significantly increased their mean values for attitude toward physics from 47.57 to 54.72 ($p = .001$). Similarly, the laboratory group's mean value significantly improved from 49.09 to 56.45 ($p = .00$). Effect sizes (Hedges & Olkin, 1985) for the post-application of the PCAS neither in the technology group ($d = .36$) nor in the laboratory group ($d = .38$) were not found to exceed Cohen's (1988) convention for a large effect ($d = .80$). However, little advancement in the curriculum-based group's attitude towards physics from the pre-test to post-test was not significant. Results indicate that when the students involved with more activities including technology and laboratory, their attitudes towards physics class enhanced.

Table 2. Dependent t-Test Results Within the Groups' Pre- and Post-Tests

Groups	n	$\bar{x}$	ss	t	sd	p
Technology pre-test	44	47.57	9.89			
Technology post-test	43	54.72	8.57	-3.602	85	.001
Total	87					
Laboratory pre-test	43	49.09	9.70			
Laboratory post-test	47	56.45	7.80	-3.978	88	.000
Total	90					
Curriculum based pre-test	44	49.70	11.51			
Curriculum based post-test	37	45.38	15.10	1.428	66.511	.158
Total	81					

Additionally, significance differences were found between the post-tests of the technology group and curriculum-based group as well as between the laboratory group and curriculum group as seen in Table 3. The mean value of the technology group ($\bar{x}$ = 54.72) was significantly higher than the mean value of the curriculum-based group ($\bar{x}$ = 45.38, p = .002). Likewise, the laboratory group's mean value ($\bar{x}$ = 56.45) was significantly higher than the curriculum-based group's mean value ($\bar{x}$ = 45.38, p = .00). The effect size between the technology and curriculum based groups was .35 and the effect size between the laboratory and curriculum based groups was .42. In addition, there was not any significant difference between the post-tests of the technology group and laboratory group. In other words, neither technology supported instruction nor laboratory based instruction displayed superiority on attitude toward science. This finding explains the miscellaneous results in the literature.

Table 3. Independent t-Test Results of The Groups' Post-Tests

Groups	n	$\bar{x}$	ss	t	sd	p
Technology	43	54.72	8.57			
Laboratory	47	56.45	7.80	-1.000	88	.320
Total	90					
Technology	43	54.72	8.57			
Curriculum-based	37	45.38	15.10	3.331	55.090	.002
Total	80					
Laboratory	47	56.45	7.80			
Curriculum-based	37	45.38	15.10	4.054	50.975	.000
Total	84					

Technology group developed more attitude towards physics class than the curriculum based group. This result is consistent with the results presented by Marty (1985) and Grimm (1995). Laboratory group performed more progression in their attitudes than the curriculum based group. This finding is in line with the results that emerged from the research by Freedman (1997). The results revealed that science instruction that was activity-based (Freedman. 1997) was shown to enhance positive attitudes toward science.

Attitude change takes time and needs having experiences. Since there was not any change in terms of instruction in the curriculum-based group, any change in attitudes of the students' in the curriculum-based group was not expected. Since the participants were ninth grade students and studied physics discipline for the first time, eight-week duration was enough for the students in the technology and laboratory groups to change their attitudes.

CONCLUSIONS AND SUGGESTIONS

Two conclusions can be drawn from the study. First. when students are given a chance to engage with technology supported and laboratory-based instructions, they tend to develop more positive attitudes toward physics. And second, there is no difference between the technology supported instruction and laboratory based instruction in terms of their impact on students' attitudes toward physics.

Haladyna, Olsen and Shaughnessy (1982) posit that students' attitudes toward science are determined by three independent constructs: teacher, student, and learning environment. Results of this study show that when learning environment is changed by changing the instruction, students' attitudes toward science alter in a positive way.

The results underscore the need for high school science teachers to adopt the use of laboratory based and technology supported instructions in order to promote high level attitude toward science, which stimulates students' learning of science.

REFERENCES

Adesoji. F.A. & Raimi. S.M. (2004). Effects of Enhanced Laboratory Instructional Technique on Senior Secondary Students' Attitude Toward Chemistry in Oyo Township. Oyo State. Nigeria. *Journal of Science Education and Technology. 13*(3). 377-385.

Azar. A. & Sengulec. O. A. (2011). Computer-assisted and laboratory-assisted teaching methods in physics teaching: The effect on student physics achievement and attitude towards physics. *Eurasian Journal of Physics and Chemistry Education (special issue)*. 43-50.

Barmby. P. Kind. P. M., & Jones. K. (2008). Examining changing attitudes in secondary school science. *International Journal of Science Education*. *30*(8). 1075-1093

Cicconi. M. (2014). Vygotsky meets technology a reinvention of collaboration in the early childhood mathematics classroom. *Early Childhood Education Journal. 42*. 57-65.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale: Lawrence
Earlbaum Associates.

Coramik. M. (2012). *The effect of teaching magnetism unit with computer-aided and experiment-aided activities on 11th grade students? self-efficacy. metacognition. attitude. motivation and conceptual understanding.* Unpublished Master Thesis. Balıkesir University. Balikesir.

Darrah. M., Humbert. R., Finstein. J., Simon. M., & Hopkins. J. (2014). Are virtual labs as effective as hands-on labs for undergraduate physics? A comparative study at two major universities. *Journal of Science Education and Technology*. 23(6). 803-814.

Engeström. Y., Miettinen. R., & Punamäki. R. L. (1999). *Perspectives on activity theory*. Cambridge University Press.

Finkelstein. N. D., Adams. W. K., Keller. C. J., Kohl. P. B., Perkins. K. K., Podolefsky. N. S.. . . . LeMaster. R. (2005). When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment. *Physics Review Special Topics Physics Education Research 1*. 1-8.

Freedman. M. P. (1995). *The relationship between laboratory instruction. attitude toward science. and physical science achievement among diverse ninth grade students.* Unpublished doctoral dissertation. Temple University. Philadelphia. PA

Freedman. M. (1997). Relationship Among Laboratory Instruction. Attitude Toward Science and Achievement in Science Knowledge. *Journal of Research in Science Teaching*. *34*(4). 343-357.

Gagne. R. M. (1984). Learning outcomes and their effects: Useful categories of human performance. *American Psychologist*. 37(4). 377-385

Gagne. R. M. (1985). *The Conditions of Learning* (4th ed.). New York: Holt. Rinehart & Winston.

Geban. Ö., Ertepınar. H., Yılmaz. G., Atlan. A., & Şahpaz. Ö. (1994). *Bilgisayar destekli eğitimin öğrencilerin fen bilgisi başarılarına ve fen bilgisi ilgilerine etkisi.* I. Ulusal Fen Bilimleri Eğitimi Sempozyumu. Dokuz Eylül Üniversitesi. İzmir.

Grimm. C. R. (1995). *The effect of technology-rich school environments on academic achievement and attitudes of urban school students*. Unpublished doctoral dissertation. Old Dominion University. Norfolk. VA.

Haladyna, T., Olsen, R., & Shaughnessy, J. (1982). Relations of student, teacher, and learning environment variables to attitudes toward science. Science Education, 66(5), 671-687.

Hedges, L., & Olkin, I. (1985). *Statistical methods for meta-analysis*. New York: Academic

Kaptelinin. V., & Nardi. B. A. (2006). *Acting with technology: Activity theory and interaction design*. MIT press.

Kenar. I., Balci. M., & Gokalp. M. S. (2013). The Effects of Tablet Computer Assisted Instruction on Students' Attitude toward Science and Technology Course. *International Journal of Science Education. 5*(3). 163-171

Koehler. M.J., & Mishra. P. (2008). Introducing TPCK. AACTE Committee on Innovation and Technology (Ed.).

The handbook of technological pedagogical content knowledge (TPCK) for educators (pp. 3-29). Mahwah. NJ: Lawrence Erlbaum Associates.

Krathwohl. D. R. (1997). *Methods of educational and social science research: An integrated approach*. Reading. UK: Addison-Wesley.

La Velle. L. B., McFarlane A., & Brawn. R. (2003). Knowledge transformation through ICT in science education: A case study in teacher-driven curriculum development. *British Journal of Educational Technology*. *34*(2). 183-199.

Marty. J. F. (1985). *Selected effects of a computer game on achievement. attitude. and graphing ability in seconday shool algebra*. Unpublished doctoral dissertation. Oregon State University. Corvallis. OR.

Norton. S. W. (1985). *The Effects of an independent laboratory investigation on the critical thinking ability and scientific attitude of students in a general microbiology class*. Unpublished doctoral dissertation. Auburn University. Auburn. AL.

Siegel. M. A. & Ranney. M. A. (2003). Developing the changes in attitude about the relevance of science (CARS) questionnaire and assessing two high school science classes. *Journal of Research in Science Teaching*. *40*(8). 757-775.

Wiggins. F. (2006). *The effects of hands-on science instruction on the science achievement of middle school students.* Unpublished doctoral dissertation. Texas Southern University. Houston. TX.

Zacharia. Z.. & Anderson. O. R. (2003). The effects of an interactive computer-based simulation prior to performing a laboratory inquiry-based experiment on students' conceptual understanding of physics. *American Journal of Physics*. *71*(6). 618-629.

Zacharia. Z., & Barton. A. C. (2004). Urban middle-school students' attitudes toward a defined science. *Science Education. 88*. 197-222.

THE COMPARISONS OF THE FRACTIONAL GAIN IN CONCEPTUAL LEARNING BY USING PEER INSTRUCTION

Tolga Gok
Dokuz Eylul University, Turkey

ABSTRACT: Conventional, teacher centered teaching is not sufficient in science, technology, engineering and mathematics education at the present time. Therefore, new teaching strategies and methods have consistently been developed by the educators. One of the new developed teaching methods is peer instruction. Peer instruction is interactive teaching method. Peer instruction is quite easy and practical to implement therefore peer instruction might be adapted to different disciplines of science, social sciences, and engineering. The effectiveness of peer instruction and conventional, teacher centered teaching on students' conceptual learning were compared by calculating fractional gains with the help of some standardized tests including "Force Concept Inventory-FCI, Force and Motion Conceptual Evaluation-FMCE, Conceptual Survey of Electricity and Magnetism, CSEM" in this study. The normalized gains of studies performed and recorded between 1990 and 2016 were evaluated and discussed. When the examined studies were generally interpreted, students' conceptual understanding performance instructed with peer instruction was higher than students' conceptual learning performance instructed with conventional, teacher centered teaching.

Keywords: conceptual learning, peer instruction, standardized tests

INTRODUCTION

Conventional, teacher centered teaching is not efficient and useful to teach and to learn not only for instructors but also for students (Gok, 2014; Hake, 1998). Smith, Sheppard, Johnson & Johnson (2005, p.8) defined conventional, teacher centered teaching as "the information passes from the notes of the professor to the notes of the students without passing through the mind of either one." Many research (Gok, 2015; Gok & Gok, 2016; Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt, & Wenderoth, 2014; Preszler, Dawe, Shuster, & Shuster, 2007) reported that conventional, teacher centered teaching is not sufficiently effective on problem solving performance, conceptual understanding, attitude and self-efficacy of the students. The instructors teach actively and transfer needed information to the students; on the other hand, the students listen to the instructors passively in conventional, teacher centered teaching. Conversely, the roles of the instructors and students change in interactive-engagement courses based on active learning as presented in Figure 1.

Many physics instructors have been using alternative teaching strategies and different educational methods instead of conventional, teacher centered teaching in their courses recently. Therefore, new teaching methods and approaches are developed by the teaching experts. One of the new developed teaching methods is peer instruction. Peer instruction (PI) was developed by Eric Mazur (1997). Peer instruction is "an effective method that teaches the conceptual underpinnings in introductory physics and leads to better student performance on conventional problems" (p. 10, Mazur, 1997). The description of peer instruction according to Michinov, Morice, & Ferriéres (2015, p.1) is "an interactive student-centred instructional strategy for engaging students in class through a structured questioning process that improves the learning of the concepts of fundamental sciences." Peer instruction based on constructivist learning theory and social constructivism (Michinov et al., 2015; Yaoyuneyong & Thornton, 2011) is an interactive teaching method for the instructor and an active learning for the students in the classroom.

The main purpose of peer instruction is to provide students interaction during class and to focus the attention of the students on fundamental concept(s) and/or principle(s). Peer instruction was first conducted to introductory physics course at Harvard University. Mazur (1997) evaluated the conceptual learning of the students by using a standardized test, Force Concept Inventory (FCI). He reported that the conceptual learning performance of the students instructed with peer instruction was higher the conceptual learning of the students instructed with traditional instruction, "conventional, teacher centered teaching". Besides, many studies (Crouch & Mazur, 2001; Lasry, Charles, & Whittaker 2016; Suppapittayaporn, Emarat, & Arayathanitkul, 2010) have been revealed the effectiveness of peer instruction on students' conceptual learning, problem solving skills, critical and analytical skills in different disciplines (Biology, Engineering, Calculus, Chemistry, Philosophy, etc.) and courses relative to conventional, teacher centered teaching.

Figure 1. The Roles of Instructor and Student in Traditional (a) and Peer Instruction Courses (b)
Note: (These photographs were taken from the web-pages respectively
(a) http://study.com/articles/The_Differences_Between_Online_and_Traditional_Classroom_Educations.html
(b) http://perusersguide.org/guides/section.cfm?G=Peer_Instruction&S=What

Peer instruction is combined teaching and learning model. Peer instruction with *just in time teaching* (Novak, Gavrin, Christian, & Patterson, 1999) provides students to do warm-up exercises, peer instruction with *tutorials in introductory physics* (McDermott, Shaffer, & PEG at UW, 2002). It provides students to enhance their engagement toward physics courses and peer instruction with group-problem solving activities (Heller, Keith, & Anderson, 1992; Heller & Hollabaugh, 1992) provides students to solve qualitative and quantitative problem and so on.

Peer instruction has been conducted in associated with other interactive teaching and learning strategies (Gok, 2015; Michinov, Morice, & Ferriéres, 2015; Novak et al., 1999; Sayer, Marshman, Singh, 2016; Simon, Esper, Porter, & Cutts, 2013; Smith, Wood, Adams, Wieman, Knight, Guild, & Su, 2009; Wang & Murota, 2016) such as flipped classroom, just in time teaching, wikis, think pair share, problem solving strategy steps, structured inquiry and stepladder technique to be more effective, useful, and practicable.

The application procedures of peer instruction were explained step by step as follows:

1. Instructor presents brief lecture by using several short presentations in a course.
2. Instructor asks students a concept test question regarding each short presentation. An example of concept test question asked during the application procedure of peer instruction could be given in Figure 2.

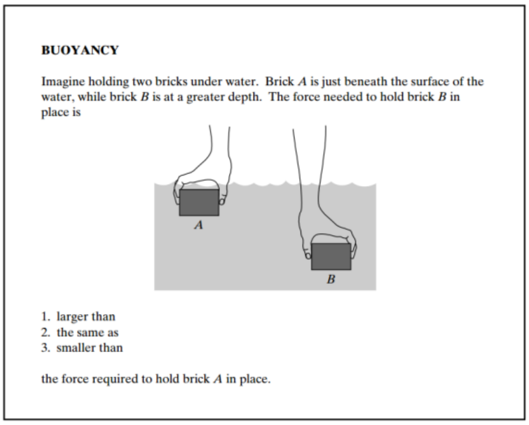
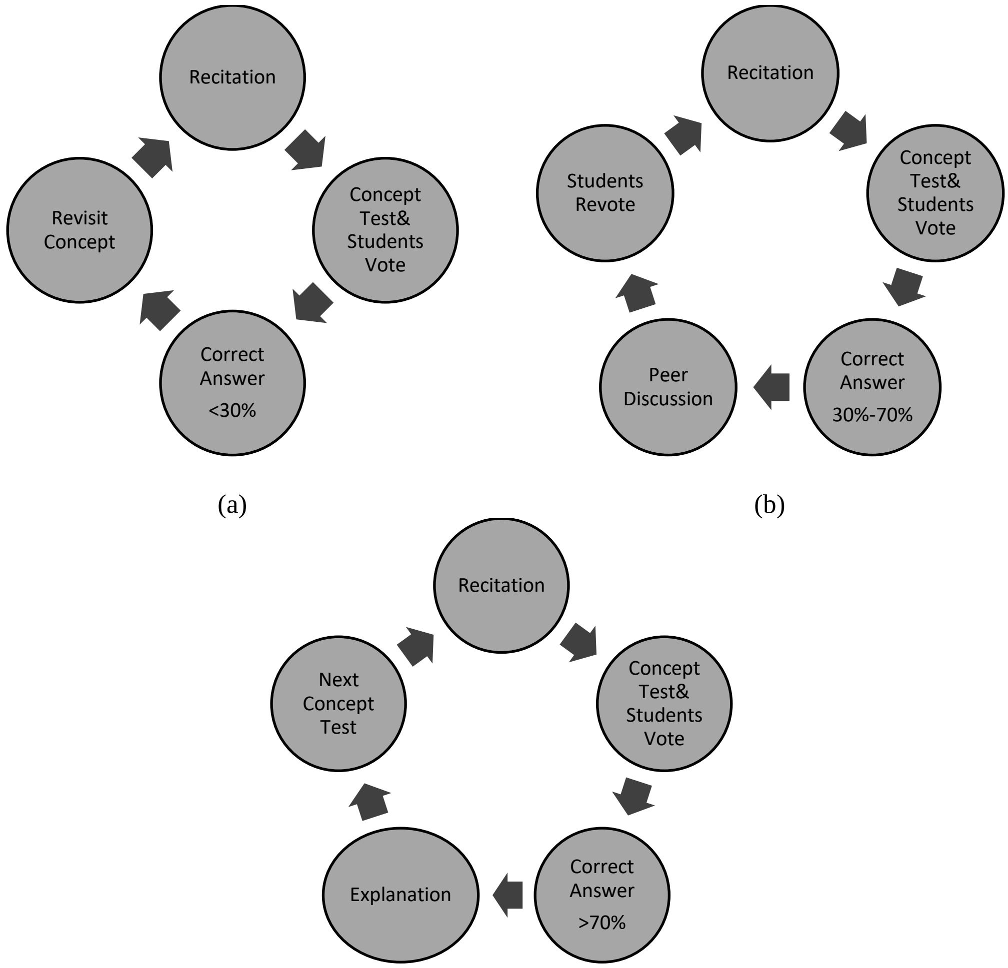


Figure 2. An Example of Concept Test Question on (Mazur, 1997, p.11)

3. Time is given to student about each concept test question.
4. Students record or report their answers individually.
5. Students show their answers by using low technological tool-flashcards (ABCDE) or high technological tools (classroom response systems, tablets etc.).
6. Instructor evaluates and analyzes their responses. The instructor comes across three circumstances for their answers as follows:
    a) If the students' performance is lower than 30%, the instructor repeats concept in question by using the same short presentation as shown in Figure 3a.

b) If the students' performance is between 30% and 70%, the instructor begins to discuss about concept test question among peers and the students try to convince each other on correct result. At the end of peers' discussion, the same concept test is voted again as indicated in Figure 3b.
c) If the students' performance is higher than 70%, the instructor shortly explains the correct results and then the instructor passes another concept test question or a new short presentation as demonstrated in Figure 3c.



(a) (b) (c)

Figure 3. The Application Procedures of Peer Instruction (Lasry, Mazur, & Watkins, 2008)

The given time for application procedures of peer instruction might be changed according to disciplines, courses, instructors, students and other factors.

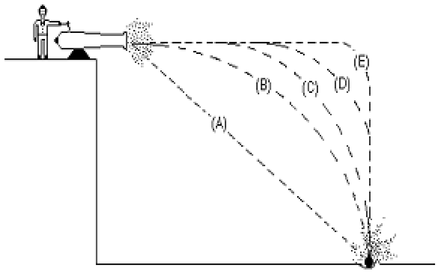
The main purpose of this study was to examine, compare and analyze the effectiveness of peer instruction and conventional, teacher centered teaching on students' conceptual learning. The results of some standardized tests "Force Concept Inventory-FCI, Force and Motion Conceptual Evaluation-FMCE, Conceptual Survey of Electricity and Magnetism, CSEM" between 1990 and 2016 were used for identifying students' conceptual learning with the help of fractional gain formula developed by Hake (1998).

METHODS

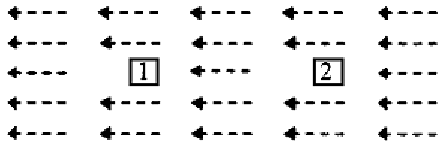
Some physics standardized tests between 1990 and 2016 were examined in order to compare the learning (fractional/normalized) gains of the students instructed with peer instruction and conventional, teacher centered teaching. Therefore, open access journals, proceedings, and dissertations were searched to obtain the data of the present study. Examined physics standardized tests were "Force Concept Inventory-FCI" (Hestenes, Wells, & Swackhamer, 1992), "Force and Motion Conceptual Evaluation-FMCE" (Thornton & Sokoloff, 1998), and "Conceptual Survey in Electricity and Magnetism-CSEM" (Maloney, O' Kuma, Hieggelke, Van Heuvelen, 2001).

Many researchers generally used indicated standardized tests in order to compare and evaluate the effectiveness of the developed educational strategies relative to conventional, teacher centered teaching; therefore, the author preferred to use these tests in the present study. Sample questions regarding standardized tests respectively were given in Figure 4.

A ball is fired by a cannon from the top of a cliff as shown in the figure below. Which of the paths would be cannon ball most closely follow?

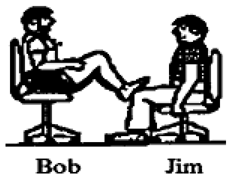


A positive charge might be placed at one of two different locations in a region where there is a uniform electric field, as shown below.



How do the electric forces on the charge at positions 1 and 2 compare?
a) Force on the charge is greater at 1.
b) Force on the charge is greater at 2.
c) Force at both positions is zero.
d) Force at both positions is the same but not zero.
e) Force at both positions has the same magnitude but is in opposite directions.

Two students sit in identical office chairs facing each other. Bob has a mass of 95kg, while Jim has a mass of 77kg. Bob places his bare feet on Jim's knees, as shown to the right. Bob then suddenly pushes outward with his feet, causing both chairs to move. In this situation, while Bob's feet are in contact with Jim's knees,



a) Neither student exerts a force on the other.
b) Bob exerts a force on Jim, but Jim does not exert any force on Bob.
c) Each student exerts a force on the other, but Jim exerts the larger force.
d) Each student exerts a force on the other, but Bon exerts the larger force.
e) Each student exerts the same amount of force on the other.
j) None of these answers is correct.

Figure 4. Sample Questions: The First Question for FCI, The Second Question for FMCE and The Third Question for CSEM

The contents of the standardized tests were presented respectively as follows: The fundamental concepts of FCI including 29 items consist of "kinematics", "Newton's first law", "Newton's second law", "Newton's third law", "superposition principle", and "kinds of force". The fundamental concepts of FMCE including 43 items comprise of several application questions (force sled, cart on ramp, coin toss, force graph etc.) based on "force and motion" concepts. The fundamental concepts of CSEM including 32 items cover "charge distribution on conductors/insulators", "Coulomb's force law", "electric force and field superposition", "force caused by an electric field", "work, electric potential, field and force", induced charge and electric field", "magnetic force", "magnetic field caused by a current", "magnetic field superposition", "Faraday's law", and "Newton's third law".

The learning gains of the students were analyzed by using Hake's fractional gain formula as shown below. Hake (1998) developed a formula and then determined three specific intervals (high, medium, and low) for fractional gain. High gain-g is higher than 0.7; medium gain-g is between 0.7 and 0.3; low gain-g is lower than 0.3.

$$Fractional\ Gain < g > = \frac{posttest\% - pretest\%}{100\% - pretest\%}$$

Hake (1998) used Force Concept Inventory-FCI and Mechanics Diagnostic-MD test as standardized tests. The purpose of these tests was to determine the conceptual learning of students about Classical (Newtonian) Mechanics. He also used Mechanics Baseline (MB) test for testing problem solving skills of students. He compared the effectiveness of traditional introduction methods and interactive-engagement (IE) methods on students' conceptual learning and problem-solving skills. Hake (1998) defined interactive-engagement methods "designed at least in part to promote conceptual understanding through interactive engagement of students in heads-on (always) and hands-on (usually) activities which yield immediate feedback through discussion with peers and/or instructors" (p.65).

Hake (1998) conducted to 6542 high school, college, and university students enrolled in 62 different introductory physics courses in order to be taken average normalized gain "g" by using above-mentioned standardized tests as pre-test and post-test. 62 introductory physics courses consisted of 14 high school-HS- (N=1113 students), 16 college-C- (N=597), and 32 university-U- (N=4832) courses. 14 physics courses of 62 introductory physics courses were instructed with traditional instruction methods with the participation of 2084 students. The other 48 physics courses were instructed by interactive-engagement methods with the participation of 4458 students.

The distribution of introductory physics courses instructed with interactive engagement methods were "Collaborative Peer Instruction" (Heller, Keith, Anderson, 1992; Heller & Hollabaugh, 1992; Johnson, Johnson, & Smith, 1991) in 48 courses, "Microcomputer-Based Labs" (Thornton & Sokoloff, 1990) in 35 courses, "Concept Tests" (Mazur, 1997) in 20 courses, "Modeling" (Wells, Hestenes, & Swackhamer, 1995) in 19 courses, "Active Learning Problem Sets (ALPS)" or "Overview Case Studies (OCS) Physics" (Van Heuvelen, 1991) in 17 courses, physics-education-research based text or no text in 13 courses, and "Socratic Dialogue Inducing (SDI) labs" (Hake, 1992) in 9 courses were conducted.

Hake (1998) averagely calculated the fraction gains at the end of the research. The fractional gain was found as g=0.23±0.04 (low-g $(< g >) < 0.3$) for traditional instruction methods while the fractional gain was calculated as g=0.48±0.14 (medium-g. $0.7 > (< g >) \geq 0.3$) for interactive-engagement methods. Average fractional gain of traditional courses was found as low-g ($< g > = 0.23$). Fractional gain of IE courses were calculated as $< g_{10HS} > = 0.55 \pm 0.11, < g_{13C} > = 0.48 \pm 0.12, < g_{25U} > = 0.45 \pm 0.15$ respectively. The difference between interactive engagement methods and traditional instruction methods ($< g_{48IE} > - < g_{14TI} > = 0.25$) is 1.8 standard deviations of IE courses and 6.2 standard deviations of traditional courses. Consequently, interactive engagement methods were more than twice ($< g_{IE} > = 2.1 \ < g_{TI} >$) as effective in constructing fundamental concepts as traditional introduction methods.

He also compared the achievement of the students' problem solving for both interactive engagement courses and traditional courses by using MB test. At the end of the research, the problem-solving achievement of the students instructed with IE courses had higher problem solving achievement of the students instructed with traditional methods. These results were supported by Mazur’s (1997) research.

The results obtained from research were analyzed and interpreted in consideration of Hake's findings and assumptions in the present study.

RESULTS AND FINDINGS

The comparison of some specific characteristics (pre-test and post-test score percentages, the differences between pre-test and post-test, fractional gains of the tests and the number of the students) between peer instruction and traditional instruction was given in Table 1. Many physics researchers generally use the physics standardized tests " Force Concept Inventory-FCI, Force and Motion Conceptual Evaluation-FMCE, Conceptual Survey in Electricity and Magnetism-CSEM" which were statistically analyzed the validity and reliability of them. Researchers prefer to use these tests for comparing the effectiveness of a new educational method on students' performance and problem-solving skills. The given data in Table 1 was examined and interpreted in three categories (FCI, CSEM, and FMCE) as follows:

FCI

Crouch & Mazur (2001) revealed the effectiveness of peer instruction from 1991 to 2000. They calculated the fractional gain of introductory physics course as low-g "0.25" for traditional instruction methods. After they instructed the introductory physics courses with peer instruction, the fractional gains of introductory physics courses were found between 0.40 and 0.74. The fractional gains of peer instruction are referred medium-g. The fractional gain of peer instruction was only obtained high-g in 1997.

The research on calculating of fractional gain with the help of peer instruction between 2000 and 2008 could not be encountered in open access database. Lasry (2008) published a research paper. He compared and examined the effectiveness of peer instruction by using higher technological tool (classroom response system) and flashcards. He calculated the fractional gain for both classroom response system and flashcards as medium-g. Kalman, Milner-Bolotin, & Antimirova (2010) modified peer instruction (M-PI) approach and they compared the effectiveness of modified peer instruction and collaborative group. At the end of the research they reported the fractional gains for both modified peer instruction and collaborative group as medium-g.

The examined results were supported by the results of Antwi, Raheem, & Aboagye (2016), Gok (2012b, 2014) and Nishimura & Nitta (2014). But Harvey (2013) reported the fractional gains for both peer instruction and traditional instruction as low-g. Recently Lasry et al., (2016) analyzed the conceptual learning performance of students by using FCI. They revealed the similar fractional gain of traditional instruction and peer instruction as medium -g.

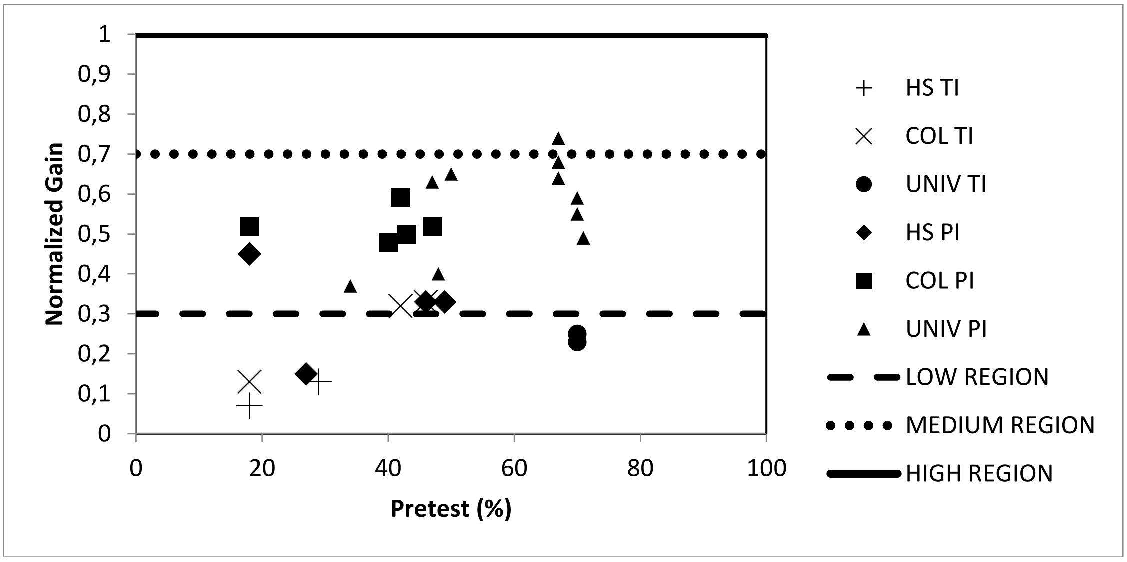


Figure 5. The Relationship between Normalized Gains and Pre-Test Scores on Force Concept Inventory
Note: HS: High School; COL: College; UNIV: University; TI: Traditional Instruction; PI: Peer Instruction

The relationships between normalized gains and pre-test scores on Force Concept Inventory were presented in Figure 5. The relationships were determined according to Hake (1998)' fractional gains (low-g, medium-g, and high-g). The pre-test scores of university students for both peer instruction and traditional instruction were mostly higher than the pre-test scores college and high school students. Therefore, the normalized gains of university students were slightly lower than the gains of college and high school students.

This is because university students learnt the fundamental concepts of introductory physics course when they came to that level. High school students' pre-test scores according to university students' pre-test scores were quite low because of having not sufficient knowledge. Consequently, the raise of high school students' fractional gain was considerable.
The learning gains of university, high school and college students instructed with peer instruction were usually found in medium-g region $(0.7 > (< g >) \geq 0.3)$. The learning gains of university, high school and college students instructed with traditional instruction were generally calculated in low-g region $\big((< g >) < 0.3\big)$. The learning gains of students taught with traditional instruction for each level were eventually low according to the learning gains of the students instructed with peer instruction. In light of these findings it could be said that the traditional instruction methods are not sufficient not only to teach the fundamental principles of introductory physics courses for instructor but also to learn the fundamental concepts of physics for students.

CSEM

Gok (2011) compared the effectiveness of peer instruction by using classroom response system with respect to flashcard on students' conceptual understanding about the principles of electricity and magnetism with the help of Conceptual Survey of Electricity and Magnetism (CSEM). He calculated the fractional gains as g=0.54 (medium-g) for classroom response system and g=0.29 (low-g) for flashcard. When the results were compared for both classroom approaches, it could be said that the effectiveness of peer instruction with classroom response system on students' conceptual learning was higher than the usage of flashcard. Gok (2012a) examined the difference between peer instruction and traditional instruction in students' conceptual learning by using CSEM. At the end of this research, the fractional gain (medium-g "0.62") of peer instruction was found higher than the fractional gain (low-g "0.36") of traditional instruction.

FMCE

Suppapittayaporn et al. (2010) investigated the difference between peer instruction and traditional instruction in students' learning gains about Newtonian Mechanics by using Force and Motion Conceptual Evaluation-FMCE. The study revealed that the students' conceptual learning gain (medium-g "0.45") instructed with peer instruction was higher than the students' conceptual learning gain (low-g "0.14") taught with traditional instruction. But Harvey (2013) presented that the fractional gains of peer instruction and traditional instruction were calculated as low-g<0.30 by using different standardized tests (FCI and FMCE).

Table 1. The Comparisons (Pre-Test, Post-Test, and Fractional Gains) of the Some Standardized Tests (FCI, FMCE, and CSEM) according to Peer Instruction and Traditional Instruction

Year	Author(s)	Standardized Test	Method	N	Pre-Test	Post-Test	Difference	Gain
1990	Crouch &Mazur	FCI	TI	121	70%	78%	8%	0.25
1991			PI	177	71%	85%	14%	0.49
1993			PI	158	70%	86%	16%	0.55
1994			PI	216	70%	88%	18%	0.59
1995			PI	181	67%	88%	21%	0.64
1996			PI	153	67%	89%	22%	0.68
1997			PI	117	67%	92%	25%	0.74
1998			PI	246	50%	83%	33%	0.65
1999			PI	129	48%	69%	21%	0.40
2000			PI	126	47%	80%	33%	0.63
2008	Lasry, N.	FCI	PI/CRS	35	40%	67%	27%	0.48
			PI/FC	34	47%	70%	23%	0.52
2008	Cummings & Roberts	FCI	TI	N/A	N/A	N/A	N/A	0.24
			PI	N/A	N/A	N/A	N/A	0.40
2008	Lasry et al.	FCI	TI-COL	22	46%	63%	17%	0.33
			PI-COL	69	43%	69%	26%	0.50
		FCI	TI-UNIV	127	70%	77%	7%	0.23
			PI-UNIV	187	71%	85%	14%	0.49
2010	Kalman et al.	FCI	M-PI	54	34%	58%	24%	0.37
			CG	77	29%	55%	26%	0.37
2010	Suppapittayaporn et al.	FMCE	TI	119	16%	28%	12%	0.14
			PI	156	18%	55%	37%	0.45
2011	Gok, T.	CSEM	PI/CRS	35	37%	72%	35%	0.54
			PI/FC	33	37%	56%	19%	0.29
2012a	Gok, T.	CSEM	TI	34	41%	63%	22%	0.36
			PI	37	41%	78%	37%	0.62
2012b	Gok, T.	FCI	TI	31	42%	61%	19%	0.32
			PI	32	42%	76%	34%	0.59
2012	Nishimura & Nitta	FCI	PI	N/A	46%	64%	18%	0.33
2013			PI	N/A	49%	65%	16%	0.33
2013	Harvey, C.	FCI	TI	62	29%	38%	9%	0.13
			PI	83	27%	38%	11%	0.15
		FMCE	TI	80	18%	20%	2%	0.02
			PI	62	17%	25%	8%	0.09
2014	Gok. T.	FCI	TI	56	18%	30%	12%	0.13
			PI	42	18%	66%	48%	0.52
2016	Antwi et al.	FCI	TI	37	18%	24%	6%	0.07
			PI	37	18%	54%	36%	0.45
2016	Lasry et al.	FCI	TI	22	N/A	N/A	N/A	0.33
			PI	86	N/A	N/A	N/A	0.47

Note: CG: Collaborative Group; CRS: Classroom Response System; COL: College; CSEM: Conceptual Survey of Electricity and Magnetism; Difference: Pre-Test- Post-Test; FC: Flashcard; FCI: Force Concept Inventory; FMCE: Force and Motion Conceptual Evaluation; MPI: Modified Peer Instruction; N; The Number of Student; PI: Peer Instruction; N/A: Not Available; TI: Traditional Instruction; UNIV: University

CONCLUSION

It was quite different to analyze and interpret conceptual understanding of the students according to the contents and fundamental concept(s)/principle(s) of the standardized tests in the present study. Because the pre and post-test results of examined studies were only presented in the literature, the conceptual learning of the students was generally evaluated instead of performing deep analysis of the test results.

The comparison of fractional gains with Hake (1998)’s research result was conducted in this research. When the pre-test and post-test scores of the students were evaluated for both peer instructional and traditional instruction "conventional, teacher centered teaching", the differences between peer instruction and traditional instruction showed in favor of peer instruction, and the fractional gains supported the achievement of the peer instruction according to years.

When the examined research results were generally interpreted and discussed from the viewpoint of peer instruction and traditional instruction, it could be said that according to Hake (1998)'s fractional gain ranges, the fractional gains of peer instruction were higher than the fractional gains of traditional instruction. The fractional gain of peer instruction is medium-g without using low technology or high technology, having professional experience of the instructors, and also having academic background of the students while the fractional gain of traditional instruction is low-g.

RECOMMENDATIONS

Some suggestions concerning the research's findings could be presented as follows: a) more studies are needed to confirm the effectiveness of peer instruction on students' conceptual learning in different disciplines by using different standardized (diagnostic) tests and the other educational tools, b) the studies could be more conducted to high school students, more data is especially needed to interpret the findings for this level, c) the effectiveness of peer instruction on students' metacognitive skills and critical analytical thinking could be examined and compared with traditional instruction, d) the demographics of the students and instructors could also be investigated in further studies, e) the performances of the students' conceptual learning, problem solving etc. by using fractional gain formula could be investigated with the help of different educational methods apart from peer instruction.

NOTE

Some parts of this research were presented at ICEMST (International Conference on Education in Mathematics, Science and Technology) 2016

REFERENCES

Antwi, V., Raheem, K., & Aboagye, K. (2016). The impact of peer instruction on students' conceptual understanding in mechanics in central region of Ghana. *European Journal of Research and Reflection in Educational Sciences, 4*(9), 54-69.

Crouch, C. H., & Mazur, E. (2001). Peer instruction: Ten years of experience and results. *American Journal of Physics, 69*, 970-977.

Cummings, K., & Roberts, S. G. (2008). A study of peer instruction methods with high school physics students. *American Institute of Physics Conference Proceedings 1064*, 103-106.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *PNAS, 111*(23), 8410-8415.

Gok, T. (2011). Using the classroom response system to enhance students’ learning and classroom interactivity. *Eurasian Journal of Educational Research, 45*, 49-68.

Gok, T. (2012a). The impact of peer instruction on college students’ beliefs about physics and conceptual understanding of electricity and magnetism. *International Journal of Science and Mathematics Education, 10*, 417-436.

Gok, T. (2012b). The effects of peer instruction on students’ conceptual learning and motivation. *Asia-Pacific*

Forum on Science Learning and Teaching, 13(1), 1-17.
Gok, T. (2014). Peer instruction in the physics classroom: Effects on gender difference performance, conceptual learning, and problem solving. *Journal of Baltic Science Education, 13*(6), 776-788.
Gok, T. (2015). An investigation of students' performance after peer instruction with stepwise problem-solving strategies. *International Journal of Science and Mathematics Education, 13*, 561-582.
Gok, T., & Gok, O. (2016). Peer instruction in chemistry education: Assessment of students' learning strategies, conceptual learning, and problem solving. *Asia-Pacific Forum on Science Learning and Teaching, 17*(1), 1-21.
Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*, 64-74.
Hake, R. R. (1992). Socratic pedagogy in the introductory physics lab. *Physics Teacher, 30*, 546-552.
Harvey, N. C. (2013). *The effects of peer instruction on ninth grade students' conceptual understanding of forces and motion*. Unpublished master's thesis, Louisiana State University, Baton Rouge, Louisiana.
Heller, P., Keith, R., & Anderson, S. (1992). Teaching problem solving through cooperative grouping. Part 1. Group versus individual problem solving. *American Journal of Physics, 60*, 627-636.
Heller, P., & Hollabaugh, M. (1992). Teaching problem solving through cooperative grouping. Part 2. Designing problems and structuring groups. *American Journal of Physics, 60*, 637-644.
Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force concept inventory. *The Physics Teacher, 30*, 141-158.
Johnson, D. W., Johnson, R. T., &. Smith, K. A. (1991). *Cooperative Learning: Increasing College Faculty Instructional Productivity*. ASHE-ERIC Higher Education Report 20(4), Washington DC: George Washington University Graduate School of Education and Human Development.
Kalman, C. S., Milner-Bolotin, M., & Antimirova, T. (2010). Comparison of the effectiveness of collaborative groups and peer instruction in a large introductory physics course for science majors. *Canadian Journal of Physics, 88*, 325–332.
Lasry, N. (2008). Clickers or flashcards: Is there really a difference? *The Physics Teacher, 46*, 242-244.
Lasry, N., Mazur, E., & Watkins, J. (2008). Peer instruction: From Harvard to the two-year college. *American Journal of Physics*, *76*(11), 1066-1069.
Lasry, N., Charles, E., & Whittaker, C. (2016). Effective variations of peer instruction: The effects of peer discussions, committing to an answer, and reaching a consensus. *American Journal of Physics, 84*(8), 639-645.
Mazur, E. (1997). *Peer instruction: A user's manual*. Upper Saddle River, NJ: Prentice Hall.
Maloney, D. P., O' Kuma, T. L., Hieggelke, C. J., & Van Heuvelen, A. (2001). Surveying students' conceptual knowledge of electricity and magnetism. *American Journal of Physics, 69*(7), S12-S23.
McDermott, L. C., Shaffer, P. S., & the PEG at UW (2002). *Tutorials in introductory physics*. Upper Saddle River, NJ: Pearson/Prentice-Hall.
Michinov, N., Morice, J., & Ferriéres, V. (2015). A step further in peer instruction: Using the stepladder technique to improve learning. *Computers & Education*, *91*, 1-13.
Nishimura, R., & Nitta, H. (2014). A peer-instruction-based physics lecture at high school in Japan. *Proceedings of the 12th Asia Pacific Physics Conference, 1*(017030), 1-4.
Novak, G., Gavrin, A., Patterson, E., & Christian, W. (1999). *Just-in Time Teaching: Blending active learning with web technology*. New Jersey: Prentice Hall.
Preszler, R. W., Dawe, A., Shuster, C. B., & Shuster, M. (2007). Assessment of the effects of student response systems on student learning and attitudes over a broad range of biology courses. *CBE-Life Science Education, 6*, 29-41.
Sayer, R., Marshman, E., & Singh, C. (2016a). Case study evaluating just-in-time-teaching and peer instruction using clickers in a quantum mechanics course. *Physical Review Physics Education Research, 12*(020133), 1-23.
Simon, B., Esper, S., Porter, L., & Cutts, Q. (2013). Student experience in a student-centered peer instruction classroom. *ICER'13, 129-136*. San Diego, California, USA.
Smith, K. A., Sheppard, S. D., Johnson, D. W., Johnson, R. T. (2005). Pedagogies of engagement: Classroom-based practices. *Journal of Engineering Education*, *94*(1), 87-101.
Smith. M. K., Wood, W. B., Adams, W. K., Wieman, C., Knight, J. K., Guild, N., & Su, T. T. (2009). Why peer discussion improves student performance on in-class concept questions. *Science, 323*, 122-124.
Suppapittayaporn, D., Emarat, N., & Arayathanitkul, K. (2010). The effectiveness of peer instruction and structures inquiry on conceptual understanding of force and motion: A case study from Thailand. *Research in Science & Technological Education, 28* (1), 63-79.
Thornton, R. K., & Sokoloff, D. R. (1990). Learning motion concepts using real-time microcomputer-based laboratory tools. *American Journal of Physics, 58*, 858-867.
Thornton, K., & Sokoloff, D. R. (1998). Assessing student learning of Newton's Laws: The force and motion conceptual evaluation and the evaluation of active learning laboratory and lecture curricula. *American*

Journal of Physics, 66(4), 338-352.

Van Heuvelen, A. (1991). Overview, case study physics. *American Journal of Physics, 59*, 898-907.

Wang, S., & Murota, M. (2016). Possibilities and limitations of integrating peer instruction into technical creativity education. *Instructional Science, 44*, 501-525.

Wells, M., Hestenes, D., & Swackhamer, G. (1995). A modeling method for high school physics instruction. *American Journal of Physics, 63*, 606-619.

Yaoyuneyong, G., & Thornton, A. (2011). Combining peer instruction and audience response systems to enhance academic performance, facilitate active learning and promote peer-assisted learning communalities. *International Journal of Fashion Design, Technology and Education, 4*(2), 127-139.

THE COMPARISONS OF QUANTITATIVE AND QUALITATIVE PROBLEMS ON STUDENTS' PHYSICS ACHIEVEMENT

Tolga Gok
Dokuz Eylul University, Turkey

ABSTRACT: Problem solving is quite important for physics and physics education. Besides, it is essential for students to develop the scientific and analytical thinking processes. These processes can be taught to students with the help of the scientific and analytical thinking. Generally, instructors solve some fundamental quantitative problems regarding the subjects after they teach the subjects in the traditional instruction model. Students also prefer to memorize some solution ways of the problems by using basic equations or formulas concerning the problems instead of learning and understanding the solution ways of the problems. These kinds of approaches do not lead to sufficient learning for the students. Solely, knowing the fundamental equations/formulas are not enough for problem solving. The instructors need to more concentrate on teaching of the qualitative problem solving. Therefore, this study investigated the effects of quantitative and qualitative problems on students' problem-solving performances. The study was conducted with 80 university students. The students were asked four classical physics problems and 20 multiple choice questions in the final examination. The content of classical problems was about "Newton's Laws" and "Work and Energy". Students' classical physics problem solutions with the help of designed assessment rubric and determined problem solving strategy steps were analyzed and reported. Some suggestions in the light of investigation were presented in the end of the research.

Keywords: higher education, physics education, problem solving, problem solver

INTRODUCTION

"Problem solving as a goal-directed behavior requires an appropriate mental representation of the problem and the subsequent application of certain methods or strategies in order to move from an initial, current state to a desired goal state" (Metallidou, 2009, p.76). Problem solving generally is a decision-making process (Gok, 2010a). Metacognition also plays an important role in this process (Gok, 2014). Problem solving refers to defining physics concepts and/or fundamental principles, analyzing mathematics and physics procedures, and evaluating the solution way.

Rosengrant, Van Heuvelen, & Etkina (2005) stated that problem solving is a scientific ability. In order to develop the scientific ability, therefore the instructors should teach to students both quantitative and qualitative problem solution ways. Problems could be separated into quantitative problems and qualitative problems. The quantitative problem refers to the numerical variables and units in the problem statements. Students are quantitatively asked to solve the quantitative problems by using concerning equations or formulas with the help of the given numerical variables and units. Consequently, they are expected to find the numerical results. The qualitative problem does not refer to the numerical variables and units in the problem statements. This kind of problem only uses the symbolic characters in the problem statements. Students are qualitatively asked to solve the qualitative problems by using concerning equations or formulas with the help of the given symbols. Eventually, they are expected to find the qualitative results based on the equations or formulas. Ploetzner and Beller (2000) examined the effects of using qualitative and quantitative concepts in classical mechanics on students' problem-solving performance. They defined the strategies to support qualitative and quantitative problem solving. At the end of their research, they revealed that the qualitative problem solving is more effective on physics instruction than the quantitative problem solving.

Several physicists (Chi, Feltovich, & Glaser, 1981; Dufrense, Gerace, & Leonard, 1997; Gok, 2015; Walsh, Howard, & Bowe, 2007) investigated the differences in problem solving between expert problem solvers and novice problem solvers. Expert problem solvers redefine the problem situation, describe the fundamental principle(s) or concept(s) of the problem, write the known and unknown variables in the problem, draw a sketch/picture or a diagram for the visual understanding if it is needed, determine the mathematical equation(s)/formula(s) and lastly check logically the solution procedure. Shortly, they solve the problems in a very structured way with the help of scientific approach. On the other hand, novice problem solvers quickly focus on the usage of quantitative numerical variables and ignore the conceptual information. Briefly they prefer to use plug and chug approach or no clear approach. Docktor and Heller (2009) also revealed the differences between expert problem solvers and novice problem solvers. These differences were process and knowledge organization.

Walsh et al. (2007) analyzed the problem-solving approaches of the students. Problem solving approaches were separated into four categories including scientific approach, plug and chug (structured and unstructured manner), memory-based approach, and no clear approach. Some popular physics textbooks presented alternative problem-solving approaches at the end of chapter problems. Young and Freedman's approach (2008) was to (a) identify, (b) set up, (c) execute, and lastly (d) evaluate. Tipler and Mosca's approach (2007) was to (i) picture the problem, (ii) solve the problem, and finally (iii) check the problem. These problem-solving approaches provide thinking like a physicist for both expert and novice problem solvers (Van Heuvelen, 1991).

Problem solving is a very complex process and there is no standard way to evaluate and analyze problem solving performance of the students. Many studies (Docktor & Heller, 2009; Fink & Mankey, 2010) investigated the evaluation of problem solving approaches while the expert and novice problem solvers were solving the qualitative and quantitative problems as homework, class-quizzes, mid-term and final examinations. Students' problem-solving approaches were analyzed by using some assessment rubrics given in the mentioning studies. Fink and Mankey (2010) identified an assessment rubric/template including "given", "find", "relevant equations", "detailed sketch", "symbolic solution", "numeric solution", "dimensions", and "order of magnitude". Docktor and Heller (2009) also developed an assessment rubric to evaluate and analyze problem solvers' written solutions about physics process based on "useful description", physics approach", "specific application of physics", "mathematical procedures", and "logical progression". These assessment rubrics reveal the relationships between learning outcome and assessment for the physics courses. Fink and Mankey (2010) indicated "the problem-solving template promises to track the process and will help to assess the development of problem-solving skills essential for doing physics"(p.278).

Many studies revealed that the students could learn quantitative problem solving, but they could not develop conceptual understanding as well (Byun & Lee, 2014; Gok, 2014; Gok, 2015; Heller, Keith, & Anderson, 1992; Heller & Hollabaugh, 1992; Thacker, Kim, Trefz, & Lea, 1994; Van Heuvelen & Zou, 2001). The students were generally taught the physics courses with traditional teaching methods, therefore they focused on memorizing the formula(s)/equation(s) instead of learning the fundamental concept(s)/principle(s) while they were solving quantitative problems or they preferred to memorize the solution ways of the problems without following systematic strategy (Gok, 2015). As a result, the students could not sufficiently enhance the problem-solving performance while problem solving with the help of traditional teaching methods. The quantitative problem solving does not develop both deep conceptual understanding regarding fundamental principle(s) and problem-solving skills of the students.

The problem-solving strategy steps were developed because the students were not good at problem solving adequately. Polya (2009), an expert mathematician, explained problem solving as four steps in *How to Solve It*. The first step is to understand the problem, the second step is to devise a plan, the third step is to carry out the plan, and the last step is to look back. Van Heuvelen (1991) determined problem solving strategy steps as pictorial representation, physical representation, mathematical representation and solution, and finally evaluation by using multiple representations based on OCS (Overview, Case Study) Physics and a set of Active Learning Problem Sheets (the ALPS kit). Problem solving strategies were divided into five steps by Heller et al. (1992). The first step is to visualize the problem, the second step is to describe problem statement, the third step is to plan a solution, the fourth step is to execute the plan, and the last step is to check and evaluate. Reif, Larkin, and Brackett (1976) described problem solving strategy as description, planning, implementation, and checking. Problem solving procedures were separated into three major steps which were initial problem analysis, construction of a solution, and finally checking solutions respectively (Reif, 1995). Recently Gok (2015) identified problem solving strategy steps including a) identifying fundamental principle(s), b) solving and c) checking, respectively.

Consequently, the problem-solving strategy steps should be taught in order to enhance problem solving skills of the students, understand the reasons about the physical process, and think about the fundamental principle(s)/concept(s) regarding both qualitative problems and quantitative problems. In this context, the main purpose of the present study was to examine and compare the quantitative and qualitative problem-solving skills of the students with the help of an assessment tool.

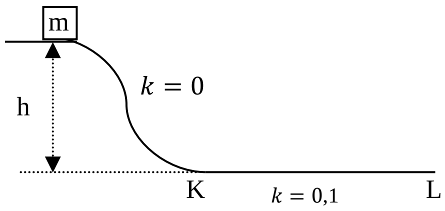
METHODS

The qualitative and quantitative problem-solving skills of the students were compared by problem solving strategy steps of Heller et al. (1992). The present study was conducted with 80 university freshman students enrolled in introductory calculus-based physics course at a state university in Turkey. The data of the research was collected with physics final examination. The students participated in the same classroom were randomly separated into two groups for only physics final examination, the final examination consisted of four classical problems and 20 multiple-choice questions. The classical problems and the multiple-choice questions were evaluated out of 40 and

60 points, respectively. The classical problems were only evaluated and analyzed in this study. The half of the students was asked four quantitative problems while the rest of the students were asked four qualitative problems. The qualitative and quantitative problem statements were similar for both groups. The distribution of the problems is given as follows: The first two problems covered "Newton's Laws of Motion" and the other problems consisted of "Work and Energy". An example problem was given in Figure 1.

Quantitative Problem

An object of mass m=1kg is released from height of h=1m and then it stops at the point L as presented in Figure. The horizontal surface is frictional (k≠0). What is the length KL?



Qualitative Problem

An object of mass m is released from height h and then it stops at the point L as presented in Figure. The horizontal surface is frictional (k≠0). What is the length KL?

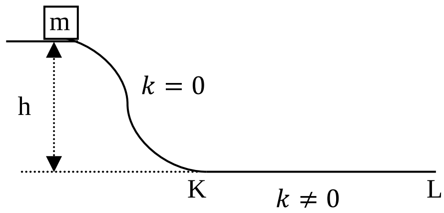


Figure1. An Example of the Qualitative and Quantitative Problem in the Final Examination

As mentioned before, the quantitative and qualitative problems were analyzed according to problem solving strategy steps developed by Heller et al., (1992). Problem solving was examined into five steps as follows:
The first step is to visualize the problem. The students are expected to describe the problem statement with the help of appropriate representations such as the usage of symbols for quantities, defining coordinate axes, drawing a graph or sketch etc.

The second step is to describe the problem statement with the help of physics terms. The students are expected to determine the known and unknown variables symbolically, to identify fundamental concepts/principles and to analyze by dividing the problem into smaller sub-problems.

The third step is to plan a solution. The students are expected to write the appropriate equations/formulas based on determined problem statement in order to find desired unknown variable by using known and given variables. Besides they are expected to determine the boundaries of the problem for problem solving.

The fourth step is to execute the plan. The students are expected to solve the problem by means of mathematical rules and defined equations/formulas. There are two conditions in this step for the present research. Firstly, the students are asked for finding a qualitative statement based on equations/formulas for final result symbolically if the students are asked qualitative problems. Secondly, the students are asked for finding numerical a final result if the students are asked quantitative problems.

The last step is to check and evaluate the solution way. The students are expected to control reasonableness of their answer such as unit, sign, magnitude etc. They are also expected to control the overall solution way of the quantitative and qualitative problems.

A rubric sheet according to problem solving strategy steps was developed for evaluating quantitative and qualitative problem-solving performance of the students. The purpose of this rubric was to evaluate each step of problem solution ways instead of focusing on final result of the problems. Thus, instructors may evaluate the learning process and cognitive psychology of the students, may analyze mathematical and physics thinking skills of the students, and may determine the difference between "expert" and "novice" problem solvers in problem solving processes. The assessment rubric provides the instructors to diagnose the problem solution ways of the students in terms of organizing the problem statement into a useful description, identifying appropriate fundamental physics principles or concepts, applying to the problem specific conditions, using mathematical procedures, and finally appraising the overall solution procedures.

Each step of the problem-solving strategy steps is evaluated out of 2 points. Each step consists of two items. Also, each item of the steps is evaluated out of 1 point. These steps can be evaluated with the help of computers (Gok, 2010b; Hsu & Heller, 2009) according to the number of students (N>50) if it is needed. The score rubric sheet was given as Appendix A. The similar rubric sheet was designed by Docktor and Heller (2009). The author will conduct the validity, reliability, and utility of the score rubric sheet in next studies. A student can only take maximum 40 points for solving of asked four classical problems in the final examination. The problem-solving strategy steps and assessment criterion of the items were listed as follows:

Step I: Visualize the problem

a) Draw a sketch or a picture of the problem situation, if it is needed.
b) Identify the known and unknown variables

Assessment 1: *Write the name of variables, conceptually*
Draw a picture or a sketch if it is needed

Step II: Describe the problem

a) Symbolically specify the known and unknown variables
b) State the physical situation with a diagram and remark axes on a graph if it is needed

Assessment 2: *Mark the symbol of the variables*
Draw a diagram or coordinate system if it is needed

Step III: Plan a solution

a) Begin to determine fundamental principles and concepts
b) Select the mathematical procedures based on required formulas

Assessment 3: *Determine the fundamental principle(s) of the problem*
Write the needed equation(s)/formula(s) to solve the problem

Step IV: Execute the plan

a) Systematically start problem solving by using appropriate mathematical procedures
b) Find desired unknown variable(s)

Assessment 4: *Solve an equation symbolically for finding the unknown variable*
Solve an equation numerically for finding the unknown variable

Step V: Check the solution way

a) Check the solution procedures
b) Verify the magnitude and unit of the answer

Assessment 5: *Write the unit of variables*
Represent the vector and dimensional analysis if it is needed

RESULTS AND FINDINGS

The problem solving of qualitative problem solvers and quantitative problem solvers were analyzed as shown in Appendix B and examined according to problem solving strategy steps as follows:

The First Step: Visualize the Problem

The qualitative problem solvers used more visualizing than the quantitative problem solvers as presented in Figure 2. The usage rate of the pictorial representation including identifying the known and unknown variables for the qualitative problem solvers was higher than 30%. This ratio was lower than 20% for quantitative problem solvers for the first item. Both qualitative problem solvers and quantitative problem solvers did not need to draw a picture or a sketch with respect to problems for the second item.

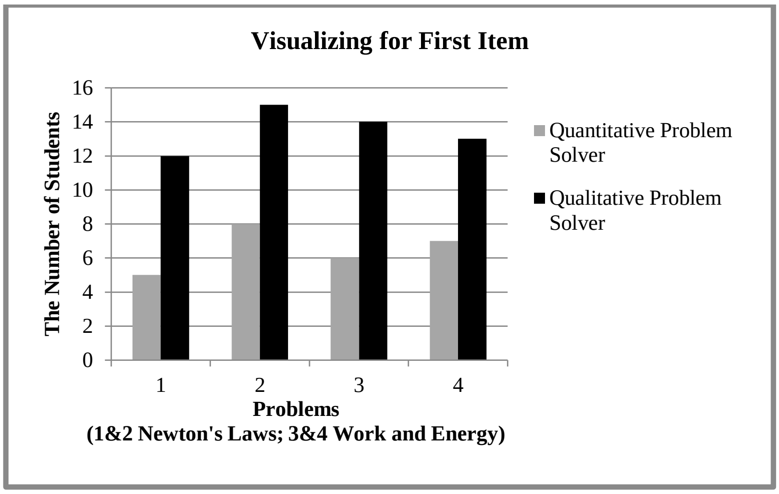


Figure 2. The Usage of First Step by Problem Solvers

The Second Step: Describe the Problem

Both qualitative and quantitative problem solvers (approximately 70%) for the first item could describe symbolically as shown in Figure 3. Besides nearly of 70% the qualitative and quantitative problem solvers included in the groups drew the force, motion and energy diagrams concerning Newton's Laws and Work and Energy problems for the second item.

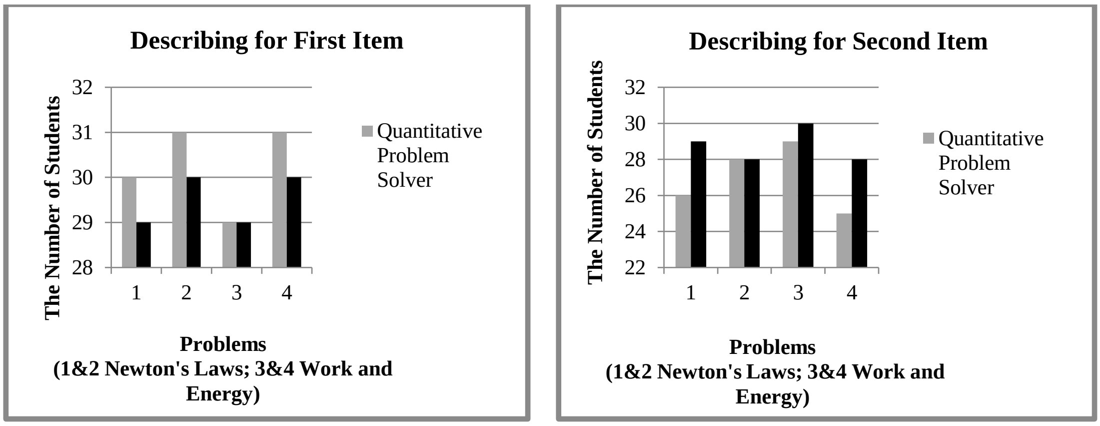


Figure 3. The Usage of Second Step by Problem Solvers

The Third Step: Plan a Solution

Approximately 10% of the quantitative problem solvers defined the fundamental principle(s) of the problem while 35% of the qualitative problem solvers for the first item identified the fundamental principle(s) of the problem as demonstrated in Figure 4. Besides, nearly 65% of both qualitative problem solvers and quantitative problem solvers wrote the needed equation(s)/formula(s) to solve problems for the second item.

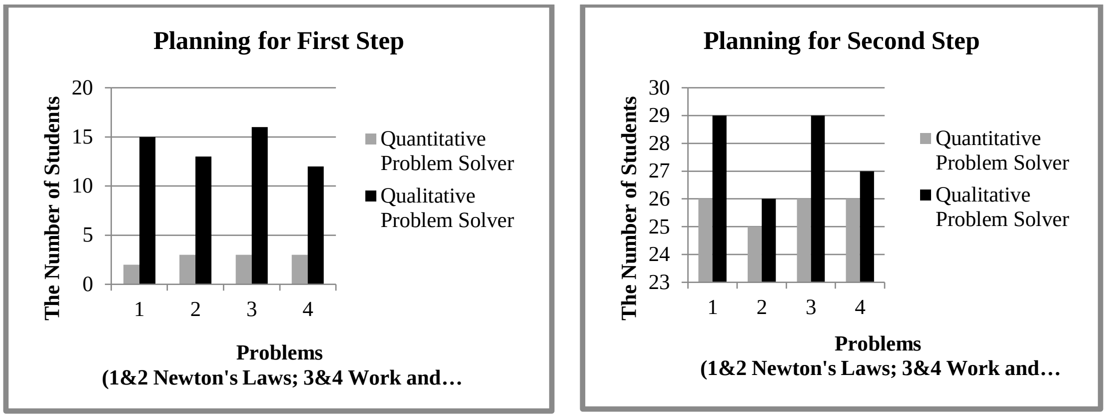


Figure 4. The Usage of Third Step by Problem Solvers

The Fourth Step: Execute the Plan

Roughly 15% of the quantitative problem solvers for the first item solved with the help of using an equation symbolically for finding the desired unknown variable while 55% of the qualitative problem solvers solved by means of using an equation symbolically for finding the desired unknown variable as shown in Figure 5. But the qualitative problem solvers could not solve an equation numerically for finding the desired unknown variables while the half of quantitative problem solvers could solve the problems in average for the second item. Besides the solutions of the qualitative problem solvers were evaluated out of 2 points for only the first item.

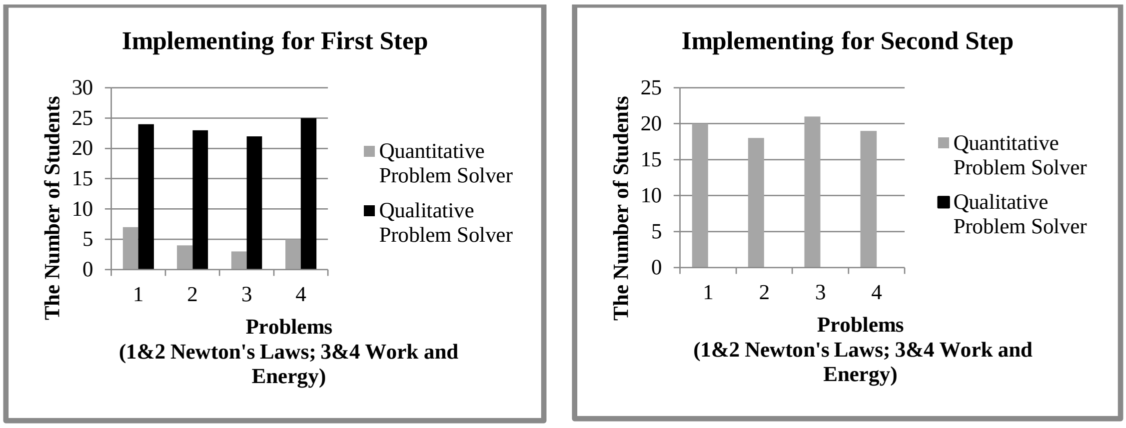


Figure 5. The Usage of Fourth by Problem Solvers

The Fifth Step: Check the Solution Way

Approximately 30% of the quantitative problem solvers checked the units of variables while the qualitative problem solvers could not mark the unit of variables for the first step. Besides both the qualitative problem solvers and the quantitative problem solvers could not represent the vector and dimensional analysis of the answers as presented in Figure 6.

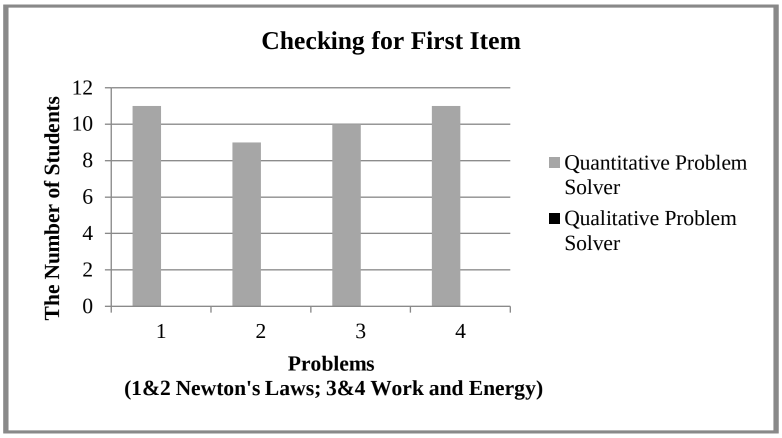


Figure 6. The Usage of Fifth Step by Problem Solvers

CONCLUSION

Qualitative and quantitative problems were evaluated and analyzed according to problem solving strategy steps "useful description, physics approach, application of physics, mathematical procedures, and finally logical progression" developed by Heller et al. (1992). These steps were important to interpret the cognitive psychology of the students, to monitor and evaluate mathematical and physics thinking skills of the students, and finally to analyze the difference in problem solving processes between experienced problems solvers "expert" and inexperienced problem solvers "novice". In this research, the approaches of the qualitative and quantitative problem solvers while solving physics problems were analyzed. Therefore, an assessment instrument for scoring rubric sheet was designed according to determined problem solving strategy steps. This rubric sheet easily provided the instructor to evaluate the problem-solving performance of the students by using determined criteria. Docktor & Heller (2009, p.16) reported "the rubric provides more meaningful information than standard grading by indicating areas of student difficulty that can be used to focus coaching and improve problem writing".

When the results of the research were interpreted to defined problem solving strategy steps it could said respectively that approximately 25% of qualitative and quantitative problems solvers wrote the names of known and unknown variables (force, net force, weight, mass, acceleration, work, energy, kinetic energy, potential energy, power etc.) while both problem solvers did not draw a picture or a sketch for visualizing step. The quantitative and qualitative problem solvers could describe approximately 70% the symbol of the variables ($\vec{F}\ for\ force, m\ for\ mass, \vec{a}\ for\ acceleration,\ \vec{v}\ for\ velocity, W\ for\ work$ etc.) and many problem solvers drew force "free-body" and energy diagrams or a coordinate system of asked problems for describing step.

10% of problem solvers determined only fundamental principle(s)/concept(s) (Newton's First Law, Newton's Second Law, and Newton's Third Law, Contact Forces, Work-Kinetic Energy, Conservation of Energy etc.) of the problem while nearly 65% of qualitative problem solvers and quantitative problem solvers wrote the needed equation(s)/formula(s) ($\vec{F} = m\vec{a}, \vec{F}_{net} = m\vec{a}, W = \Delta K, W = \vec{F}\Delta\vec{x}$ etc.) in order to solve problems for planning step. Approximately 55% of the qualitative problem solvers symbolically solved by means of using an equation for finding desired unknown variable. This ratio for quantitative problem solvers was quite low. Half of the quantitative problem solvers focused on the numerical results of the problems and nearly 55% of the qualitative problem solvers tried to solve problems with the help of equation(s)/formula(s) for finding desired unknown variables for implementing step. For checking step, 30% of the quantitative problem solvers controlled the units ($^{m}/_{s^2}\ for\ acceleration, ^{m}/_{s}\ for\ velocity, kg\ for\ mass, N\ for\ force,\ J\ for\ energy,$ $^{J}/_{s}\ \ for\ power\ etc.$), signs ($x\ for\ distance, h\ for\ height, \mu_k\ for\ coefficient\ of\ kinetic\ friction$ etc.), and magnitudes (scalar and vector quantities) of the variables while none of qualitative problems solvers did check the variables. Both quantitative problem solvers and qualitative problem solvers could not also perform the vector and dimensional analysis.

When the results of the research were generally discussed, it could be said that the quantitative problem solvers immediately tried to reach a conclusion by using needed equation(s)/formula(s). The research results of Gok (2015), Gok (2013), Reif (1995), and Van Heuvelen (1991) supported the present research results. Because it was important to find correct and/or meaningful numerical answer for them on the other hand the qualitative problem solvers showed tendency to write everything about problems-solving (concepts, principles, formula/equations etc.).

Consequently, the logical procedures of the problem solving are crucial to learn for both the qualitative problem solvers and the quantitative problem solvers, besides the instructors should present students the logical procedures and teach the students the alternative solution ways of problem according to problem solving strategy steps.

RECOMMENDATION

Some suggestions in the light of the research results might be presented as follows: a) instructors should teach students how to solve a problem and they should explain the students how to use problem solving strategy steps on a sample problem; b) they should encourage the students to use problem solving strategy; c) the instructor should focus on logical procedures instead of finding numerical results by problem solving; d) they should motivate the students to think about the problem solving approaches instead of memorizing the formula(s)/equation(s).

NOTE

Some parts of this research were presented at ICEMST (International Conference on Education in Mathematics, Science and Technology) 2016

REFERENCES

Byun, T., & Lee, G. (2014). Why students still can't solve physics problems after solving over 2000 problems. *American Journal of Physics, 82*(9), 906-913.

Chi, T., Feltovich, P., Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognition Science*, *5*, 121-152.

Docktor, J., & Heller, K. (2009). Robust assessment instrument for students' problem solving. *Proceedings of the NARST Annual Meeting*. Garden Grove, California, USA.

Dufrense, R., Gerace, W., & Leonard, J. (1997). Solving physics problems with multiple representations. *Physics Teacher*, *35*, 270-275.

Fink, J. M., & Mankey, G. J. (2010). A problem-solving template for integrating qualitative and quantitative physics instruction. *The Journal of General Education, 59*(4), 273-284.

Gok, T. (2010a). The general assessment of problem solving processes and metacognition in physics education. *Eurasian Journal of Physics and Chemistry Education*, *2*(2), 110-122.

Gok, T. (2010b). A new approach: Computer-assisted problem-solving systems. *Asia-Pacific Forum on Science Learning and Teaching, 11*(2), 1-22.

Gok, T. (2013). A comparison of students' performance, skill and confidence with peer instruction and formal education. *Journal of Baltic Science Education, 12*(6), 747-757.

Gok, T. (2014). Students' achievement, skill and confidence in using stepwise problem-solving strategies. *Eurasian Journal of Mathematics, Science & Technology Education, 10*(6), 617-624.

Gok, T. (2015). An investigation of students' performance after peer instruction with stepwise problem-solving strategies. *International Journal of Science and Mathematics Education, 13*, 561-582.

Heller, P., Keith, R., & Anderson, S. (1992). Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving. *American Journal of Physics, 60*(7), 627-636.

Heller, P., & Hollabaugh, M. (1992). Teaching problem solving through cooperative grouping. Part 2: Designing problems and structuring groups. *American Journal of Physics, 60*(7), 637-644.

Hsu, L., & Heller, K. (2009). Computer problem-solving coaches. *Proceedings of the NARST Annual Meeting*. Garden Grove, California, USA.

Metallidou, P. (2009). Pre-service and in-service teachers' metacognitive knowledge about problem-solving strategies. *Teaching and Teacher Education, 25*, 76-82.

Ploetzner, R., & Beller, S. (2000). Teaching and supporting the use of qualitative and quantitative concepts in classical mechanics. In Gleitman, L., & Joshi, A. K. (Eds.), *Proceedings of the Twenty-Second Annual Conference of the Cognitive Science Society.* Mahwah, NJ: Lawrence Erlbaum.

Polya, G. (2009). *How to solve it: A new aspect of mathematical method*. New York: Ishi Press.

Reif, F., Larkin, J. H., & Brackett, G. C. (1976). Teaching general learning and problem-solving skills. *American Journal of Physics, 44*(3), 212-217.

Reif, F. (1995). Millikan Lecture 1994: Understanding and teaching important scientific thought processes. *American Journal of Physics, 63*(1), 17-32.

Rosengrant, D., Van Heuvelen, A., & Etkina, E. (2005). Case study: Students' use of multiple representations in problem solving. *Physics Education Research Conference*. Salt Lake City, Utah.

Thacker, B., Kim, E., Trefz, K., & Lea, S. M. (1994). Comparing problem solving performance of physics students in inquiry-based and traditional introductory physics courses. *American Journal of Physics, 62*(7), 627-633.
Tipler, P., & Mosca, G. (2007). *Physics for scientists and engineers (6th ed.).* New York: W. H. Freeman & Co.
Van Heuvelen, A. (1991). Overview, case study physics. *American Journal of Physics, 59*(10), 898-907.
Van Heuvelen, A., & Zou, X. (2001). Multiple representations of work-energy processes. *American Journal of Physics, 69*(2), 184-194.
Walsh, L. N., Howard, R. G., & Bowe, B. (2007). Phenomenographic study of students' problem solving approaches in physics. *Physical Review Special Topics-Physics Education Research, 3*(020108), 1-12.
Young, H., & Freedman, R. (2008). *University physics* (12 th ed.). Upper Saddle River, NJ: Pearson.

Section 3: Educational Technology

WHERE HAVE ALL THE TABLETS GONE? AN EXAMINATION OF THE TECHNOLOGY PURCHASING HABITS OF SUBURBAN TEXAS SCHOOL DISTRICTS

Joshua W. Tabor
Texas A&M University, USA

Mary Margaret Capraro
Texas A&M University, USA

Bugrahan Yalvac
Texas A&M University, USA

ABSTRACT: The rapid growth of technology has left many schools scrambling in search of the best technology to implement in their classrooms. Tablet devices such as iPads have seen their popularity rise quickly and dramatically. Teachers want their students to have the ability to be more mobile and engaged in the learning process. However, even with the rapid growth of iPad and tablet use, more recent trends are demonstrating that school districts are slowly moving away from tablet devices to cheaper, more cost-effective laptop options, specifically Chromebooks. We employed an instrumental and multiple case study design to examine the technology directors' tablet or laptop purchase choices at several suburban and public-school districts in the Southern US. We collected data through interviews and surveys. The within-case and cross-case analyses revealed that technology directors often consult district decision makers, but not the students when making purchasing decisions. In one example, a curriculum director chose the district's technological purchases based on personal preference, rather than technology that would best benefit the district long-term, giving the technology director no choice. We recommend further research in what methods are most effective in determining long-term success when purchasing large amounts of technology.

Keywords: iPads, tablet computers, chromebooks, technology

INTRODUCTION

As demands for technology in the classroom increase, district technology directors are faced with a daunting task: choosing the right hardware for their districts. For those outside of education, this may appear to be a simple decision: choose what everyone likes and learning will occur. However, this idea ignores the reality many technology directors face daily. Issues include hardware and software costs, old and new equipment compatibility, and the working together of technological components to prevent network failure. A correct choice can lead to a district's technological future, supporting greater student engagement and learning; the wrong choice can leave a district burdened with technology that is not successfully integrated and costs the district both economically and educationally for years to come. This thin line between success and failure is what drove this study, as we examined the importance of proper technology purchases in suburban school districts in the Southwestern United States (Montrieux et al., 2015).

The demand for technology has never been higher as the educational industry has seen significant growth over the last twenty years. Connections created by the Internet are a significant driver of that growth. Students can interact not only with their classroom teachers and peers but have the opportunity to connect to other students worldwide. Students can now take courses online which has increased the urgency for technological growth. Postsecondary institutions' online enrollments grew from 9.6% in 2002 to 32% in 2011 in regard to their total enrollment (Allen & Seaman, 2013). Researchers have been designing educational programs to determine better methods of learning and increased their sample size by having students log in from their homes across their country to participate (Shute & Rahimi, 2017). While some of these ideas are trickling from post-secondary to area high schools, technology itself has practically invaded all school levels down to pre-school.

GROWTH OF TECHNOLOGY

The growth and importance of technology was illustrated by the U.S. Department of Education spending millions in grant awards for those incorporating technology in innovative ways (U.S. Department of Education). The goal to cultivate '21st Century Skills' is becoming more prevalent in schools as students are expected to think critically while using technology as an aid to solve problems (Tweed, 2013). Post-secondary researchers have been examining the benefits of technology use in classrooms and how it has begun to change the 'traditional classroom environment' (Diemer, Fernandez, & Streepey, 2012; Demski, 2012; Johnson, Adams, & Cummins, 2012; Mango, 2015; Meyer, 2015; Montrieux et al., 2015). Research was conducted in Denmark where a growing phenomenon called 'iPad-schools' has been appearing across the country (Meyer, 2015). School districts have invested in a 1:1 student to iPad program to ultimately limit overhead costs. The deciding economic factor was the considerable amount of money spent on paper copies and textbooks. With iPads, neither was thought necessary because both could have been easily transitioned and used in a digital format. Meyer (2015) went on to argue, "this mobile and personalized tablet support is transforming learning spaces that will allow schools to be more inclusive of different learners and learners' needs, including children with cognitive challenges" (p. 27).

The idea of 'freeing' students by unplugging them from walls and allowing them to use mobile devices was supported by the New Media Consortium's report (Johnson, Adams, & Cummins, 2012) which pointed out that tablet computing offered new opportunities not offered by more 'traditional' devices. Tablets were seen as less cumbersome tools than their predecessors and could have functioned more readily in the field and lab. Johnson et al. (2012, pp. 4-5) went on to point out the following trends in education:

1. People expect to be able to work, learn, and study whenever and wherever they like.
2. The technologies we use are increasingly cloud-based, and our notions of IT support are decentralized.
3. The world of work is increasingly collaborative, driving changes in the way student projects are structured
4. The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators.
5. Education paradigms are shifting to include online learning, hybrid learning, and collaborative models.
6. There is a new emphasis in the classroom on more challenge-based and active learning.

These trends are still evident today in schools and seem to be growing each year. Diemer et al. (2012) found that the use of iPads in the classroom increased students' sense of engagement and in turn had a positive effect on students' active and collaborative learning. Additionally, Hargis, Cavanaugh, Kamali, and Soto (2014) reported that students who used iPads gained empowerment as they became researchers and more independent learners. This 'empowerment' was highlighted by increased levels of lesson engagement and a noticeably positive effect on students' active and collaborative learning (Mango, 2015). Karsenti and Fievez (2013) found the following benefits to touch screen use in Canadian classrooms:

1. Increases motivation (see Kinash, Brand, & Mathew, 2012; Sachs & Bull, 2012; Wainwright, 2012);
2. Facilitates access to, management of, and sharing of information (see Babnik et al., 2013; Fri-Tic, 2012; Hahn & Bussell, 2012; Martin, Berland, Benton, & Smith, 2012);
3. Fosters student learning and performance (see Churchill, Fox, & King, 2012; Fernández-López, Rodríguez-Fórtiz, Rodríguez-Almendros, & Martínez-Segura, 2013; Isabwe, 2012; Lau & Ho, 2012; McKechan & Ellis, 2012; Ostler & Topp, 2013; Rossing, Miller, Cecil, & Stamper, 2012);
4. Allows a wider range of teaching strategies (see Fernández-López et al., 2013);
5. Fosters individualized learning (see McClanahan, Williams, Kennedy, & Tate, 2012; Wasniewski, 2013);
6. Improves the reading experience (see Fernández-López et al., 2013; Huber, 2012; Sloan, 2012; Zambarbieri & Carniglia, 2012);
7. Encourages communication and collaboration among students and between teachers and students (see Geist, 2011; Henderson & Yeow, 2012; Hutchison, Beschorner, & Schmidt-Crawford, 2012);
8. Improves computer literacy skills (Huber, 2012; Killilea, 2012);
9. Nurtures students' creativity (Sullivan, 2013);
10. A highly portable tool (see Henderson & Yeow, 2012; Hill, Nuss, Middendorf, Cervero, & Gaines, 2012; Kinash, Brand, Mathew, & Kordyban, 2013; Villemonteix & Khaneboubi, 2012; Williams, Wong, Webb, & Borbasi, 2011);
11. Facilitates student assessment (Alberta Education, 2012; Isabwe, 2012; McKechan & Ellis, 2012);
12. Improves the quality of pedagogical support (Murray & Olcese, 2011);
13. Facilitates learning how to write (Murray & Olcese, 2011);
14. Makes it easier to organize schoolwork and assignments (Churchill et al., 2012);
15. Students can make versatile and vivid multimedia presentations (Murphy & Williams, 2011);
16. Significant benefits for students with learning problems (McClanahan et al., 2012).

When selecting a tablet, districts have a variety of options, but the majority select Apple iPads. If technology directors are searching for an alternative tablet, options such as the Microsoft Surface Pro line, HP Pavilion, Samsung Galaxy Tab, or the Kindle Fire are also available at different price points. Some school districts are choosing to move away from tablet computers all together, instead opting for the Chromebook line of internet-based laptops. The original Chromebook, which received its name from the Linux-based Chrome OS that runs as its operating system, hit the market in January of 2011. Since its introduction, its fast boot up speed, reliability, and low cost have made it a highly sought-after tablet alternative. Today, Chromebooks are making large strides in education as they have become the tool used most frequently by students and educators in the classroom per a survey conducted by *Education Week* (see Figure 1). Chromebooks provide greater mobility to students, much like iPads, but have more of the laptop feel that tablets lack. Each Chromebooks can cost from $229 to $259 for a school district (Herold, 2014) versus the more expensive iPad which costs anywhere from $250 to $830 per unit (Molnar, 2014) depending on the included features. The cost of Chromebooks is a huge draw for school districts as they are making their device selections (Sandford, 2013; Schaffhauser, 2013). As of 2017, the Google operating system, installed on devices made by different companies, represents 58 percent of the U.S. market, an increase of 20 percent from just two years ago (Cavanagh, 2017). The remaining 42 percent of the US market is shared by Windows, Mac OS, Linux, iOS, and Android. A recent Edweek Market Brief, *Amazon, Apple, Google, and Microsoft Battle for K-12 Market, and Loyalties of Educators* (Cavanagh, 2017), highlighted the growth of the Google operating system and Chromebook sales further. In Figure 2, teachers were surveyed to determine which ed-tech productivity suite they use most frequently in their districts and classrooms (Cavanagh, 2017). These results demonstrate a shift away from touchscreen tablets, back to a lighter, quicker laptop.

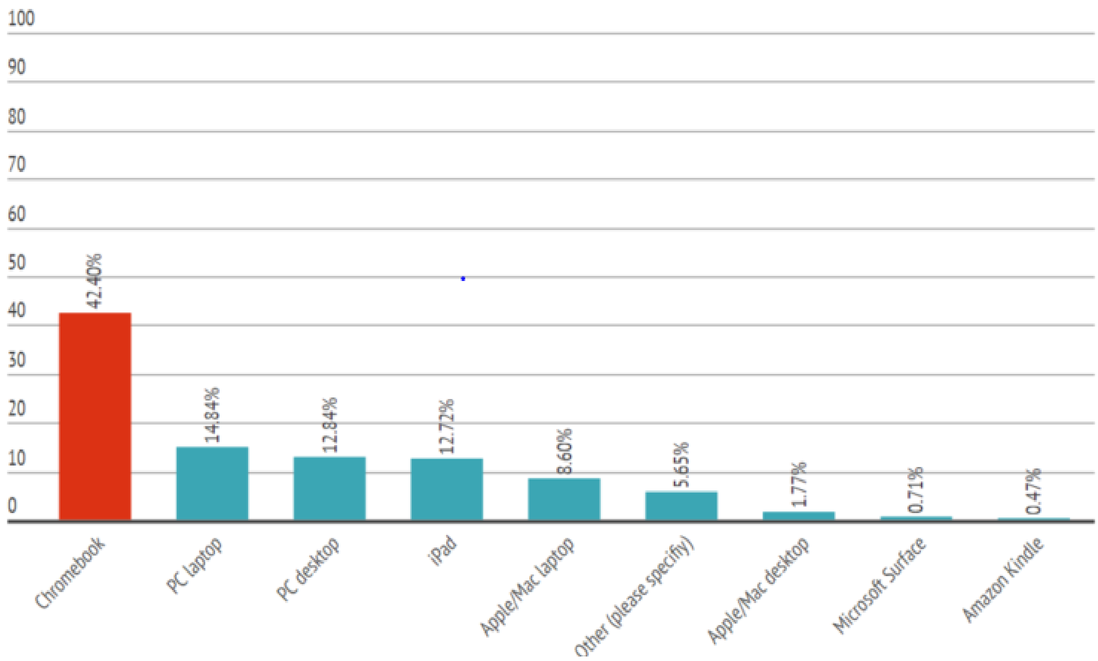


Figure 1. The tools most frequently used for instructional purposes in classrooms surveyed by *Education Week* (Cavanagh, 2017)

Some of the reasons for this shift are listed in the Technotes Blog (2017) from the Texas Computer Education Association (TCEA):

1. Save money (anywhere from $50-$600)
2. Simple is good
3. Long battery life
4. Easy sharing
5. More security
6. A gentle learning curve

While every piece of technology has its downside, Figures 1 and 2 illustrate that an increasing number of Chromebooks have been purchased by schools instead of iPads since 2012 (Herold, 2014).

Microsoft, traditionally more of a computer software company, has recently announced its entry into the educational computing market with its ‘Surface Laptop’ which runs on a lighter, faster version of Windows 10, called Window 10 S. While the $999 price tag targets college students, the company is endorsing new devices made by their partners Acer, Dell, HP and Toshiba. These partner companies’ devices, priced at $189, are aiming at the school market. (Cavanagh, 2017). The cost-efficient price point of the new partner devices would put them on par with current versions of Chromebooks and at half the price of iPads. No matter what choice is made, student learning opportunities can be multiplied when technology is applied properly (Clark & Luckin, 2013)

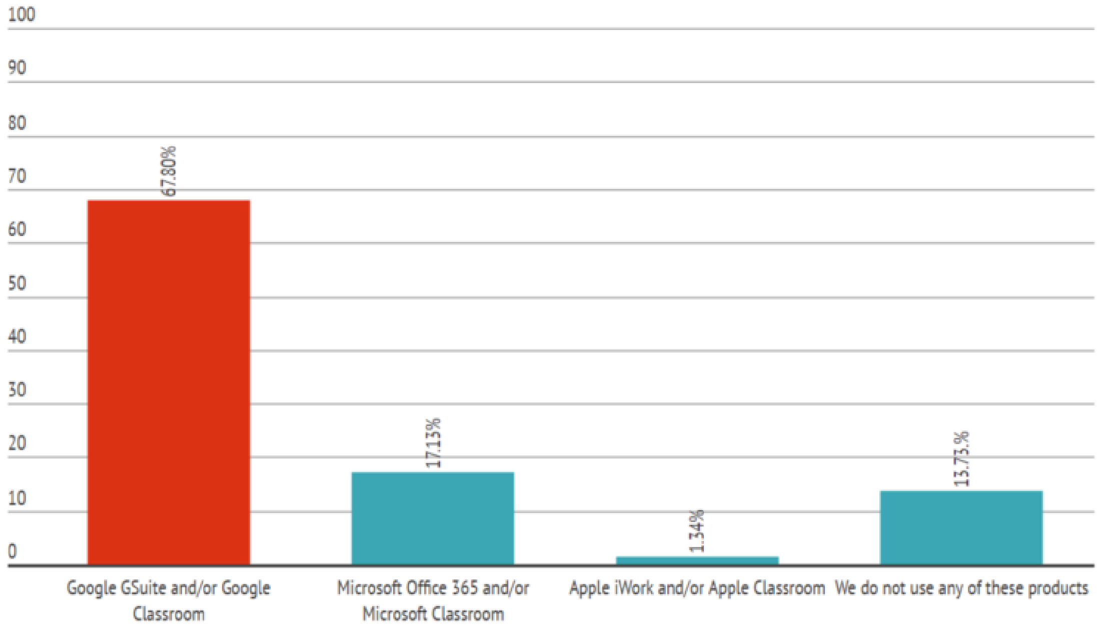


Figure 2. The productivity suite used most frequently by teachers in their districts and classrooms (Cavanagh, 2017)

Technology Application and Integration

The proper application of technology has been examined by researchers explaining how teachers and their development are central in properly applying technology in the classroom. In 2004, Clifford, Friesen, and Lock declared:

Preparing teachers for the 21st century requires a close look at what it means to teach and learn in increasingly networked, technology-rich, digital classrooms. Teacher preparation programs need to create intentional learning environments, where pre-service teachers can explore issues that are relevant and develop pedagogies that are effective for a knowledge era. They need to develop new images and expertise to design and facilitate meaningful learning with technology. (p.19)

However, Tweed (2015) highlighted the belief that the real key to proper technology application and success is not professional development but teacher self-efficacy. Schools considering transitioning to 1:1 student to iPad programs or increasing additional technology investment should first confirm that their teachers are as open to the idea of technology in the classroom as district leadership. Without teacher acceptance, as supported by Tweed (2015) and somewhat by Clifford et al. (2004), districts will find their expensive technology quickly becoming unused. Abrahams (2010) explained that to fully incorporate technology, the issues of the teachers must be addressed, otherwise there will be push back and the technology will remain unused.

With research showing proper technology integration and use improving student engagement and achievement, why are school districts not immediately going to a 1:1, student to iPad program? As stated above, this idea ignores the reality of most school districts. When it comes to selecting an appropriate device for students in a school district, several factors must be examined.

Selecting a Device

Each school district across the country has unique technological needs. Demski (2012) highlighted three main foci when making hardware decisions (listed in no specific order): instructional needs, management, and cost. Each person interviewed in the study held a leadership position within their district, most were superintendents and the rest technology directors. District leaders discussed the need for research and the process involved in making such a critical decision. Many formed stakeholder committees, visited nearby districts, read current research on which devices were more effective, and finally, compared the cost of the different hardware/software packages. The demand for proper planning and research has grown to such an extent that there are now websites district leaders can go to find current research and pricing information. These websites were developed to ‘help provide guidance to administrators and educators in the selection of instructional materials’ (Rationale, 2017). District leaders can visit these websites and find breakdowns dealing with planning, budget and funding, selection, and implementation and effectiveness.

STUDY PURPOSE, QUESTION, AND METHODS

The purpose of this study was to explore the technology directors’ tablet or laptop purchase choices at several suburban and public-school districts in the Southern US. To guide our study, we posed the following main research question: What methods do district technology directors employ when choosing a type of computer, tablet, or laptop for their district? We employed a multiple case study design (Stake, 2013) to explore technology directors’ choices of purchasing either tablet computers or laptops.

Participants and Their Selection

When selecting technology directors to interview, we chose six different districts in a fairly close geographical area. We used a convenient sampling strategy (Creswell, 2013) in which researchers selected the interviewees according to their proximity and accessibility to the researchers. Additionally, each district represented one of three popular technology implementation methods: 1:1 laptop computer program, 1:1 iPad program, or bring your own device (BYOD) program.

Study Instruments

Interviews

We created a questionnaire (see Appendix A) seeking to establish the technology directors’ backgrounds, why their districts selected a particular technology, and where they believed technology was heading in the near future.

Data Collection

The first author interviewed the technology directors from the six districts. Some participants were interviewed in person and others were interviewed by telephone at their convenience. We invited each participant individually by email. Each volunteered and their rights as participants were explained prior to conducting the interview. They also reviewed and signed the human consent forms approved by the University’s Institutional Review Board (IRB) for research.

Analysis

To analyze the multiple case study findings, we used two methods of analysis: a) within-case analysis and b) cross-case analysis.

Within-Case Analysis

District A

This district represents the smallest district in the study with a student population of 2,349. They have a predominantly White student population, 1,564, followed by Hispanic, 571, and African American, 81. District A is a 1:1 laptop district that uses MacBook Airs. While they have followed this method for more than 5 years, there are currently plans to shift to the more cost-effective Chromebooks.

District B

This district is the most technologically advanced district in the group. They offer a number of types of technology to their teachers and the 11,851 students within their district. District B district has chosen the 1:1 iPad method and applies it from grades 4-12. This is the only district in the study in which White is not the dominant demographic. The Asian population represents 4,832 students, while the White population represents 4,540 of the student body.

District C

This district has the most diverse student population of the six districts. White is the dominant demographic at 13,841, with Hispanic at 8,219 and African American at 3,683. This district follows the bring your own device (BYOD) model. They offer a number of technology programs for students to gain certifications prior to graduation. They have decided to focus not just on the devices, but the entire classroom environment. They are spreading their funds to a variety of areas such as classroom redesign, charging stations, and the investment in a more robust network to support the increased device use.

District D

This district represents the largest and fastest growing district of the group. It has a student population of 53,130, which is led by the White demographic at 27,062, followed by Asian, 11, 087, Hispanic, 7,313 and African American, 5,547. This district is growing so quickly that there is little money to keep up with the growing technology needs of its students. They have chosen the BYOD model and allow their campus administrators and technology coaches to determine what needs to be purchased instead of making district wide purchases. The belief is that this will support individual student needs more effectively than making district wide decisions.

District E

This district is an established district that is in the initial stages of implementing a 1:1 approach using MacBook Airs. They will complete their laptop distribution to the high school population next year. They fall into the middle of the district populations at 24,626 students. Their largest population is White, 37,062, followed by Hispanic, 6,935, and African American, 3,270. This is the only district to convene a committee of all stakeholders: community members, administrators, teachers, and students, to make the final technology choice. Each group member was able to try out each technology option considered and then weighed in with their choice.

District F

This district is the second smallest district in the study with a population of 8,254. The largest demographic is White, 5,869, followed by Hispanic, 1,032, and African American, 606. This district is in the process of piloting a 1:1 program with Chromebooks. They want to ensure that the correct long-term technology decision is made; however, they are progressing slowly because their growth projections continue to increase dramatically.

Cross-Case Analysis

Each district, except one, came to their technology decisions as part of a group. District E was the most inclusive, bringing in all stakeholders, while the rest focused mainly on the district decisions makers: superintendents, technology directors, administrators, etc. District A was the exception because their path was chosen by one person. Due to the size of the district, this approach was not as much of an anomaly as it would be at the larger districts in this study. All directors believed technology should be a tool for teachers and students, not a replacement for learning. In their search for technology, each director commented that they wanted to select a device that would engage students and allow them to become active participants in their learning. Interestingly, when asked to outline their 'perfect' technology path, as if money were not an option in their district, their decisions were all strikingly similar. Each thought students at the Kindergarten level should start with iPads as there are a number of excellent learning apps that will accommodate a number of learning needs. Next, all agreed that students should eventually shift to some form of laptop. While opinions varied on which grade, from 2nd to 4th, this transition to laptops should take place, the majority of directors believed the Chromebook would be ideal. This would allow students to learn to use a 'traditional' laptop device without giving them an incredibly expensive tool. All directors agreed that by high school students should have a fully functioning laptop, with the majority stating the MacBook Air would be their device of choice. Each believed this type of device would properly prepare students for post-secondary education.

FINDINGS

Table 1 describes and contains demographics for each of the six districts included in the interviews. District X did not respond or participate in the interviews. Using a case study design, defined as 'an intense study of a single

Table 1. District Student and Teacher Demographic Data (Texas Academic Performance Reports, 2016)

		A	B	C	D	E	F	X
Total Students (K-12)		2,349	11,851	27,296	53,130	24,626	8,254	53,396
Ethnic Distribution:	African American	81	543	3,683	5,547	3,270	606	5,392
	Hispanic	571	1,560	8,219	7,313	6,935	1,032	15,147
	White	1,564	4,540	13,841	27,062	12,549	5,869	23,777
	American Indian	23	48	197	313	134	48	245
	Asian	17	4,832	772	11,087	987	296	6,966
	Pacific Islander	0	14	41	42	69	11	50
	Two or More Races	93	314	543	1,766	682	392	1,819
Economically Disadvantaged		586	1,048	11,468	5,750	7,548	549	17,421
Non-Educationally Disadvantaged		1,763	10,803	15,828	47,380	17,078	7,705	35,975
English Language Learners (ELL)		149	1,247	4,104	2,650	2,728	280	8,290
Students w/Disciplinary Placements (2014-2015)		24	36	369	187	253	21	772
At-Risk Student Enrollment by Program		560	3,051	9,307	8,590	7,228	1,493	19,150
	Bilingual/ESL Education	148	1,496	4,111	2,597	2,886	280	8,942
	Career & Technical Education	608	2,593	7,254	10,230	5,676	2,113	9,696
	Gifted and Talent Education	133	2,370	2,714	5,810	2,015	764	5,598
	Special Education	177	619	2,861	4,619	2,444	599	5,405
Total Staff		307.1	1,100.9	3,127.2	5,117.7	2,544.7	665.1	6,253.4
Gender	Male	38.2	164.7	493.5	705.8	380.9	112.0	764.4
	Female	116.9	596.5	1,485.4	2,813.1	1,289.9	436.1	4,033.0
Degree	Bachelors	132	552.8	1,406.5	2,480.5	1,181.7	388.2	2,740.0
	Masters	22.2	205.4	549.1	972.8	476.2	149.6	988.7
	Doctorate	1	3	11.4	10	10.0	2	31.2
Experience	Beginning Teachers	4	33.4	103.3	238.1	86.7	37.2	158.9
	1-5 Years	44	217.0	448.5	996.3	353.3	153.7	866.1
	6-10 Years	29.8	188.3	532.2	985.9	433.4	148.3	794.5
	11-20 Years	56.2	213.0	630.9	1,002.6	612.0	163.4	1,333.1
	Over 20 Years	21.2	109.5	264.0	296.0	185.4	45.4	644.6
Number of Students per Teacher		15.1	15.6	13.8	15.1	14.7	15.1	14.1

unit for the purpose of understanding a larger class of (similar) units…observed at a single point in time or over some delimited period of time' (Gerring, 2004, p. 342), we compared collected demographic data (TAPR, 2016, see table 1) with interview responses.

Districts' Demographics

Table 1 contains the district populations ranged from the lowest, District A, at 2,349 students to the highest, District X, at 53,396 students. The student to teacher average ranged from 13.8 (District C) to 15.6 (District B). In all districts, except District B, the largest student population was White; in District B, the White and Asian populations were roughly equal. The percentage of economically disadvantaged students ranged from 7% of the student population (District F) to 42% (District C), and students classified as 'at-risk' ranged from 16% (District D) to 36% (District X). These numbers had a significant impact on how decision makers evaluated which type of technology should be purchased.

The first half of the interviews sought to establish the directors' backgrounds and beliefs about classroom technology. They likewise determined the districts' stances on classroom technology, why the districts chose their technology, and if the directors were part of the ultimate decision. All the directors have been involved in educational technology for over 10 years, except one. Mr. G (pseudonym) had the least experience in the field of education, but prior to entering the school system, he was self-employed in the tech industry. Each director believed technology should be accessible to students and teachers at all times. There was a unanimous belief that the technology should be a tool for engagement and enrichment, not a replacement for instruction. The choices made by each district leader were different, so there was a wide variety of representation of the different technological philosophies currently operating in schools in this part of the state. Districts C, D, and F (see Table 1) support their students and teachers with carts of iPads and Chromebooks. None of their technology is allowed to leave the classroom setting. District D also allows BYOD (Bring Your Own Device) if students would like to bring what they have from home instead of using campus equipment. Districts A and E (see Table 1) are both 1:1 districts using MacBook Airs, and District B (see Table 1) is 1:1 using iPads.

Decisions Made by the Districts

Like the technology purchased, each district came to their decision in a unique way. District A went with MacBook Airs because they received a $4.1 million grant, and the secondary curriculum director, at the time – not the current director, made the unilateral decision to purchase MacBook Airs instead of other products on the market. District E created a committee with selected students from leadership groups on each campus who tested different options. Some of those options included: MacBook Air, Dell Venue, HP Pavilion, MS Surface, Windows laptop, and Chromebook. After the testing phases, students ultimately chose the MacBook Air, which the district has begun purchasing and will finish distributing next year. District B conducted a great deal of research on the different options and felt the iPad 'led to not only consumption but also creation.' In Districts C, D, and F, one of the major criteria cited by these directors was that the device must be cost effective. Based on this requirement, Chromebooks became both the obvious and preferred choice of technology.

The last few questions of the interviews were used to understand what each district offered their teachers. Beyond the specified technology already discussed, we wanted to understand what a 'typical' classroom environment is like and what is available for teacher use. All districts were relatively similar; each classroom had projectors, document cameras, and teacher computers. Districts E and F both had interactive whiteboards, Promethean, and EPSON, respectively. District A offered interactive boards by reservation for teachers, and District B had an offering specific to their technology choice called Reflector. Reflector is a program that allows teachers to project their iPad screens onto the projector.

With the final question, we wanted to obtain input from these decision makers about where they see technology in the classroom heading. Ultimately, these are the people who will have significant input in the purchasing decisions, so we were curious about their thought processes. All agreed that technology should be in the hands of students and teachers and that it should align well with the curriculum and be a useful tool, not a constant distraction. Additionally, teachers should be properly trained so that technology is not just limited to research projects but instead used to enhance the overall educational experience.

There was also a consistency with how they viewed the growth of technology in their own districts. Most believed their elementary students, especially those in K-3, should have iPads. The rationale was that the full-size keyboards are a bit large and bulky for younger students, and there are many great iPad apps to assist students with basic reading, writing, and mathematics. Students in these grades may still associate iPads with 'play,' and the use of them creates a rich, interactive environment for students. Beyond the 3rd grade, district directors differed on when to start students on laptop computers. Most directors stated that 4th grade would be an ideal stage for this transition and that laptop computers should be used through the 8th grade. The belief was that these students should have Chromebooks or a similar type of laptop. The idea behind this move away from iPads is explained by the need to teach keyboarding skills and basic computer usage. The directors of Districts A, C, D, and F all spoke of the ease of managing Chromebooks in contrast to a 'full computer' such as a MacBook air. Their belief is supported by O'Donnell and Perry (2013) who found that, with a high reliability (82%), reducing time spent in managing desktop PCs, laptop PCs, or netbooks, allowed for an increase in the amount of time spent on teaching and administration. Upon reaching high school, all directors agreed a full laptop would be best; however, only Districts A and E are able to provide 1:1 laptop programs. District B is 1:1 but opted for iPads, and the rest of the districts either do not have the funds to go 1:1 or the number of students is too great to make this type of program possible. The purpose of moving students to 'full laptops', as stated by the directors of Districts A and E, is to prepare them for computer usage in college and beyond.

Where are the Tablets?

All the directors interviewed stated their district had a number of iPads across every grade. However, most explained they are no longer purchasing as many as they had in the past. When asked why, they all had the same, simple answer — cost. An iPad, on average, costs a district $400, but a Chromebook costs them only $200. In District D, teachers were surveyed to determine their technology preferences for students in their classroom, and over 75% asked for Chromebooks. When asked why, they stated that with this technology, students could create, not just consume. This shift is representative of tablet to Chromebook sales across the United States. From 2012-2014, the educational market held by digital tablets declined 7%. According to Futuresource Consulting (Figure 3), more than 729,000 Chromebooks were sold to K-12 schools in the United States in the second quarter of 2014 (Herold, 2014).

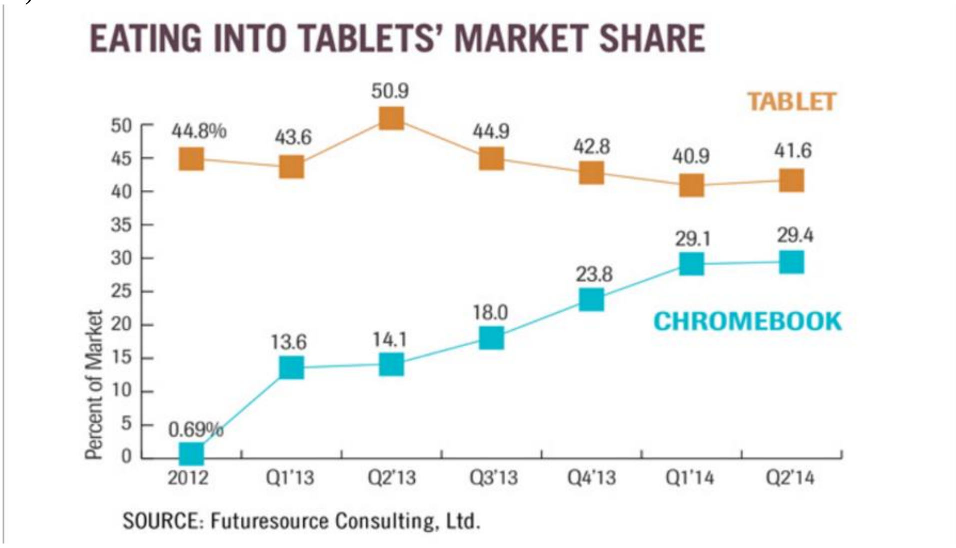


Figure 3. Tablet vs. Chromebook sales 2012-2014.

This growth in purchasing, while driven in part by savings, is also due to the platform on which the device runs. For example, the chief technology officer of Montgomery Country schools in Maryland was looking for a device that was not only cost effective, but allowed for collaboration between students and teachers. He cited Google's Apps for education, a collection of word-processing, spreadsheet, email, storage, and other Web-based applications predicated on making it easier for students and teachers to work together (Herold, 2014). The same can be seen with Perris Union School District in California; Chromebooks were given to each of their more than 10,000 students to take home and use. (Herold, 2017).

Issues

Due to the visible failure of school districts that are implementing 1:1 iPad programs, a growing number of school districts may find themselves straying away from tablet computers, specifically iPads. The most notable being L.A. Unified which purchased 650,000 iPads and updated networking gear and educational software from Pearson at a total cost of $1.3 billion dollars. All the funding came from construction bonds, with $500 going to Apple and Pearson and $800 going toward the improvement of the existing infrastructure (Newcombe, 2015). Several issues plagued the rollout: lack of teacher training, technology and internet issues, and instances in which students bypassed district security on their devices. Overall, these factors were a major impediment for 1:1 iPad programs. In 2014, another suburb of a southwestern metroplex, District X (see Table 1), attempted their own 1:1 iPad rollout program. The price tag was significantly lower than that of L.A. Unified, coming in at a mere $103 million dollars. However, District X has experienced their own issues with system crashes, spotty signals, security breaches, and the loss of at least 483 iPads, totaling more than $79,000. These devices have been reported lost, stolen, or damaged (Hundley, 2014). In each of these instances and the dozens more that have occurred with other devices, it can take years for a school district to recover monetarily.

RECOMMENDATIONS

Based on the literature and collected data, informed school districts have an obligation to pursue any necessary changes in the purchase of technology after examining the research. Due to the intricacies of school budgeting, spending significant amounts of money on technology can be a difficult, if not a risky proposition and should be approached with the greatest of care. Technology directors, as highlighted above, should take the time to read current research, form exploratory committees of different stakeholders – especially students, and evaluate cost effectiveness versus length of use. In other words, to purchase technology that will be outdated in the next few years would be a significant waste of district resources. Once the decision and purchases have been made, the investment should shift to teacher training. Without teacher approval and training, the technology will not be used to its fullest potential and frustration will set in. Teachers must continue to be supported as their training is completed, either by district personnel, which is recommended for cost saving, or by third-party vendors if necessary.

CONCLUSION

The use of technology, whether in the form of an iPad, Chromebook, Macbook Air, or other product purchased by a school district is here to stay. Research has shown, when used properly, devices enhance and engage students in a variety of ways (Mango, 2015). District technology directors have the difficult task of selecting the proper devices for their district. Each school district is unique in its make-up and technological needs, and directors will have to find a method for device selection that suits the particular needs of their district. For some districts, tablet computers will be the best option; for others, laptops are more appropriate. No matter what they choose, there seem to be four major criteria for device selection common amongst directors: 1) familiarity, 2) ease of use, 3) cost, and 4) program/app availability. Based on these ideas, directors will make selections that will send their districts down a technological path that meets the needs of their teachers and ultimately, their students.

REFERENCES

Abrahams, D. (2010) Technology adoption in higher education: A framework for identifying and prioritizing issues and barriers to adoption of instructional technology. *Journal of Applied Research in Higher Education 2*(2), 34-49. DOI: 10.1108/17581184201000012

Alberta Education. (2012). *iPads: What are we learning? Summary report of provincial data gathering day, October 3, 2011.* Retrieved from http://education.alberta.ca/media/6684652/ipad%20report%20-%20final%20version%202012-03-20.pdf

Allen, E., & Seaman, J. (2013). *Changing course: Ten years of tracking online education in the United States.* Babson Survey Research Group Report. Retrieved from: https://static1.squarespace.com/static/52777b57e4b070cdcec2d886/t/5294bd65e4b009e91812340a/1385479525827/changingcourse+Allen+_+Seaman+SLOAN+C+Report+2013.pdf

Babnik, P., Dorfinger, J., Meschede, K., Waba, S., Widmer, M., & Mulley, U. (2013). Tenhnologiee in satz in der schule. In M. Ebner, & S. Schön (Eds.), *Lehrbuch für lernen und lehren mit technologien* (2nd Ed.). Retrieved from http://l3t.tugraz.at/index.php/LehrbuchEbner10/article/view/47

Cavanagh, S. (2017, May 2). Microsoft unveils K-12 operating system, tools to challenge google. *Edweek Market Brief.* Retrieved from: https://marketbrief.edweek.org/marketplace-k-12/microsoft-unveils-k-12-operating-system-tools-challenge-google/?cmp=eml-contshr-shr-mktbf

Cavanagh, S. (2017, May 8). Amazon, Apple, Google, and Microsoft battle for K-12 market, and loyalties of educators. *Edweek Market Brief.* Retrieved from: https://marketbrief.edweek.org/special-report/amazon-apple-google-and-microsoft-battle-for-k-12-market-and-loyalties-of-educators/?cmp=eml-enl-eu-news1

Churchill, D., Fox, B., & King, M. (2012). Study of affordances of iPads and teachers' private theories. *International Journal of Information and Education Technology*, *2*(3), 251-254. Retrieved from http://www.ijiet.org/papers/122-K10017.pdf

City of Frisco. (2017). *Population estimates and projections*. Retrieved from: http://www.ci.frisco.tx.us/578/Population-Estimates-Projections

Clark, W., & Luckin, R. (2013). iPads in the classroom. *Institute of Education, University of London.* Retrieved from: https://digitalteachingandlearning.files.wordpress.com/2013/03/ipads-in-the-classroom-report-lkl.pdf

Clifford, P., Friesen, S., & Lock, J. (2004). Coming to teaching in the 21st century: A research study conducted by the Galileo Educational Network for Alberta Learning. Retrieved from: http://www.galileo.org/research/publications/ctt.pdf

Demski, J. (2012). The hard(ware) choice: Selecting a 1-to-1 computing device. *THE Journal: Transforming Education Through Technology*. Retrieved from: https://thejournal.com/Articles/2012/11/01/1-to-1-computing-the-hardware choice.aspx?Page=1

Fernandez, E., & Streepey, J. (2012). Student perceptions of classroom engagement and learning using iPads. *Journal of Teaching and Learning with Technology*, *1* (2), 13-25.

Fernández-López, Á., Rodríguez-Fórtiz, M., Rodríguez-Almendros, M., & Martínez-Segura, M. (2013). Mobile learning technology based on iOS devices to support students with special education needs. *Computers & Education*, *61*(0), 77-90. doi:10.1016/j.compedu.2012.09.014

Fri-Tic. (2012). *Projet One to One iPad: visite de l'Institut international de Lancy*. Retrieved from http://www.fri-tic.ch/dyn/bin/45214-46185-1-fritic_visite_onetoone_lancy_v2.pdf

Geist, E. (2011). The game changer: Using iPads in college teacher education classes. *College Student Journal*, *45*(4), 758-768.

Gerring, J. (2004). What is a case study and what is it good for? *American Political Science Review*, *98*(2), 341-354.

Hahn, J., & Bussell, H. (2012). Curricular use of the iPad 2 by a first-year undergraduate learning community. *Library Technology Reports*, *48*(8), 42-47. doi:10.5860/ltr.48n8

Henderson, S., & Yeow, J. (2012). iPad in education: A case study of iPad adoption and use in a primary school. In R. H. Sprague (Ed.), *Proceedings of the 45th Annual Hawaii International Conference on System Sciences* (pp. 78-87). New York, NY: IEEE. doi:10.1109/HICSS.2012.390

Herold, B. (2014). Chromebooks gaining popularity in school districts. *Education Week*. Retrieved from http://www.edweek.org/ew/articles/2014/11/12/12chromebooks.h34.html?r=258542091

Herold, B. (2017). Smart ed-tech strategy that comes from the classroom. *Education Week: Leaders to Learn From.* Retrieved from: https://leaders.edweek.org/profile/joseph-williams-executive-director-educational-technology/

Hill, J., Nuss, M., Middendorf, B., Cervero, R., & Gaines, J. (2012). Using iPads to enhance teaching and learning in third-year medical clerkships. In T. Bastiaens, & G. Marks (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2012* (pp. 1482-1488). Chesapeake, VA: AACE.

Huber, S. (2012). *iPads in the classroom: A development of a taxonomy for the use of tablets in schools*. Norderstedt, Germany: Books on Demand GmbH. Retrieved from http://l3t.eu/itug/images/band2.pdf

Hundley, W. (2014). Lewisville ISD's iPad program gets mixed reviews. *Dallas Morning News.* Retrieved from http://www.dallasnews.com/news/lewisville/2014/04/08/lewisville-isds-ipad-program-gets-mixed-reviews

Hutchison, A., Beschorner, B., & Schmidt-Crawford, D. (2012). Exploring the use of the iPad for literacy learning. *The Reading Teacher*, *66*(1), 15-23. doi:10.1002/TRTR.01090

Isabwe, G. (2012). Investigating the usability of iPad mobile tablet in formative assessment of a mathematics course. In *2012 International Conference on Information Society* (pp. 39-44). New York, NY: IEEE. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6285043

Johnson, L., Adams, S., & Cummins, M. (2012). *The NMC horizon report: 2012 higher education edition.* Austin, TX: New Media Consortium.

Killilea, J. (2012). *Leveraging mobile devices for asynchronous learning: Best practices*. Retrieved from http://www.scs.org/upload/documents/conferences/autumnsim/2012/presentations/etms/4_Final_Submission.pdf

Kinash, S., Brand, J., & Mathew, T. (2012). Challenging mobile learning discourse through research: Student perceptions of blackboard mobile learn and iPads. *Australasian Journal of Educational Technology*, *28*(4), 639-655. Retrieved from http://www.ascilite.org.au/ajet/ajet28/kinash.pdf

Lau, A., & Ho, S. (2012). Using iPad 2 with note-taking apps to enhance traditional blackboard-style pedagogy for mathematics-heavy subjects: A case study. In M. J. W. Lee, & H. Va Leong (Eds.), *Proceedings of IEEE International Conference on Teaching, Assessment, and Learning for Engineering 2012* (pp. H3C-4-H3C-6). New York, NY: IEEE. doi:10.1109/TALE.2012.6360349

Mango, O. (2015). iPad Use and student engagement in the classroom. *The Turkish Online Journal of Educational Technology 14*(1), 53-57.

Martin, T., Berland, M., Benton, T., & Smith, C. (2013). Learning programming with IPRO: The effects of a mobile, social programming environment. *Journal of Interactive Learning Research*, *24*(3), 301-328.

McClanahan, B., Williams, K., Kennedy, E., & Tate, S. (2012). A breakthrough for Josh: How use of an iPad facilitated reading improvement. *Techtrends, 56*(3), 20-28. doi:10.1007/s11528-012-0572-6

McKechan, S., & Ellis, J. (2012). Collaborative learning in the Scottish curriculum for excellence: The challenges of assessment and potential of multi-touch technology. *Education 3-13. Advanced Online Publication*. doi:10.1080/03004279.2012.717959

Meyer, A. (2015). iPads in inclusive classrooms: ecologies of learning. *E-Learning Systems, Environments and Approaches,* 25-37.

Fix indention Montrieux, H., Vanderlinde, R., Schellens, T., & De Marez, L. (2015). Teaching and learning with mobile technology: A qualitative explorative study about the introduction of tablet devices in secondary education. *PLoS ONE 10*(12): e0144008. https://doi.org/10.1371/journal.pone.0144008

Molnar, M (2014). Chromebooks gain in K-12 market, challenging iPads. *Education Week*, *34(*12), 10-11. Retrieved from http://www.edweek.org/ew/articles/2014/11/12/12chromebooks-market.h34.html

Murphy, T., & Williams, C. (2011). The iPad as a class presentation platform. In *Proceedings of the 2011 ASEE Southeastern Section Conference, ASEE, Charleston, SC*. Retrieved from http://se.asee.org/proceedings/ASEE2011/Papers/FP2011mur183_199.PDF

Murray, O., & Olcese, N. (2011). Teaching and learning with iPads, ready or not? *TechTrends*, *55*(6), 42-48. doi:10.1007/s11528-011-0540-6

Newcombe, T. (2015). What went wrong with L.A. unified's iPad program. *Government Technology.* Retrieved from: http://www.govtech.com/education/What-Went-Wrong-with-LA-Unifieds-iPad-Program.html

O'Donnell, B., & Perry, R. (2013). Quantifying the economic value of chromebooks for K-12 education. *White Paper.* Retrieved from: http://static.googleusercontent.com/media/ggg.re/en/us/intl/en/chrome/assets/education/pdf/IDC-WP-Quantifying.the.Economic.Value.of.Chromebooks.for.K-12.Education-082012.pdf

Ostler, E., & Topp, N. (2013). Digital note taking: An investigation of an iPad application as a strategy for content review and practice in intermediate algebra. In R. McBride, & M. Searson (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2013* (pp. 72-77). Chesapeake, VA: AACE.

Rational. (2017). Retrieved from http://qualitycontent.setda.org/about-the-project/

Rossing, J., Miller, W., Cecil, A., & Stamper, S. (2012). iLearning: The future of higher education? Student perceptions on learning with mobile tablets. *Journal of the Scholarship of Teaching and Learning, 12*(2), 1-26. Retrieved from http://josotl.indiana.edu/article/view/2023

Sachs, L., & Bull, P. (2012). Case study: Using iPad2 for a graduate practicum course. In P. Resta (Ed.), *Proceedings of Society for Information Technology & Teacher Education International Conference* 2012 (pp. 3054-3059). Chesapeake, VA: AACE.

Schaffhauser, D. (2015). 3 Reasons Chromebooks Are shining in education. *THE Journal (Technological Horizons in Education)*, *42*(3), 22.

Shute, V., & Rahimi, S. (2017). Review of computer-based assessment for learning in elementary and secondary education. *Journal of Computer Assisted Learning*, *33*, 1–19. doi: 10.1111/jcal.12172.

Sloan, R. (2012). Using an e-textbook and iPad: Results of a pilot program. *Journal of Educational Technology Systems*, *41*(1), 87-104. doi:10.2190/ET.41.1.g

Stake, R. E. (2013). *Multiple case study analysis*. Guilford Press.

Sullivan, R. (2013). The tablet inscribed: Inclusive writing instruction with the iPad. *College Teaching*, *61*(1), 1-2. doi:10.1080/87567555.2012.700339

Technotes Blog (2017). Retrieved from: https://www.tcea.org/blog/chromebook-perfect-teaching-aid/ Texas Academic Performance Reports (2016). Retrieved from: http://tea.texas.gov/perfreport/tapr/index.html

Tweed, S. (2013). *Technology implementation: teacher age, experience, self-efficacy, and professional development as related to classroom technology integration* (Doctoral dissertation, East Tennessee State University).

U.S. Department of Education. (1999). Education and Title IV. Retrieved from http://www2.ed.gov/about/offices/list/ocr/docs/hq43e4.html.

Villemonteix, F., & Khaneboubi, M. (2012). *Utilisations des tablettes tactiles à l'école primaire*. Retrieved from http://hal.archives-ouvertes.fr/edutice-00765323

Wainwright, K. (2012). Putting iPads in the hands of faculty. In *Proceedings of the ACM SIGUCCS 40th annual conference on Special interest group on university and college computing services* (pp. 139-144). New York, NY: ACM. doi:10.1145/2382456.2382489

Wasniewski, E. (2013). One-on-one with an iPad: A faculty perspective on iPad supports for students with disabilities. In R. McBride, & M. Searson (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2013* (pp. 4346-4351). Chesapeake, VA: AACE.

Williams, P., Wong, W., Webb, H., & Borbasi, S. (2011). Mobile technologies in the field: iPads – rescuer or rescuee? In G. Williams, P. Statham, N. Brown, & B. Cleland (Eds.), *Changing demands, changing directions: Proceedings of ascilite 2011* (pp. 1325-1331). Retrieved from http://www.ascilite.org.au/conferences/hobart11/downloads/papers/Williams-concise.pdf

Zambarbieri, D., & Carniglia, E. (2012). Eye movement analysis of reading from computer displays, eReaders and printed books. *Ophthalmic and Physiological Optics, 32*(5), 390-396. doi:10.1111/j.1475-1313.2012.00930.x

Appendix A

Interview Questions:

1. How long have you served in your current position? Did you hold any technology positions in prior districts?
2. What is your belief about technology in the classroom? Why?
3. What is your districts position on technology in the classroom? (BYOD, iPads, Chromebooks, Macs)
4. Why did your district choose its current method instead of an alternative method?
5. Were you part of that decision?
6. What kind of general technology is available to classroom teachers? (projectors, smartboards, etc.)
7. Are the offerings consistent across all grades or does it vary by level? For example, does the elementary level get more of certain technologies than middle schools/high schools, etc.
8. Where do you see districts heading when it comes to purchasing technology? Is there any new technology currently out or coming out that will is particularly interesting? Why?
9. In your ideal world, where money is not an option what type of technology would you find in the classroom?

A DESIGN OF EDUCATIONAL COMPUTER GAME

Ali Ozdemir
Manisa Celal Bayar University, Turkey

Aysegul Alaybeyoglu
Izmir Katip Celebi University, Turkey

Kadriye Filiz Balbal
Manisa Celal Bayar University, Turkey

ABSTRACT: Nowadays, computer-assisted games have become a popular activity, especially for young people and children. It is expected that using computer games for educational purposes will make learning fun and amusing for every age of individuals. In this study, an educational computer game is designed especially to help students learn amusingly. The designed game can be used either individually or by teachers in the classroom environment and can easily be adapted to each course and topic. The questions in the game can be easily updated. In the study, questions are designed for mathematics lesson.

Keywords: educational game, educational computer game, mathematics game, game design

INTRODUCTION

Mathematics, which is indispensable in every field of daily life from past to present, is also a scientific discipline that originates from all other sciences. For this reason, great importance has been attached to the learning and teaching of mathematics throughout history. Effective teaching of mathematics is very important for understanding, learning, interpreting and using mathematics (Fırat, 2011).

In general, there are many difficulties in learning and teaching of abstract mathematics consisting of concepts and rules (Ekinözü and Sengül, 2007). Increasing opportunities through the development of technology enable the development of new methods and techniques for overcoming these difficulties. By using computer technology, abstract concepts can be embodied and learning and teaching activities can be more permanent, effective, meaningful and fun.

The vast majority of today's young people pass their time by playing computer games (Kafai, 2001). It is expected that applying game to the learning activity will provide more effective, meaningful and permanent learning. There are many studies in literature which use computer games in education and researchers attract more attention to this field day by day.

In this study, an educational game design which can be played in both class environment or individually is developed. It has been applied to mathematics lesson and at the end of the study, students' opinions are evaluated. In following sections of the paper, related works, educational computer games, the designed educational computer games, methods and findings are stated.

RELATED WORKS

There are many studies about educational computer games in the literature. In this section, related studies carried out in Turkey and abroad are summarized.

Nuhoğlu, Tüzün, Kaya and Cınar (2011) developed an educational game design model. They pointed out that using the model they developed in the educational game design process as a result of the summer examination of the area they were doing with the educational game.

Bakar, Tüzün and Cağıltay (2008) determined the opinions of the 6th grade students in the study they have conducted in the social studies course related to the use of educational computer games in the lessons. As a result of their study conducted on 24 number of students for 9 weeks, they found that the educational environment is found usefull by the students.

Offenbach (1964) designed a game about probability and attempted to determine its effects on learning ability of the pre-school and primary 4th grade students. He has found that both age groups have different approaches and older children are more normative.

Brown (2000) examined the effect of computer-assisted instruction on primary and middle school students in a two-year study. At the end of the study conducted on 214 students, it was determined that they could make a great contribution to the learning of computer-assisted instruction when it was used in an appropriate way.

Oztürk (2005) has implemented computer aided instruction design and has studied on the topic of permutation and probability. The software, which is provided with activities and simulations, also includes multiple-choice questions at the end of the topic.

Gürbüz and Birgin (2012) investigated the effects of computer-based instruction on the students' perceptions of probability. At the end of the study, they found that computer-assisted instruction is more effective than traditional teaching.

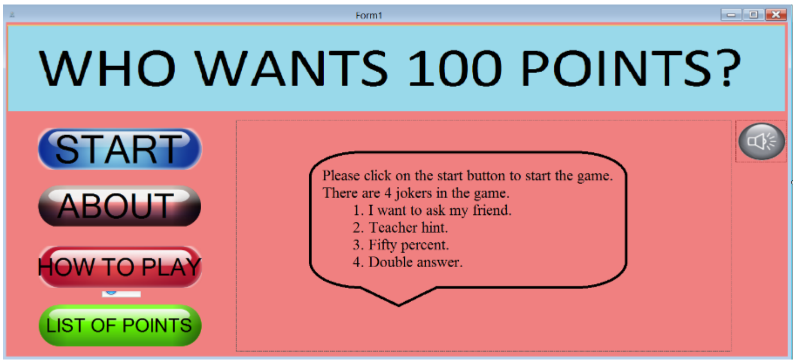
EDUCATIONAL COMPUTER GAMES

It is inevitable that computer technologies that effect every area of our life are also used in the field of education. Especially, courses like mathematics, in which abstract concepts are taught must be enriched with technology support. The visualization and concretization of abstract concepts by using computer technologies provide more effective, permanent and meaningful learning for students (Hewson, 1985; Novak and others, 1983; Thornton and Sokoloff, 1990 and 1998). It is supposed that student who actively participates in the learning environment learns the knowledge better (Bayraktar, 2002).
Today's young people spend a lots of their time on the computer. A large part of this time is spent by playing games. The use of highly enjoyable and motivating computer games for educational purposes may be beneficial in increasing the efficiency and quality of educational activities (Squire, 2011). Students who are bored in the classical learning environment and are reluctant to lessons can enjoy learning by participating in learning environments which are enriched by educational computer games. In particular, if students are organized as groups and participate in the game, learning can be encouraged in a collaborative manner. Indeed, in learning environments supported by an educational game, students are more concerned with the problem and concentrate better on the lesson (Çakmak, 2000).

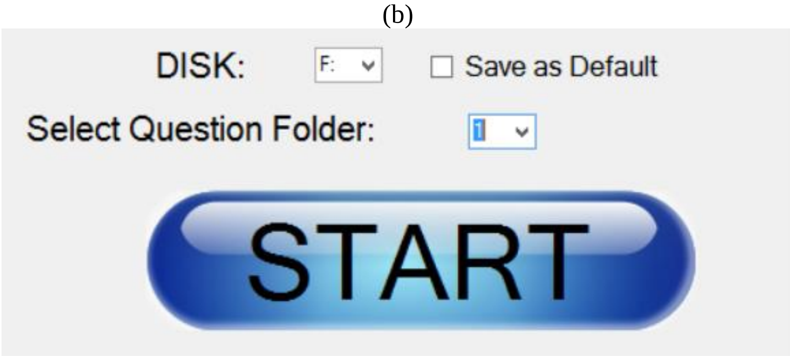
DESIGNED EDUCATIONAL COMPUTER GAME

When the educational computer games used in the learning environment are designed appropriately, they enable the students to participate in the learning process in an active way (Whelan, 2005). In the teacher-centered learning environment, the student who tries to learn only by listening passively, is active, authoritative and motivated during playing the game (Whelan, 2005).
The purpose of the designed educational computer game is to enable student to participate actively to the learning process in the classroom environment. The designed educational computer game is named "Who Wants to Get 100 Points". Figure 1 shows the screenshots of the educational computer game.

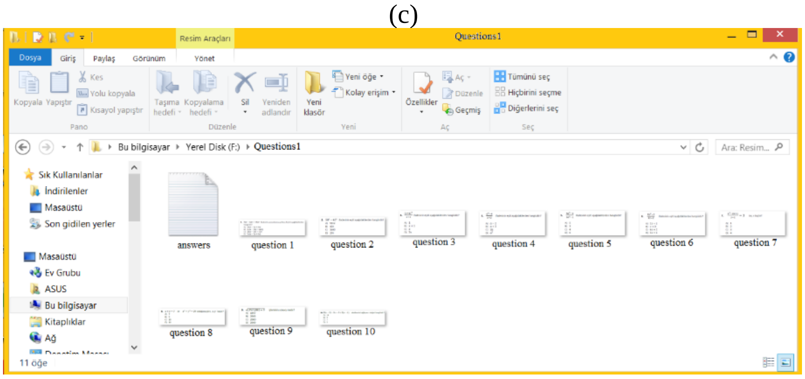
(a)


Form1
WHO WANTS 100 POINTS?
START
ABOUT
HOW TO PLAY
LIST OF POINTS
Please click on the start button to start the game.
There are 4 jokers in the game.
1. I want to ask my friend.
2. Teacher hint.
3. Fifty percent.
4. Double answer.

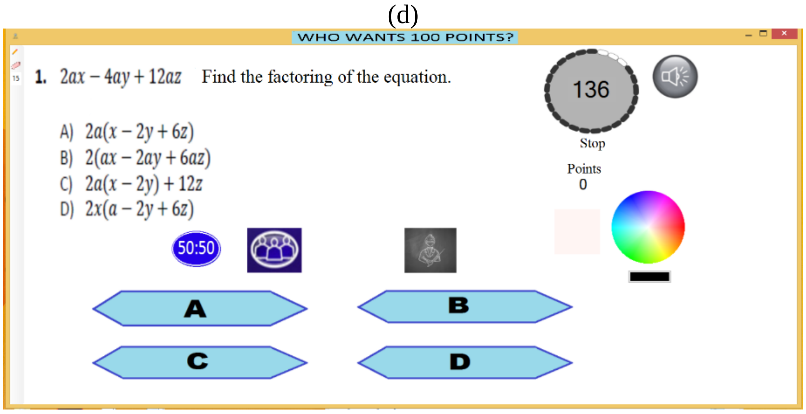
(b)


DISK:
F:
Save as Default
Select Question Folder:
1
START

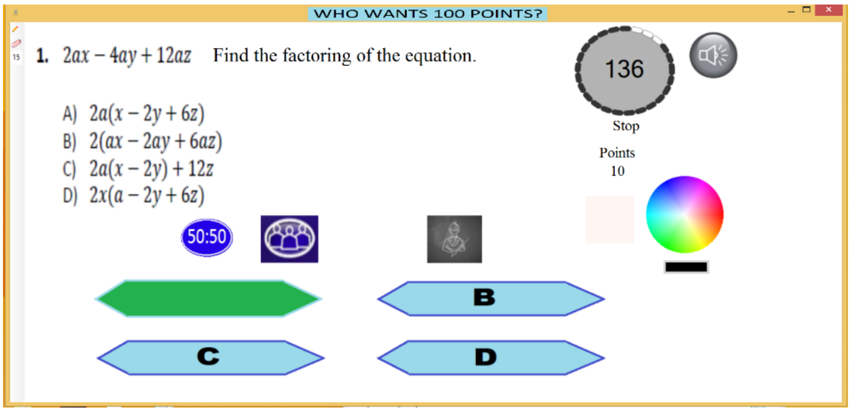
(c)


Questions1
Bu bilgisayar › Yerel Disk (F:) › Questions1
answers
question 1
question 2
question 3
question 4
question 5
question 6
question 7
question 8
question 9
question 10
11 öğe

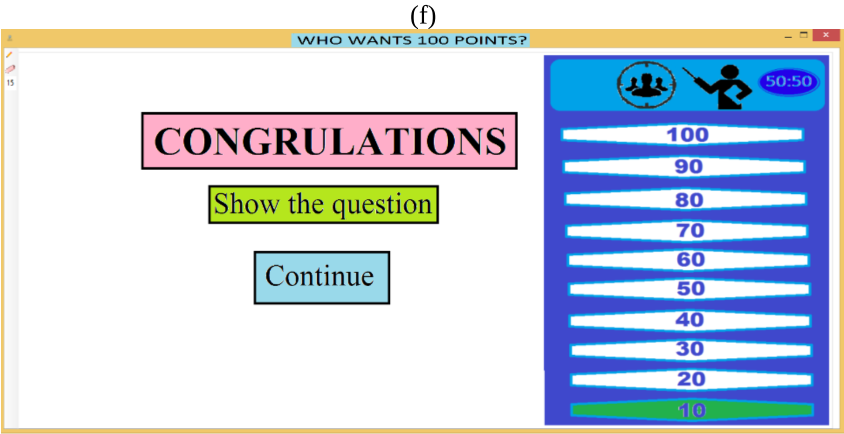
(d)


WHO WANTS 100 POINTS?
1. $2ax - 4ay + 12az$ Find the factoring of the equation.
A) $2a(x - 2y + 6z)$
B) $2(ax - 2ay + 6az)$
C) $2a(x - 2y) + 12z$
D) $2x(a - 2y + 6z)$
136
Stop
Points
0
50:50
A
B
C
D

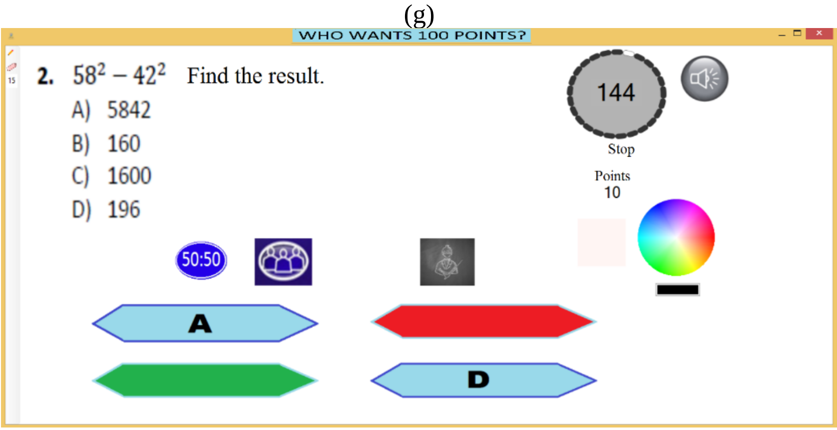
(e)


WHO WANTS 100 POINTS?
1. $2ax - 4ay + 12az$ Find the factoring of the equation.
A) $2a(x-2y+6z)$
B) $2(ax-2ay+6az)$
C) $2a(x-2y)+12z$
D) $2x(a-2y+6z)$
136
Stop
Points
10
50:50
B
C
D

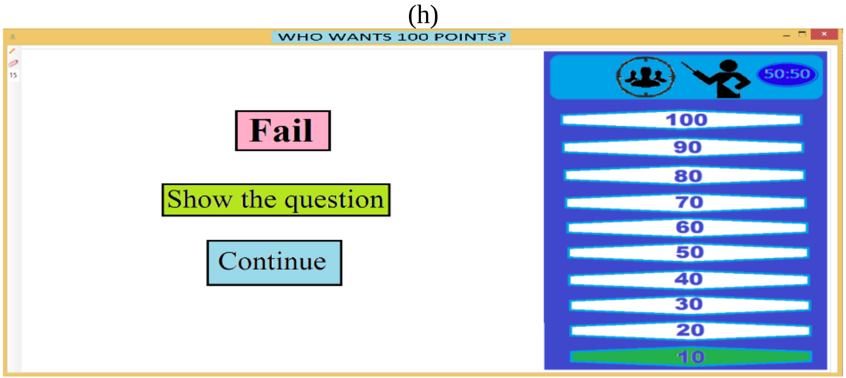
(f)


WHO WANTS 100 POINTS?
CONGRULATIONS
Show the question
Continue
50:50
100
90
80
70
60
50
40
30
20
10

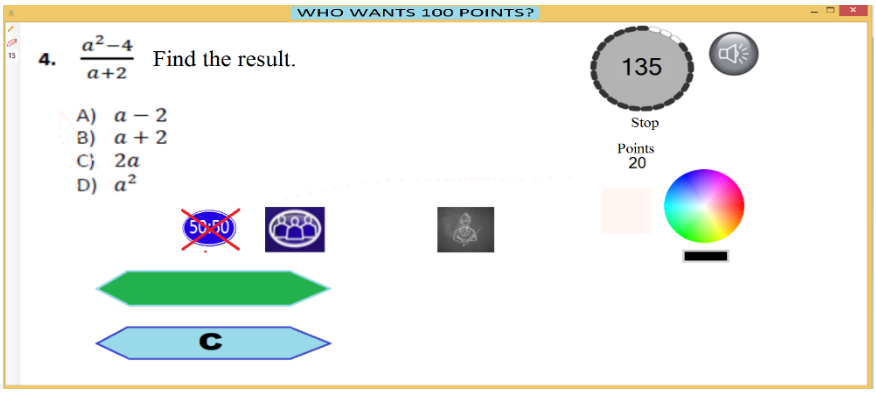
(g)


WHO WANTS 100 POINTS?
2. $58^2 - 42^2$ Find the result.
A) 5842
B) 160
C) 1600
D) 196
144
Stop
Points
10
50:50
A
D

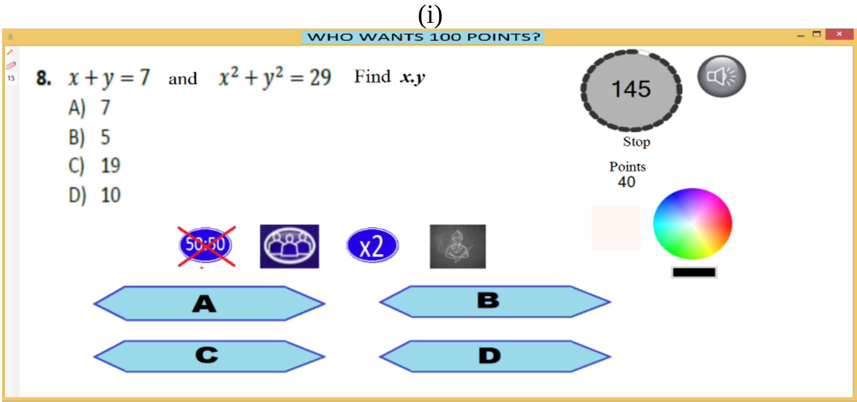
(h)


WHO WANTS 100 POINTS?
Fail
Show the question
Continue
50:50
100
90
80
70
60
50
40
30
20
10

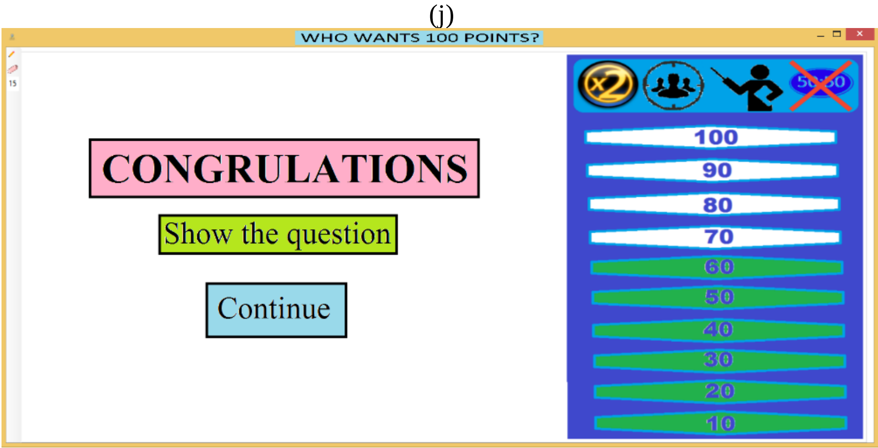
(ı)



(i)



(j)



(k)

Figure 1. Screen Views of the Developed Educational Computer Game

Figure 1.a shows main page of the designed educational computer game. Figure 1.b shows screenshot of the information displayed when the "How to Play" button is clicked. When the "Start" button is clicked, a window is opened to select the drive and folder where the questions are stored during the game is being played (Figure 1.c). The questions were prepared in advance by the teacher and collected in picture format as shown in Figure 1.d and collected in a folder. By this way, several folders consisting of different questions can be prepared and different games can be played on top of each other. As it can be seen in Figure 1.e, there are options of jokers namely fifty percent, “I want to ask my friend” and teacher hint joker; one of which can be selected by the learner. Since the eighth question, there is also a double answer joker (Figure 1.j). The learner has 140 seconds to answer the question. But if necessary, the teacher can stop the time counter. Designed game also includes the status of the answer, whether it is correct or incorrect, pen and the eraser to use when solving the question, color palette for the pen, and sound effects to increase excitement (Figure 1.e,f,g,h,k).

METHOD

The aim of this study is to help students learn in an effective and permenant way by designing an educational computer game. In the scope of this study, an educational computer game design was realized. Semi-structured interviews were held with the students participating in the study at the end of the game, which was played with participation of all the students in the classroom environment and in mathematics lesson. These interviews were recorded and analyzed respectively.

RESULTS

In this part of the study, the findings related to the students' views on the practice in the light of the teacher's observations on the play line, records and interview results are explained.

In the interviews, all students stated that they enjoyed the educational computer game they played. For example, one of the students answer is "*I enjoyed the game very much. Because when you're solving a question, it's like you're in a real race. It is very nice to have fun with sweet excitement."* Another student stated his opinion as "*It was a very pleasant play. Solving a mathematical question has become pleasurable, fun and exciting."*. Many students stated that they were happy when they solved the questions and won points and they also stated that they never bored and they wanted to play again and again. Even a student said that "*Mathematics has never been so enjoyable. I always want to play games. I don't want you to stop asking questions.".*

A large number of students stated that educational play is contributing to the success of the course. While one of the student stated as "I *solved questions at home to earn more points in the rating*.", another student stated his opinion as "*I did not like math lessons, I could not. But I want to do it now. Because I want to score points*".

Most of the students agree that playing the game in a class environment with whole students participate made it very enjoyable. In this subject, one of the students stated his opinion as "*It is very nice to solve each question in groups of 2 or 3 people. I have solved the question with my friend. When I get stuck in a place, I ask my friend's opinion. By this way I both learn and proud of myself as I earned points. My friends are congratulating me."*.

According to observations made by the teacher during the play of the designed educational computer game, positive findings were reached. We observed that there was a collaborative learning environment based on solidarity and assistance manner between students and an exciting and entertaining lesson with active participation of students during the game. He also pointed out that students repeatedly play games and therefore insist on solving more questions.

CONCLUSIONS AND RECOMMENDATIONS

In this study, an educational computer game design was proposed and the opinions of the students related to the game played in the classroom environment were analyzed. When the findings in the study are examined, the following conclusions are obtained.

When both the observations of teacher and the results of the interviews made with the students participating in the application are examined, it is obtained that educational computer games play a positive role in the mathematics lesson. It is very important for the student-centered learning that the designed educational computer game enables students to participate actively in the classroom.

Especially in mathematics lessons it is very difficult for students to solve questions without bothering and even enjoying solving questions. The students who enjoyed playing, having fun and solving the questions with pleasure during the game stated that they were not bored and wanted to play again and again. The whole class act as a as a single team to get points, and they are congratulated by their friends when they solved the question, and they are supported when they could not solve it.

As a result, it was observed that students preferred a game-based course instead of a classical mathematics course. The teacher was happy to see that students solved the questions in amusement and found the application positive. In this study, educational game has made a great contribution to students' interest in mathematics lesson. Moreover, students have stated that they want to be taught in a similar way in all subjects.

According to findings from this study, the following subjects can be suggested for new studies.

1. The research was conducted by high school students. Other work can be done at different class levels.
2. The designed educational computer game was applied in mathematics lesson. By applying in other lessons, the effects on students can be determined.
3. The research data were obtained as semi-structured interviews and observation results. Other studies can be collected using different data collection methods and techniques.

4. More studies involving educational computer game design can be done.
5. While the game design is implemented, more interviews can be made with the educators. By this way educators participation can be provided while designing the game.

REFERENCES

Akgün, E., Nuhoğlu, P., Tüzün, H., Kaya, G. & Çınar M. (2011). *Bir eğitsel oyun tasarımı modelinin geliştirilmesi*. Eğitim Teknolojisi Kuram ve Uygulama, 1(1), 41- 61.

Bakar, A., Tüzün, H., & Çağıltay, K. (2008). *Öğrencilerin Eğitsel Bilgisayar Oyunu Kullanımına İlişkin Görüşleri: Sosyal Bilgiler Dersi Örneği*. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi (H. U. Journal of Education) 35: 27-37

Bayraktar, B. B. (2002). Bilgi Sistemleri ve Yönetim Bilgi Sistemi Olarak Yüksek Performans Yönetim Modeli. Endustri İliskileri ve İnsan Kaynakları Dergisi. Cilt 4, Say. 2.

Brown, F., 2000. Computer Assisted Instruction in Mathematics Can Improve Students' Test Scores: A Study, Nabse Journal, p. 18.

Çakmak, M. (2000). İlköğretimde matematik öğretimi ve aktif öğrenme teknikleri. Gazi Üniversitesi Eğitim Fakültesi Dergisi, 20(3), 111-118.

Ekinözü, İ. ve Şengül, S. 2007. Permütasyon ve olasılık konusunun öğretiminde canlandırma kullanılmasının öğrenci başarısına etkisi. Kastamonu Eğitim Dergisi, 15(1), 251–258.

Fırat, S. (2011). *Bilgisayar destekli eğitsel oyunlarla gerçekleştirilen matematik öğretiminin kavramsal öğrenmeye etkisi.* Yüksek Lisans Tezi, Adıyaman Üniversitesi Fen Bilimleri Enstitüsü, Adıyaman.

Gürbüz, R. ve Birgin, O. 2012. The effect of computer-assisted teaching on remedying misconceptions: The case of the subject "probability". Computers & Education 58, s. 931–941

Hewson, P.W. (1985). "Diagnosis and Remediation of an Alternative Conception of Velocity Using a Microcomputer Program". American Journal of Physics. 53,684-690.

Kafai, Y. B. 2001. The educational potential of electronic games: From games-to-teach to games-to learn. Playing by the rules. https://culturalpolicy.uchicago.edu/sites/culturalpolicy.uchicago.edu/files/kafai.pdf Erişim Tarihi: 10.01.2017

Novak, J.D., Gowin, D.B. ve Johansen, G.T., (1983), "The Use of Concept Mapping and Knowledge Vee Mapping with Junior High Science Students". Science Education, 67(5), 625-645.

Offenbach, S. I. 1964. Studies of Children's Probability Learning Behavior: I. Effect of Reward and Punishment at Two Age Levels. Child Development, 35(3), 709- 771.

Öztürk, G. 2005. İlköğretim 8. Sınıf Düzeyinde Permutasyon ve Olasılık Ünitesinin Bilgisayar Destekli Öğretim Tasarımı. Yüksek Lisans Tezi. Balıkesir Üniversitesi, Balıkesir.

Squire, K. (2011). Video Games and Learning: Teaching and Participatory Culture in the Digital Age. Technology, Education--Connections (the TEC Series). Teachers College Press. 1234 Amsterdam Avenue, New York, NY 10027.

Thornton, R.K.; Sokoloff, D.R. (1998), "Assesing Students Learning of Newton's Laws: The Force and Motion Conceptual Evaluation of Active Learning Laboratory and Lecture Curricula". American Journal of Physics. 66,338-352.

Thornton, R.K., Sokoloff, D.R. (1990), "Learning Motion Concepts Using Real-Time Microcomputer-Based Laboratory(MBL) Activities to Help Students Overcome Some Common Conceptual Difficulties in Kinematics". American Journal of Physics. 58,858-867.

Ural, M. N. (2009). Eğitsel bilgisayar oyunlarının eğlendirici ve motive edici özelliklerinin akademik başarıya ve motivasyona etkisi. *Doktora Tezi, Anadolu Üniversitesi Eğitim Bilimleri Enstitüsü, Eskişehir*.

Whelan, D.L. (2005). Let the games begin. *School Library Journal, 51*(4), 40-43.

INVESTIGATION OF METHODS USED IN MODELING AND FORECASTING OF STREAM FLOWS AND LOCATION OF MACHINE LEARNING METHODS IN THIS AREA

Osman Selvi
Istanbul Aydin University, Turkey

Ilham Huseyinov
Istanbul Aydin University, Turkey

ABSTRACT: Machine learning is used today to produce different kinds of results in many areas of engineering. In our work, studies on modelling hydrological processes of machine learning methods have been investigated. The researchers make short or long term forecasts by modeling the hydrological processes of a selected basin. Researchers thanks to the estimates made can be created early warning systems in the short term or can be provide knowledge to decision makers in the long term for sustainable water resource management. In the literature survey made in this context, the answers to the questions about the modeling methods of streamflows in hydrology, the place of machine learning methods in this area, input parameters used in modeling, input methods used for selecting models and performance evaluation methods of developed models were searched. Most commonly used methods for modeling stream flows are artificial neural network methods (ANN), support vector machine(SVM), bayesian methods, fuzzy logic methods and AR & MA derivative methods. While stream flow data is used as the basic input parameter, it is seen that parameters such as the amount of precipitation and the evaporation rate are used in some studies. The most frequently used methods for efficiency evaluation are MSE, MAE, RMSE, r, R^2 and NSE.

Keywords: stream flow forecasting, machine learning, hydrological models

INTRODUCTION

Water is an important compound that supply viability in the biosphere which have an important task like blood circulation. The continuation or sustainability of biophysical and social processes is closely related to the existence of water (Falkenmark, 2017).

In our world with limited water resources, population growth, rapid urbanization, the increase in the standard of living, the need for renewable energy sources resulted in an increase in the demand for water increase with each passing day. In addition, hazardous waste involved in water resources, climate change and other adverse effects increase the stress on water resources. Therefore, effective management of water resources both locally, regionally and globally is important for the welfare of humanity, economic development and protection of the environment. ((WWAP) U. N., 2017) ((WWAP) U. N., 2016) (KANSAL, 2005) (Rockström and others, 2014) Human as a dominant force behind the changes in water resources, deals with the optimization of using water for different purposes in the management of water resources for the continuation of its existence (Falkenmark, 2017).

There are many research topics such as stream flow forecasting, change in lake water level or storage volume prediction in the literature for the purpose of effective management of water resources. Stream flow forecasting, which is the subject of our work, is a demanding process due to the complexity and non-linear structure of the factors affecting the formation of stream flow (Maheswaran & Khosa, 2012) (Yaseen and others, 2016).

Researchers use various modelling tools (SWAT, TOPNET, GR4J, GR2M etc.) or machine learning tools (Neural Network, Support Vector Machine, Fuzzy Lojic, Bayesian Approaches, ARIMA or ARMAX etc.) or hybrit modelling in order to effective predictions about the future. And they compare them with various performance criteria such MSE, MAE, RMSE, NSE, r, R^2. Researchers which using machine learning methods are often used lagged days stream flow values for their model. The precipitation and evaporation parameters, however, used with the stream flow parameter at various delay times.

Researches mostly are used trial and error method or corelation analysis methods (ACF, PACF etc.) for appropriate feautere selection. According authors, in the studies made under the article on stream flow forecasting, the least studied input parameter is the selection topic. Stream flow forecasting is used for many purposes depending on the forecast period. Hourly or daily forecasting models approaches often involve floods or disasters are aimed to be avoided. By weekly, monthly or seasonal forecasting models, the aim is to ensure effective use of water resources for various areas. By long term prediction, it is aimed to assist decision makers in future planning.

In this context, 32 studies between 1998 and 2017 were examined. The methods used in the researchs are examined under the headings such as estimation ranges, performance evaluation criterias and countries of implementation.

METHODS

In the literature, it is possible to examine the methods used for stream flow forecasting in three groups.
These;

1. Hydrological modelling tools,
2. Machine learning tools,
3. Create hybrid models from hydrological modeling tools and machine learning tools.

When the studies are examined, it seems that there is not a single solution that can produce the right result under all conditions. When the performance of the same method is examined in terms of the input parameters, it is seen that there are differences in the field from the applied area.

While (Demirel, Venancio, & Kahya, 2009) using stream flow and precipitation as the input parameters in their studies, (XU, ZHU, ZHANG, XU, & XIAN, 2009) using stream flow, precipitation and evaporation values for the best result.

1. Hydrological Modeling

In literature review most used hydrological model is SWAT (Soil Water Assesment Tool). And others TOPNET, TOPMODEL, GR4J and GR2M models. We can be examined hydrological models based on two perspective. First based on spatial representation and second based on internal processes (Toro, Meire, F.Gálvez, & Riverola, 2013).

1.1. Examining Based on Spatial Representation

1.1.1. Aggregated Hydrological Models

In aggragated hydrological models, rain and other hydrological variables for modelled basin are assumed to have global and constant properties for the whole basin.

1.1.2. Distributed Hydrological Models

In distributed models a selected basin divided into cells. And rainfall and other hydrological variables used for simulating each cells. The hydrological models in this structure are more data and process intensive modeling methods than the other modelling methods. Ant they require more expretise than others. TOPNET model and TOPMODEL model are two examples used in this respect.

1.1.3. Semi Distributed Hydrological Models

At this modelling approaches, a basin divided in sub basins. And hydrological variablles like rainfall are divided for subbasin and hydrological process is calculated for each sub basin.

1.2. Examining Based on Internal Process

When the hydrological model is analyzed in terms of hydrological processes, it is possible to distinguish three categories. First one based on physically based, second on conceptual based and third metric based models.
The hydrological models in all three categories show differences in the manner in which hydrological processes are handled as follows.

1.2.1.Physical Models

Such models are models in which physical, chemical or biological processes are represented mathematically. They use measurable state variables of time and space. Physical models are useful methods to understand the physical operation of the region where modeling is to be performed. However, one of the challenges is the multitude of the needed parameters.

1.2.2. Conceptual Models

In this modeling approach, hydrological processes all trying to be processed through a conceptual model. Calculation of hydrological processes takes place on the created conceptual model. GR4J model and GR2M model are two examples used in this respect.

1.2.3. Empirical Models

Models that work in this modeling approach are models that do not take into account hydrological processes related to the relevant basin. This modeling approach aims to establish various relationships among existing data and to model the behavior of the basin. And at these models phisical process don't care. Their main advantage is that they require minimum data. But it can be disadvantage to don't care physical process.

This modeling approach will be examined in more detail below under the heading of black box methods. Readers who wish to examine the detailed comparison of hydrological models can benefit from (Devi, P, & S, 2015) or from (Kauffeldt, Wetterhall, Pappenberger, Salamon, & Thielen, 2016).

2. Black Box Modeling

Unlike hydrological modeling approaches, black-box modeling approaches are not concerned with how the hydrological process takes place. Black box approaches are known as "data driven". The aim here is to establish a relationship between the target data for the relevant hydrological structure (Stream Flow, Precipation, Evatoration, etc.). In this way hydrological modeling of the relevant region can be carried out and forecasts for the future can be made.

Most of the studies for stream flow forecasting in the literature are composed from Neural Networks. And other frequently used modelling approaches are Support Vector Machine(SVM), Fuzzy Logic approaches, Bayesian approximations, AR & MA derivative approaches.

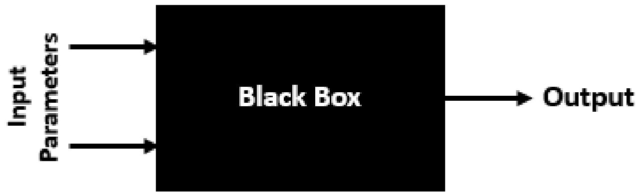


Figure 3 - Black box methods

In the black-box approach, it is seen that the input parameters are mostly used for the forecasting of stream flow and precipitation parameters. Selecting the correct input parameters is another important topic in the Black Box methods, which have the approach of entering a certain set and associating the parameters with the output parameters. A more detailed explanation will be given in Chapter-4.

The stream flow or precipitation parameters used are not based solely on the previous time slot data from the time slot to be estimated. Some studies show that they are used to estimate values from more than one previous time period. In the literature, the number of days of the past is indicated by lag. Lag (1) represents the previous day, Lag (2) represents the data of the past two days.

2.1. Neural Network

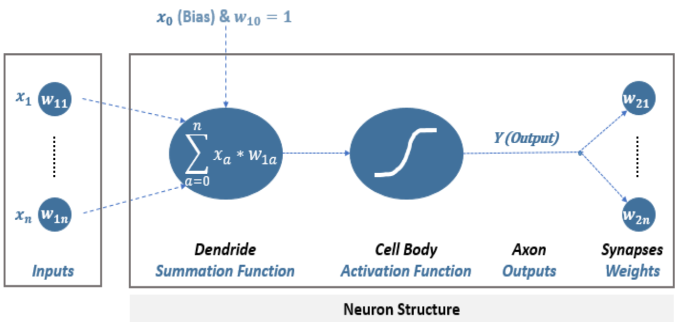


Figure 4 - The logic of working an artificial neuron

As can be seen, a simple artificial neural network uses input parameters (outputs and weights from other neurons) to produce output of the kind targeted with the aid of two functions. These are the summationt function and the activation function. The task of the summation function is to calculate the sums of the multiplied results of weight and produced output by previous neurons. The activation function is used to produce the desired results from the neuron's collection function. A linear function can be used when it is considered that there is a linear relationship between input and output data, while a step function can be used when two different results like 0 or 1 are desired to be produced. In artificial neural networks, each neuron will produce results depending on the nature of the selected activation function.

An artificial neural network consists of three different types of layers. Input layer, hidden layer and output layer. When studies done in the literature are examined, it can be seen that the activation function of artificial neural networks varies in the selection of the backpropagation algorithm, the selection of the number of hidden layers or the selection of the number of neuron in the hidden layers. The researcher specifies the number of hidden layers, the number of neurons in each these layers, the activation function to be used in neuron, and the backpropagation algorithms, so that the ideal result can be obtained. When the activation functions used in the hidden layers are examined, it is seen that the following activation functions are used. (Prasad, Deo, Li, & Maraseni, 2017) is used tangent sigmoid ve log sigmoid, (Yaseen and others, 2016) logarithmic sigmoid, (Noori and others, 2011), (Demirel, Venancio, & Kahya, 2009), (Ballini, Soares, & Andrade, 1998) and (Uysal, Lorman, & Lensoy, 2016) sigmoid, (Noori & Kalin, 2016) log-sigmoid and hyperbolic tangent sigmoid, (B.Humphrey, Gibbs, Dandy, & Maier, 2016) Logistic transfer function, (Singh A. , 2016) Gaussian transfer function and (XU, ZHU, ZHANG, XU, & XIAN, 2009) ise used logistic function. When Linear transfer function used by (Prasad, Deo, Li, & Maraseni, 2017), (Demirel, Venancio, & Kahya, 2009), and (B.Humphrey, Gibbs, Dandy, & Maier, 2016) at output layer, purline functions used by (Prasad, Deo, Li, & Maraseni, 2017) and positive linear function used by (Prasad, Deo, Li, & Maraseni, 2017). Another properties that should be known in an artificial neural network is the choice of the back propagation algorithm.

The task of backpropagation algorithms is to change the weights between the neurons so that the difference between the net result and the actual result can be minimized. If selected backpropagation is to be specially examined, (Prasad, Deo, Li, & Maraseni, 2017) and (Uysal, Lorman, & Lensoy, 2016) use the Newton's method and (Kalteh, 2013) use the Levenberg-Marquardt algorithm. It is seen that 32 studies that were investigated in the literature survey developed 18 indent ANN and derivative models. Researchers are evaluating the results of hydrological models or other machine learning tools with ANN in their work. Some researchers used ANN hydrological models in conjunction with performance evaluation. Let's start by examining the hydrological models and models created with ANN. (Singh A. , 2016) compared SWAT with the Radial Basis Neural Network (RBNN) and showed that RBNN gave better results. (XU, ZHU, ZHANG, XU, & XIAN, 2009) Compared the ANN with the XXT hydrological model and showed that ANN gave better results. (XU, ZHANG, & ZHAO, Stream Flow Forecasting by Artificial Neural Network and TOPMODEL in Baohe River Basin, 2009) Compared the performances of the ANN with the TOPMODEL hydrological modeling tool and found that ANN gave better results. (Demirel, Venancio, & Kahya, 2009) Show that ANN can model peak flow better than SWAT in their study.

Now let's examine some of the results of ANN modeling with other machine learning tools.(Sun, Wang, & Xu, 2014) compared ANN with Gaussian Process Regression (GPR) and ARMAX in their study. When the results produced by the models are examined, they stated that GPR is the best end result model. ANN produced better results than ARMAX. (Baratti and others, 2003) compared ANN and ARMAX results in the study they performed and stated that ANN produced better results. We will also discuss further work on ANN in the following issues, as the topic title is compared to ANN in other topics.

2.2.Support Vector Machine

Is a another commonly used methods for modeling hydrological processes is the SVM. SVM is a statistically based machine learning tool. SVM is used for classification in machine learning methods as well as for regression (Kalteh, 2013). If it is desired to classify with SVM and the classes in the data set are separable, it is desirable to draw a hyperplane between the classes so that they are farthest from class boundary lines. When SVM is used for regression, it is desirable to have such a function that it is within a certain range (+ε , - ε) to find a function that can produce results that will cover the whole data set.

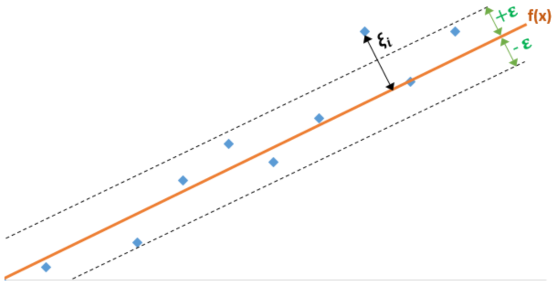


Figure 5. Working logic of SVR

Suppose we have an f (x) function like Eq.-1 (Equation-1) that will cover almost the entire data set, such as the figure.

$\boldsymbol{f(x)} =< \boldsymbol{w}, \boldsymbol{x} > +\boldsymbol{b}$ (Equation-1)

w is used for support vector weight and **b** is bias.

In order to satisfy this equation, it is aimed to minimize **w**.

$minimize\ \frac{1}{2} \parallel w \parallel^2$ (Equation-2)

Subject $\begin{cases} y_i - < w, x_i > -b \leq \varepsilon \\ < w, x_i > +b - y_i \leq \varepsilon \end{cases}$ (Equation-3)

Sometimes it may be desirable to increase the error tolerance of the results produced by the function. In this case $\boldsymbol{\xi_i}, \boldsymbol{\xi_i^*}$ variables are used.

In this case, equations Eq.-2 and Eq.-3 will be updated as follows.

Subject: $minimize\ \frac{1}{2} \parallel w \parallel^2 + C \sum_{i=0}^{N} (\xi_i, \xi_i^*)$ (Equation-4)

$$Constraints \begin{cases} y_i - < w, x_i > -b \leq \varepsilon + \xi_i \\ < w, x_i > +b - y_i \leq \varepsilon + \xi_i^* \\ \xi_i, \xi_i^* \geq 0 \end{cases} \quad \text{(Equation-5)}$$

C is constant user defined in the objective function in Eq.-4. And is used as a balance element.

As can be seen from the equation, slack variables are used as an balance element on the equation.

The method used to find the minimum or maximum value of a function bound to a certain constraint is the Lagrange method.

Lagrange multipliers are often used to solve the objective function in Eq.-4.

$$\mathrm{W}(a, a^*) \max -\frac{1}{2} \sum_{i}^{N} \sum_{j}^{N} (a_i - a_i^*)(a_j - a_j^*) K(x_i - x_j) - \varepsilon \sum_{i}^{N} (a_i + a_i^*) + \sum_{i}^{N} y_i (a_i - a_i^*)$$

$$Constraints \begin{cases} \sum_{i}^{N} (a_i - a_i^*) = 0 \\ 0 \leq a_i \leq C \\ 0 \leq a_i^* \leq C \end{cases}$$

The equation for non-linear function is as follows.

$$f(x) = \sum_{i}^{N} (a_i - a_i^x) K(x_i, x_j) + b$$

a represent lagrange coefficients. And K represent selected kernel function.

In SVR application, researchers first point out that a proper kernel function is chosen (Asefa, Kemblowski, McKee, & Khalil, 2006). It is seen that radial basis function is used in all of the kernel functions used in the researches. (Asefa, Kemblowski, McKee, & Khalil, 2006), (Kalteh, 2013), (Sattari, Pal, Apaydin, & Ozturk, 2013)

In order to model with SVM, the researchers must have chosen the appropriate **C**, **ε** and **ξ** values.

When the studies comparing SVM with other models are examined, it is seen that the researchers reached the following results.

(Yaseen and others, 2016) show that ELM produces better results than SVM when they compare the models they created with ELM and SVM in their study.

They show that when comparing (Sattari, Pal, Apaydin, & Ozturk, 2013) models in which they work with ELM and SVM, the ELM produces similar results to SVM.

(Kalteh, 2013) used a 40-year stream flow value for monthly stream flow forecasting. In their work, they are derivated differient models from SVR and ANN. They have reported that SVR produces better results when comparing the performances of the models it produces.

2.3. Fuzzy Logic

Fuzzy Logic is a introduced by Lotfi A. Zadeh in 1965. In this approach, it is accepted that all events in nature have certain degrees of uncertainty, which does not include certainty. In fuzzy logic there is a different approach from classical cluster membership. In fuzzy logic, the actual value of any variable is expressed by membership rates between 0 and 1 by each of the fuzzy clusters concerned. Various membership functions are used to determine membership levels. With the help of membership functions, real values can be transformed into fuzzy values or fuzzy values with real values (Defuzzification).

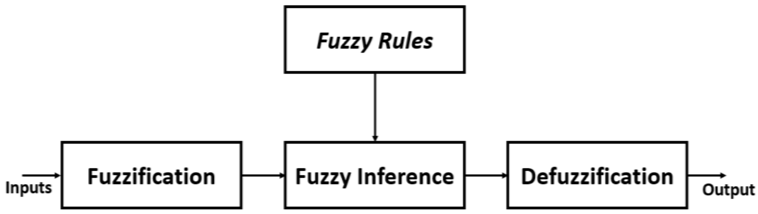


Figure 6 - Working logic of Fuzzy Logic

With the help of the fuzzy rules it is aimed to establish relation between input variables and output value. Fuzzy rules are created by people in the field of expertise that is required to be modeled. The fuzzy rules are similar to the if examples in basic programming information. In the fuzzy inference phase, the results obtained from membership functions for each rule created by the investigator are obtained by logical operations with various results. Subsequently, the results obtained from each rule are combined using methods such as the Tusukamoto method, the Takagi-Sugeno-Kang method, or the mamdami method. In the last stage, the fuzzy results obtained from the fuzzy interference phase are converted into real values.

Literature research in this context shows that fuzzy logic is used as part of hybrid systems. (Ballini, Soares, & Andrade, 1998) Compared the results of a model constructed with ANN using ANFN (Adaptive Neural Fuzzy Network) containing fuzzy logic and ANN. The comparison also shows that ANFN models produce better results from the ANN network. (Valença & Ludermir, 2000) Developed different models with PARMA (Periodic ARMA) and FuNN (Fuzzy Neural Network). When models evaluate the results, FuNN has shown that produces better results. In another research different from before, (Turan & Yurdusev, Fuzzy Conceptual Hydrological Model for Water Flow Prediction, 2016) are used fuzzy system in interior process (Soil Moisture and Routing Storage Process) of GR2M hydrological modeling tool. Modeled soil moisture and routing storage processes using fuzzy systems. They have shown that the F-GR2M models produce better results in the GR2M around 10%.

2.4. AR & MA Derivative Models

Some of the methods used with stream flow forecasting are ARIMA or ARMAX models. Relevant models are derived under the heading AR & MA because they are derived from Autoregressive (AR) and Moving Average (MA) models. They are known in the literature as Box-Jenkins models. Before explaining ARIMA and ARMAX models, AR and MA and ARMA models must be understood. The requirement for three models (AR, MA or ARMA) to be installed is that the data set must be stationary.
In AR model, a dependent variable is a function of lagged days data.

$$AR(p) = b + \sum_{i=1}^{p} a_i Y_{t-i} + \varepsilon_t$$

Y the future value is the desired value to predict, while the $\boldsymbol{a}$ coefficient indicates the relationship between the lagged values and the value to be estimated. $\boldsymbol{\varepsilon_t}$ Represent the white noise.
In the MA model, it is assumed that the function of **Y** is related to past error terms in predicting the future value.

$$MA(q) = \varepsilon_t + \sum_{i}^{q} m_i \varepsilon_{t-i}$$

ε_t Represent the white noise,while the m coefficients indicate the relationship between the error terms and the value to be estimated.

$$ARMA(p,q) = b + \varepsilon_t + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{i}^{q} m_i \varepsilon_{t-i}$$

ARMA model is a combination of AR and MA models.
The researcher decides which AR, MA, or ARMA model to use by looking at the graph of the autocorrelation function (ACF) and partial autocorrelation fuction’s results.

If the ACF graph is slow, and the PACF graph shows a rapid decline, the AR model is preferred. If the ACF graph shows a rapid decline and the PACF graph shows a slow decline, the MA model is preferred, whereas if both graphs show a slow decline, the ARMA model is preferred. Unlike the ARMA model, ARIMA model can be operated with non-stationary data set. In this model, the non-stationary data set is subjected to a certain degree of difference processing until it becomes stationary. For this reason, unlike ARMA model, it also needs d parameter. The d parameter indicates the differencing degree. With stabilization, observation values are made to move within a fixed average. In the ARMAX model, unlike the other Box-Jenkins models, only the history data of the target variable is used as the input parameter. Variables from different types are also used in this model which are thought to affect the outcome of the targeted variable. Unlike the ARMA model, the k variable is used in the equation but represents other variables.

$$ARMAX(p,q,k) = Y$$

$$Y = b + \varepsilon_t + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{i}^{q} m_i \varepsilon_{t-i} + \sum_{i}^{k} d_i x_{t-i}$$

(Sun, Wang, & Xu, 2014) Compared the models they created with ANN (MLP), GPR and ARMAX in their study, and showed that GPR and ANN (MLP) produced better results than ARMAX. (Baratti and others, 2003) have created two different models of ANN(MLP) and ARMAX in their studies. They have shown that ANN (MLP) produces better results than ARMAX when comparing two models. (Valença & Ludermir, 2000) Compared the FNN (Neural Fuzzy Network) model with the ARIMA model and showed that the FNN models produce better results than the ARIMA models.

3. Hybrid Approaches

When investigating the preferred methods of this method, it is seen that the modeling of the related basin using hydrological modeling tools. Researchers who prefer this approach aimed to make forecasting by outputting output values as input parameters to black box approaches (mostly ANN) without calibrating output obtained from the modeling program (Noori & Kalin, 2016) or after calibrating (B.Humphrey, Gibbs, Dandy, & Maier, 2016)**.**

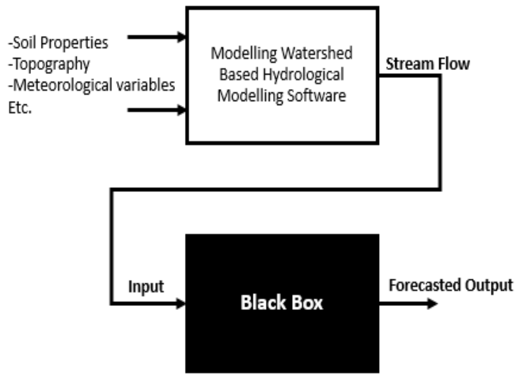


Figure 7 - Working logic of hybrit approaches

Researchers therefore aim to achieve more robust results by combining the power of hydrological modeling programs to better model the hydrological process and the ability of black box approaches to make better predictions. (Noori & Kalin, 2016) and (B.Humphrey, Gibbs, Dandy, & Maier, 2016) we shall try to explain the reasons why the hydrological modeling programs and the ANN method from black box approaches are preferred together;

As an advantage of the use of hydrological modeling programs, stream flow data can be obtained better than ANN methods, since the modeling takes into account the hydrological processes. The disadvantage of using hydrological modeling programs is that if this approach is preferred, a number of temporal and spatial variables will be needed. However, in this modeling approach, it is stated that the calibration process is much more time consuming and laborious than ANN. The advantage of modeling with ANN is that the relationship between limited and well-chosen input parameters and output data can be established without having to evaluate the hydrological processes of the relevant basin.

In addition to the advantage described above, it is stated that ANN approaches can produce better results in some cases than the forecasting data obtained with hydrological modeling programs (B.Humphrey, Gibbs, Dandy, & Maier, 2016). Modeling with ANN has advantages as well as possible disadvantages. These are: The input parameters may be selected incorrect, backpropagation algorithm may be stick around to the local minimum or overfitting. (Noori & Kalin, 2016) and (B.Humphrey, Gibbs, Dandy, & Maier, 2016) have worked on three different scenarios. Forecasting with the hydrological modeling tools, forecasting with the black box approaches (both preferred different variants of ANN) and the third model hybrid models in both models. The results show that when evaluated by researchers, hybrid approaches produce better results than the other two modeling approaches.

FEATURES AND SELECTION CRITERIA

In hydrological modeling approaches, the parameters required by the model used are specific. However, in the black box approach, the choice of input parameters is decided by the researchers. The input parameters and input parameter selection criteria used in the black box approaches under this topic are examined. (XU, ZHU, ZHANG, XU, & XIAN, 2009) Indicated that Stream Flow, Precipication, Evaporation data as input parameters are parameters that should be used in the basin. (XU, ZHANG, & ZHAO, Stream Flow Forecasting by Artificial Neural Network and TOPMODEL in Baohe River Basin, 2009) Have indicated that past and current precipitation and stream flow data are important input parameters for stream flow forecasting.

(XU, ZHANG, & ZHAO, Stream Flow Forecasting by Artificial Neural Network and TOPMODEL in Baohe River Basin, 2009) Have observed that the results obtained from the stream flow and precipitation data as ANN input parameters produced better results than the studies using only stream flow or only precipitation data. Also there was a limited decrease in the performance of the ANN structure when the evaporation data was used as the input parameter. If the black-box approaches are evaluated in general, it is seen that the Stream Flow parameter is commonly used in various lagged numbers. The precipitation and evaporation parameters, however, appear to be used with the stream flow parameter at various delay times. Here, it is seen that only inputting the model data to be used is not enough and it is seen that the selection of the appropriate input parameters is an important topic title in order to increase the performance of the model. One of his tasks is to be able to select the correct input parameters so that the model he wants to establish can produce the closest accuracy. (Yaseen and others, 2016)

An unnecessarily selected parameter can weaken the working speed of the model or the resultant power it produces. Or correctly selected parameters can increase the degree of closeness to the model's accuracy. When the approaches used to select input parameters are examined, it seems that basically one of the two approaches is preferred. First is trial and error method and second is correlation analysis.

1.Trial and Error Method

In this method, the researcher uses different combinations of input parameters or different lagged day’s values in his hands to produce the results closest to the truth.

2. Correlation Analysis Methods

Another approach used to select input parameters is to analyze the correlation between input parameters and output parameters. For this purpose, ACF (Auto-Corelation Function) and PACF (Partial Auto Corelation Function) methods are widely used. (Yaseen and others, 2016) aimed to increase the performance of the model by using ACF and PACF functions with different lagged days of the stream flow parameter. In each of the five models created by them, they used the stream flow value for different days of the past to find the value of the day that wanted to estimate.

3. Another Feature Selection Methods

(Prasad, Deo, Li, & Maraseni, 2017) using the IIS(Iterative Input Selection) algorithm and (B.Humphrey, Gibbs, Dandy, & Maier, 2016) using the IVS(Input variable selection) algorithm to use the most ideal input parameters for modeling. In the studies made under the article on stream flow forecasting, the least studied input parameter is the selection topic.

FORECAST RANGE

The data on stream flows and other hydrological variables belonging to many rivers in our country and in the world have been measured regularly for many years. From this point of view, forecasting can be done by considering stream flow forecasting time series. When studies done in the literature are examined, it is seen that forecasting is used to make short-term estimates (daily, hourly) or long-term estimates (seasonal, monthly, weekly). In short-term estimates, the aim is to create early warning systems to protect against natural disasters such as floods. (Yaseen and others, 2016) (Keshtegar, Allawi, Afan, & El-Shafie, 2016) In long-term studies, the goal is to be able to provide highly accurate estimators of decision makers in order to effectively manage water resources

(Keshtegar, Allawi, Afan, & El-Shafie, 2016) (Yaseen and others, 2016). This enables effective sharing between stakeholders (Agriculture, Industry, Nature, People) using water resources. It can also be used to set up early warning systems to protect against various natural disasters.

MODEL EVALUATION CRITERIAS

Evaluating the performance of a generated model can be more than one purpose. These (P. Krause, 2005), assessing how closely the model created can model the related basin to the truth, improving the performance by changing the input parameters or the internal processes of the model by looking at the results of the generated model and comparison of performances of studies done by different researchers in the same basin as the generated model. It is expected that the results of the generated model will produce the closest values to the truth. Various methods should be used to evaluate the performance of the model created for this purpose. Performance evaluation is made by comparing estimated value with actual value. More than one performance evaluation criterion appears to be used in the literature review. For this reason, a single method for evaluating performance is not considered adequate. Each of the methods used can make the comparison from a different angle. To this end, researchers have evaluated the results of their work, often using different combinations of the approaches outlined below. Researchers evaluate their work under two headings.

1. Subjective Evaluation

One of the first methods used by researchers who want to work in any field is to examine the data of the basin they want to work with various kinds of graphs. They can evaluate the methods they can use to model the basin.
Another reason for the demand of the researchers to use the graphics may be that they want to examine the real values of the basin related to the model with visual materials. In this context, nearly all of the studies reviewed show that scatter plots are used.

2. Objective Evaluation

Another method of evaluation used by researchers is objective assessment. The researchers who want to use this method are evaluating the results of the models and the results with various mathematical methods. The researchers basically compare the following two properties between the model and the real values. First the amount of error between two models and second investigation of the change of consequences together. There are many methods to evaluate the performance in the examined articles. You can access them from the Table-5. In our topic, we will briefly describe the five most commonly used methods.

2.1. Methods Used to Determine Fault Quantities

Mean Absolute Error (MAE)

$$MAE = \frac{1}{n}\sum_{t=1}^{n} |Q_m^t - Q_o^t|$$

m is used to represent the model, while **o** is used for the observed value.
MAE is a value found by dividing the totals of errors by the number of errors. Producing near-zero results indicates that the generated model produces near-true results. It produces the same result in error vectors with different error values but with the same average of errors.

Mean Square Error (MSE)

$$MSE = \frac{\sum_{t=1}^{n}(Q_m^t - Q_o^t)^2}{n}$$

it is value that sum of the squares of errors divided by number of elements in vector. Producing near-zero results indicates that the generated model produces near-true results. If the error size increases, it will produce very large results. RMSE can be used instead of this feature when it is desired to evaluate with smaller numbers. It can produce the same result in two vectors with different standard deviation characteristics.

Root Meas Square Error (RMSE)

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(Q_m^t - Q_o^t)^2}{n}}$$

it is value that root of sum of the squares of errors divided by number of elements in vector. Producing near-zero results indicates that the generated model produces near-true results.

A Simple Comparison of Three Method

Now let's consider that we have created 4 different models for a related basin. And let's examine the difference between our models and the observed values on the following table.
The table shows the error amounts of 5 models with different standard deviation values.

Table 1 - Error vectors for five models

	Error Amount For Each Observation									
Model-1	3	3	3	3	3	3	3	3	3	3
Model-2	2	2	2	2	2	4	4	4	4	4
Model-3	1	1	1	1	1	1	1	1	2	20
Model-4	5	6	5	6	5	6	5	6	5	6
Model-5	7	0	8	0	8	0	8	0	8	0

Now let's look at a table using 3 methods that we have explained the amount of errors.

Table 2 - Comparison of 5 models against different performance criteria

	Model-1	Model-2	Model-3	Model-4	Model-5
Standart Deviation	0	1.05	5.67	0.50	3.91
MAE	3	3	3	5.50	3.90
MSE	9	10	41.20	30.50	30.50
RMSE	3	3.16	6.42	5.52	5.52

2.2. Investigation of the Change of Consequences Together

There are a variety of tools that are used when it is desired to examine the direction and degree of the relationship between a dependent variable and an independent variable, or for the purpose of interchanging the generated model and the actual values and the direction of the changes. Under this heading, Correlation Coefficient (r), Determination Coefficient (R^2) and Nash-Sutcliffe Efficiency (NSE) will be explained and their results will be shown with a sample application.

Corelation Coefficient (r)

$$r=\left[\frac{\sum_{t=1}^{n}(Q_o^t-\bar{Q}_o)(Q_m^t-\bar{Q}_m)}{\sqrt{\sum_{t=1}^{n}(Q_o^t-\bar{Q}_o)^2(Q_m^t-\bar{Q}_m)^2}}\right]$$

It is a value between -1 and 1. It shows the relationship and direction between a dependent variable and an independent variable.
In the case of zero-result generation, there is no relationship between the two variables. As the produced result is closer to +1, it is understood that the strength of the similarity in the positive direction is increased. When the result is closer to -1, it is understood that the similarity increases in the negative direction.

Determination Coefficienct (R^2)

$$R^2=\left[\frac{\sum_{t=1}^{n}(Q_o^t-\bar{Q}_o)(Q_m^t-\bar{Q}_m)}{\sqrt{\sum_{t=1}^{n}(Q_o^t-\bar{Q}_o)^2(Q_m^t-\bar{Q}_m)^2}}\right]^2$$

It is a value between 0 and 1. Used to express how the dependent variable is affected by a independent variable. A value of 0.7 can be said that which are affected by a 70% independent variable of a dependent variable.

Nash-Sutcliffe Efficiency(NSE)

$$NSE = 1-\frac{\sum_{t=1}^{n}(Q_m^t-Q_o^t)^2}{\sum_{t=1}^{n}(Q_o^t-\bar{Q}_o)^2}$$

Value between +1 and -∞. As the produced result approaches +1, it is understood that the output of the generated model approximates the actual values.
Obtaining the +1 value expresses the excellence of the model. If a value between 0 and +1 is considered to produce an acceptable result, values less than 0 will show how far the model is from reflecting the actual values.

A Simple Comparison of Three Method

Let's say that we have 3 different models and that the output they produce is like Table-3.

Table 3 - Sample observations and sample outputs of three models

	Mon	Tue	Web	Thu	Fri	Sat	Sun
Observed	2	4	3	6	7	5	3
Model-1	1	3	2	5	6	4	2
Model-2	0	2	1	4	5	3	1
Model-3	-2	-4	-3	-6	-7	-5	-3

And let's examine and compare the results with our models r, R^2 and NSE.

Table 4 - Comparison of 5 models against different efficiency criteria

	Model-1	Model-2	Model-3
NSE	0,74	-0,44	-29,47
R^2	1,00	1,00	1,00
r	1,00	1,00	-1,00

When the results produced by **r** are examined, it is seen that there is a negative direction and similarity between the data of Model-3 and the realized values. When the results produced by R^2 are examined, it is seen that although there is a change in the negative direction between, it is understood that the model is strong in explaining the real values. When the results produced by NSE are examined, it can be interpreted that Model-1 produces acceptable results but the other two models are far from producing acceptable results.

COUNTRIES

Under the Stream Flow Forecasting topic, studies from Science Direct, Springer Link, and IEEE Xplore sources are the most studied countries in terms of applied countries, with 4 studies in the USA, 4 in China, 4 in Turkey, 4 in Iran, 3 in India, 3 in Australia.

CONCLUSION

Stream flow forecasting, which is the subject of our work, is a demanding process due to the complexity and non-linear structure of the factors affecting the formation of stream flow (Maheswaran & Khosa, 2012) (Yaseen and others, 2016). Researchers do their work for one of two goals. While short-term estimates are used to establish early warning systems, long-term estimates are made for effective water resources management. In this context, 32 studies between 1998 and 2017 were examined. One of the most used hydrological modeling tools is the SWAT. ANN are the most frequently used modeling tools among machine learning tools. SVM are also one of the commonly used tool. It can be seen that models derived from ANN and SVM give better results. Hydrological models used in conjunction with machine learning models are producing better results. Researchers which using machine learning methods are often used lagged days stream flow values for their model. The precipitation and evaporation parameters, however, used with the stream flow parameter at various lagged days. Researches mostly is used trial and error method or corelation analysis methods (ACF, PACF etc.) for appropriate feautere selection. This section is the least worked part of the works done. The most frequently used methods for efficiency evaluation are MSE, MAE, RMSE, r, R2 and NSE.

Table 5 - Detailed table of literature studies

Authors	Methods	Time	Features	Performance Criteria	Applied Region
(Wang, Wang, Wang, Gao, & Yu, 2017)	Bayesian MCMC (Monte Carlo and Markov Chain)	d	Flow Rates	MLE (Maximum Likelihood Estimation)	Zhujiachuan watershed in China
(Prasad, Deo, Li, & Maraseni, 2017)	IIS-Wavelet – ANN, IIS-W-M5 Tree Model	m	Precipitation, Temperature, Evaporation, Mean solar radiation and Vapor pressure	r, Willmott's Index,NSE,RMSE, MAE	Richmond, Gwydir, and Darling River in Australia
(Noori & Kalin, 2016)	SWAT + ANN	d	ANN: SWAT simulated baseflow and stormflow	NSE, BIAS	Atlanta, USA
(Uysal, Lorman, & Lensoy, 2016)	ANN(MLP) , ANN(RBF)	d	Temperature, Precipitation, Snow Data	R^2,RMSE,MAE, Nash-Sutcliffe Model Efficiency	Karasu River, Turkey
(B.Humphrey, Gibbs, Dandy, & Maier, 2016)	GR4J Model + ANN(MLP)	m	Rain, Evaporation, Ground Water, Antecedent Precipitation Index	RMSE , NSE	South East of South Australia
(Turan & Yurdusev, Fuzzy Conceptual Hydrological Model	GR2M Model + Fuzzy System (Takagi-Sugeno)	m	Precipitation, Potential Evapotranspiration,	R^2, RMSE, Nash-Sutcliffe coefficient	Gediz Basin, Turkey

for Water Flow Prediction, 2016)			Soil Moisture Accounting,...		
(Turan, Fuzzy Systems Tuned By Swarm Based Optimization Algorithms for Predicting Stream flow, 2016)	Fuzzy System (Takagi-Sugeno)	m	Stream Flow	MSE, R^2, Nash-Sutcliffe coefficient	Susurluk Basin, Turkey
(Singh S. K., 2016)	TopNet + Hindcast Method	s	TOPNET: DEM, Soil moisture, Snow water equivalent, Depth to ground water, Land cover	RMSE, Ranked Probability Score, Ranked Probability Skill Score	South Island, New Zealand
(Singh A. , 2016)	SWAT , RBNN(ANN)	m	RBNN : Stream Flow, Temperature, Rainfall	R^2, NSE	Nagwa Sub-Watershed In India
(Keshtegar, Allawi, Afan, & El-Shafie, 2016)	HORS	m	Stream Flow	MAE, Normalized RMSE, RMSE, MSE, R^2, Relative Error	Aswan High Dam, Egypt
(Yaseen and others, 2016)	ELM , SVR , Generalized Regression Neural Network	m	Stream Flow	r,NSE, Willmott's Index, RMSE, MAE	Tigris River, Iraq
(Londhe & Gavraskar, 2015)	SVR	d	Stream Flow + Rainfall	r, RMSE	Krishna, Narmada River Basin, India
(Zhao and others, 2015)	Bayesian Joint Probability	d	Stream Flow	RMSE, Continuous Ranked Probability	Three Gorges Reservoir, China
(Vilaysane, Takara, Luo, Akkharath, & Duan, 2015)	SWAT	m	DEM, Land Use, Soil Types, Hydrlogical and meteorological data	NSE, R^2	Xedone River Basin, Laos
(Dehghani, Saghafian, Rivaz, & Khodadadi, 2015)	Dynamic Linear Spatio Temporal Model	m	Stream Flow	Discrepancy ratio	The Great Karun Basin, Iran
(Sun, Wang, & Xu, 2014)	GPR , ARMAX , ANN(MLP)	m	Stream Flow, Precipitation, Temperature	NSE, Water Balance Error	Basins Across The U.S.
(Toro, Meire, F.Gálvez, & Riverola, 2013)	Statistic + ANN	d	River Flow, Rainfall	MAE, Mean Absolute Percentage Error, MSE	Salvajina Reservoir, Colombia
(Sattari, Pal, Apaydin, & Ozturk, 2013)	M5 Tree Model , SVM	d	Stream Flow, Rainfall, Temperature	r, RMSE	Sohu Creek, Ankara, Turkey
(Rathinasamy, Adamowski, & Khosa, 2013)	Bayesian Model Averaging Based Ensemble Multi Wavelet Volterra Nonlinear Model	d, w, m	River Flow	RMSE, MAE, r, NSC	Selway River, ST Joe River, USA
(Kalteh, 2013)	Wavelet-ANN , Wavelet -SVR	m	River Flow	RMSE, MAE, CC	Kharjegil and Ponel Stationsin

					Northern Iran
(Robertson, Pokhrel, & Wang, 2013)	WAPABA	s		RMSEP, Continuous Ranked Probability	Catchments in Eastern Australia
(Maheswaran & Khosa, 2012)	ANN, Wavelet-ANN, Wavelet Linear Regression, Coupled Wavelet–Volterra	m	Stream Flow, Rainfall	Nash–Sutcliffe model efficiency coefficient, RMSE, MAE, r	Cauvery River Basin, India
(Noori and others, 2011)	ANN - SVM	m	Rainfall, Discharge, Sun Radiation, Temperature	R^2, MAE, RMSE	Sofichay River, Iran
(Demirel, Venancio, & Kahya, 2009)	ANN , SWAT	d	ANN : Stream Flow, Precipation	MSE, RMSE	Pracana Basin, Portugal
(Asefa, Kemblowski, McKee, & Khalil, 2006)	SVM, Transfer Function Noise Model	s	Stream Flow, Snow Water Equivalent, Temperature	R^2, MSE, RMSE	Sevier River Basin, USA
(Baratti and others, 2003)	ANN(MLP), ARMAX	m, d	Runoff, Rainfall, Temperature	r, RMSE, Mean Squared Relative Error, MAE,E, Mean 4th Order Error	Tirso Catchment, Italy
(Adenan, Hamid, Mohamed, & Noorani, 2017)	Local Linear Approximation Method	d	River Flow	r	Klang River, Malaysia
(Valença & Ludermir, 2000)	FNN , ARIMA	m	Inflow	Absolute Average Percentual Error	Sobradinho Hydroelectric Power Plant, Brazil
(Ballini, Soares, & Andrade, 1998)	ANFN	s	Inflow	MSE, Mean Absolute Deviation, MRE	Hydroelectric Plants, Brazilian
(Khadangi, Madvar, & Mehdi, 2009)	ANN(RBF), Adaptive Neuro Fuzzy Inference	d	Stream Flow	R^2, MAPE, Relative RMSE	Mahabad River, Iran
(XU, ZHU, ZHANG, XU, & XIAN, 2009)	ANN, XXT	d	ANN:Stream Flow, Precipitation, Evaporation	NSE	Yingluoxia Basin, China
(XU, ZHANG, & ZHAO, Stream Flow Forecasting by Artificial Neural Network and TOPMODEL in Baohe River Basin, 2009)	ANN , TOPMODEL	d	ANN: Stream Flow, Precipitation	Nash And Sutcliffe Efficiency Coefficient	Baohe River Basin, China

D = Daily, W = Weekly, M = Monthly, S = Seasonal

REFERENCES

(WWAP), U. N. (2016). *WATER AND JOBS.* Paris: UNESCO.

(WWAP), U. N. (2017). *Wastewater: The Untapped Resource.* Paris: UNESCO.

Adenan, N. H., Hamid, N. Z., Mohamed, Z., & Noorani, M. S. (2017). A pilot study of river flow prediction in urban area based on phase space reconstruction. *AIP Conference Proceedings, 1870*(1).

Asefa, T., Kemblowski, M., McKee, M., & Khalil, A. (2006, March 1). Multi-time scale stream flow predictions: The support vector machines approach. *Journal of Hydrology, 318*(1-4), 7-16.

B. Humphrey, G., Gibbs, M. S., Dandy, G. C., & Maier, H. R. (2016, September). A hybrid approach to monthly streamflow forecasting: Integrating hydrological model outputs into a Bayesian artificial neural network. *Journal of Hydrology, 540*, 623-640.

Ballini, R., Soares, S., & Andrade, M. G. (1998). An adaptive neural fuzzy network model for seasonal stream flow forecasting. *Neural Networks, 1998. Proceedings. Vth Brazilian Symposium on. IEEE* (s. 215-219). Belo Horizonte, Brazil, Brazil: IEEE.

Baratti, R., Cannas, B., Fanni, A., Pintus, M., Sechi, G. M., & Toreno, N. (2003, October). River flow forecast for reservoir management through neural networks. *Neurocomputing, 55*(3-4), 421-437.

Dehghani, M., Saghafian, B., Rivaz, F., & Khodadadi, A. (2015). Monthly stream flow forecasting via dynamic spatio-temporal models. *Stochastic Environmental Research and Risk Assessment, 29*(3), 861-874.

Demirel, M. C., Venancio, A., & Kahya, E. (2009, July). Flow forecast by SWAT model and ANN in Pracana basin, Portugal. *Advances in Engineering Software, 40*(7), 467-473.

Devi, G. K., P, G. B., & S, D. G. (2015). A Review on Hydrological Models. *Aquatic Procedia, 4*, 1001-1007.

Falkenmark, M. (2017). Water and human livelihood resilience: a regional-to-global. *International Journal of Water Resources Development, 33*(2), 181–197.

Kalteh, A. M. (2013, April). Monthly river flow forecasting using artificial neural network and support vector regression models coupled with wavelet transform. *Computers & Geosciences, 54*, 1-8.

Kansal, M. L. (2005). *System Analysis Techniques In Water Resources Management.* Su Vakfı Yayınları.

Kauffeldt, A., Wetterhall, F., Pappenberger, F., Salamon, P., & Thielen, J. (2016, January). Technical review of large-scale hydrological models for implementation in operational flood forecasting schemes on continental level. *Environmental Modelling & Software, 75*, 68-76.

Keshtegar, B., Allawi, M. F., Afan, H. A., & El-Shafie, A. (2016, September). Optimized River Stream-Flow Forecasting Model Utilizing High-Order Response Surface Method. *Water Resources Management, 30*(11), 3899-3914.

Khadangi, E., Madvar, H. R., & Mehdi, M. (2009). Comparison of ANFIS and RBF Models in Daily Stream flow Forecasting. *Computer, Control and Communication, 2009. IC4 2009. 2nd International Conference on. IEEE* (s. 1-6). Karachi, Pakistan: IEEE.

Londhe, S., & Gavraskar, S. S. (2015). Forecasting One Day Ahead Stream Flow Using Support Vector Regression. *Aquatic Procedia, 4*, 900-907.

Maheswaran, R., & Khosa, R. (2012, July 11). Wavelet–Volterra coupled model for monthly stream flow forecasting. *Journal of Hydrology, 450-451*, 320-335.

Noori, N., & Kalin, L. (2016, February). Coupling SWAT and ANN models for enhanced daily streamflow prediction. *Journal of Hydrology, 533*, 141-151.

Noori, R., Karbassi, A. R., MOghaddamnia, A., Han, D., Zokaei-Ashtiani, M., Farokhnia, A., & Housheh, M. G. (2011, May 3). Assessment of input variables determination on the SVM model performance using PCA, Gamma test, and forward selection techniques for monthly stream flow prediction. *Journal of Hydrology, 401*(3-4), 177-189.

P. Krause, D. P. (2005). Comparison of different efficiency criteria for hydrological model. *Advances in Geosciences, 5*, 89-97. 09 01, 2017

Prasad, R., Deo, R. C., Li, Y., & Maraseni, T. (2017, November). Input selection and performance optimization of ANN-based streamflow forecasts in the drought-prone Murray Darling Basin region using IIS and MODWT algorithm. *Atmospheric Research, 197*, 42-63.

Rathinasamy, M., Adamowski, J., & Khosa, R. (2013, December 12). Multiscale streamflow forecasting using a new Bayesian Model Average based ensemble multi-wavelet Volterra nonlinear method. *Journal of Hydrology, 507*, 186-200.

Robertson, D. E., Pokhrel, P., & Wang, Q. J. (2013). Improving statistical forecasts of seasonal streamflows using hydrological model output. *Hydrology and Earth System Sciences, 17*, 579-593.

Rockström, J., Falkenmark, M., Allan, T., Folke, C., Gordon, L., Jägerskog, A., . . . Varis, O. (2014, October). The unfolding water drama in the Anthropocene: towards a resilience-based perspective on water for global sustainability. *ECOHYDROLOGY, 7*(5), 1249–1261.

Sattari, M. T., Pal, M., Apaydin, H., & Ozturk, F. (2013, May). M5 model tree application in daily river flow forecasting in Sohu Stream, Turkey. *Water Resources, 40*(3), 233-242.

Singh, A. (2016, June). Modeling Stream Flow with Prediction Uncertainty by Using SWAT Hydrologic and RBNN Models for an Agricultural Watershed in India. *National Academy Science Letters, 39*(3), 213-216.

Singh, S. K. (2016, May). Long-term Streamflow Forecasting Based on Ensemble Streamflow Prediction Technique: A Case Study in New Zealand. *Water Resources Management, 30*(7), 2295-2309.

Sun, A. Y., Wang, D., & Xu, X. (2014, April 16). Monthly streamflow forecasting using Gaussian Process Regression. *Journal of Hydrology, 511*, 72-81.

Toro, C. H., Meire, S. G., F.Gálvez, J., & Riverola, F. F. (2013, August). A hybrid artificial intelligence model for river flow forecasting. *Applied Soft Computing*, *13*(8), 3449-3458.

Turan, M. E. (2016, September). Fuzzy Systems Tuned By Swarm Based Optimization Algorithms for Predicting Stream flow. *Water Resources Management, 30*(12), 4345-4362.

Turan, M. E., & Yurdusev, M. A. (2016, January). Fuzzy Conceptual Hydrological Model for Water Flow Prediction. *Water Resources Management, 30*(2), 653-667.

Uysal, G., Lorman, A. A., & Lensoy, A. (2016). Streamflow Forecasting Using Different Neural Network Models with Satellite Data for a Snow Dominated Region in Turkey. *Procedia Engineering, 154*, 1185-1192.

Valença, M., & Ludermir, T. (2000). Monthly streamflow forecasting using an Neural Fuzzy Network Model. 2. P. Neural Networks (Dü.). içinde (s. 117-119). Rio de Janeiro, RJ, Brazil, Brazil: IEEE.

Vilaysane, B., Takara, K., Luo, P., Akkharath, I., & Duan, W. (2015). Hydrological Stream Flow Modelling for Calibration and Uncertainty Analysis Using SWAT Model in the Xedone River Basin, Lao PDR. *Procedia Environmental Sciences*, *28*, 380-390.

Wang, H., Wang, C., Wang, Y., Gao, X., & Yu, C. (2017). Bayesian forecasting and uncertainty quantifying of stream flows using Metropolis–Hastings Markov Chain Monte Carlo algorithm. *Journal Of Hydrology, 549*, 476-483.

Xu, J., Zhang, W., & Zhao, J. (2009). Stream Flow Forecasting by Artificial Neural Network and TOPMODEL in Baohe River Basin. *2009 Third International Symposium on Intelligent Information Technology Application Workshops.* Nanchang, China: IEEE.

Xu, J., Zhu, X., Zhang, W., Xu, X., & Xian, J. (2009). Daily streamflow forecasting by artificial neural network in A. *Information, Computing and Telecommunication, 2009. YC-ICT'09. IEEE Youth Conference on. IEEE* (s. 487-490). Beijing, China: IEEE Xplore.

Yaseen, Z. M., Jaafar, O., Deo, R. C., Kisi, O., Adamowski, J., Quilty, J., & El-Shafie, A. (2016, November). Stream-flow forecasting using extreme learning machines: A case study in a semi-arid region in Iraq. *Journal of Hydrology, 542*, 603-614.

Zhao, T., Wang, Q. J., Bennett, J. C., Robertson, D. E., Shao, Q., & Zhao, J. (2015, September). Quantifying predictive uncertainty of streamflow forecasts based on a Bayesian joint probability model. *Journal of Hydrology, 528*, 329-340.

PEDAGOGICAL APPROACH TO USE INTERACTIVE BOARD IN MATH AND SCIENCE CLASSES FOR 6TH GRADE IN PALESTINIAN SCHOOLS

Karram Omar
Palestinian Ahliya University, Palestine

ABSTRACT: Interactive boards in school's classrooms considered as an important and valuable educational technology tool in the education process. It becomes famous in the educational system in Palestine. It has been installed in many public and private schools for different classes' level. Several training courses were conducted to train teachers in how to use interactive boards in their classes. Unfortunately, most of the teachers understood how to use the interactive boards as a technology tool without having a good understanding how to use it as a pedagogical tool. Therefore, teachers start to avoid using this tool since they believe it does not have any pedagogical perspective benefits. In this research the researcher will address a pedagogical technology approach to integrate and implement the interactive board in Math and Science classes for the grade 6th. The approach integrates between normal boards and interactive boards. It shows how teachers may combine between the two boards in delivering the class's subjects to the students, which covers the pedagogical aspects and the correct usages of the interactive boards. Qualitative research approach is used to create and develop an effective plan to implement the interactive boards in delivering classes' subjects to the students and integrates them with the traditional boards. The plan was developed from several global and Arabic researches and experiences which matches the Palestinian education needs.

Keywords: pedagogical, interactive boards, math, science 6th grade

INTRODUCTION

There has been a considerable investment in the implemention of the interactive boards in classrooms schools in Palestine. The Palestinian Ministry of Education has installed two to three interactive boards in different schools and private schools as well. Their major goal was to enhance the teaching effectiveness in classrooms for all school's subjects. Several training hours were conducted to train teachers how to use the interactive boards in their classes and get advantages of this technology tool to increase their teaching skills and professionalism.

Effective teaching is a requirement nowadays in the education process in Palestine and the world as well. Traditionally, teachers were the focal point for information at schools and their role was to impart their knowledge and skills to their students. The Internet myth has changed that as information are available anywhere and anytime. Thus, the roll of teachers become in the 21th century to develop the skills and tools to assist their students in understanding the plethora of information available and to simplify the school subjects' contents.

In math and science education, it is commonly claimed that the use of multiple representations and the flexibility to switch among them is a crucial component in math and science thinking, learning and problem solving. (Heinze et al., 2009) addressed how "instructional environments wherein learners are confronted with multiple representations of a given mathematical concept, principle or situation, and wherein they learn to switch fluently and flexibly between these various representations, are considered as more effective in enabling learners to understand and apprehend mathematical notions and to develop a genuine mathematical disposition than environments that do not emphasize multiple representations".

The 6th grade in the Palestinian education system considered as a ground based principles knowledge for students. They have to gain and clearly understand subjects' contents in all subjects specially math and science. Teachers need at this stage to modeling mathematical and science ideas and strategies, explaining concepts, demonstrating theorems, stimulation discussion and challenging students to apply their knowledge and skills to solve problems (Miller & Glover, 2007). Math and science learning are constructive activities. Students need to engage in the processes of thinking, solving, making conjecture and so forth (Schoenfeld, 1992).

Interactive boards provide high quality graphics illustrations, variety types of multimedia presentations, animation, collaborative opportunities, hypothesis testing and interpretation. There are several types of Interactive boards in the Palestinian market such as Hitachi, Qomo, promethean, etc. and each brand provides different type and usages of the Interactive boards. Each Interactive board provides special tools for teaching math and science in addition to related interactive software application.

Palestinian schools lack high technology infrastructure specially the Internet connection. Therefore, they are suffering the implementation of high quality educational tools which depend on the Internet connection. They are not totally getting advantages of the installed Interactive boards. Thus, most of teachers are avoiding using the Interactive boards in their classes since it might affect their lessons pedagogical wise.

This research provides a pedagogical approach to use the Interactive boards in the Palestinian schools which is proportional to the infrastructure situation and the schools culture. The researcher has a deeply experience in integrating interactive boards in school classrooms for different subjects and has conducted several training courses for teachers in using the interactive boards as a technology tools in pedagogy perspective.

Aims of the Research

The fundamental aim of the research was to provide an approach that helps math and science teachers to integrate interactive boards in their classrooms in a proper and effective way. The approach combines between both the traditional board and the interactive board in the same lesson class. It provides two plans; the first plan focuses on teachers training and the second one provides a typical math lesson plan.

The initial plan considered as a fundamental for teachers to implement and integrate the interactive boards correctly taking into consideration the pedagogy and technology as a tool of the interactive boards. The plan consists of 30 practical training hours on a Hitachi touch board projector which makes the traditional board becomes interactive board.

The second proposed plan illustrates a typical math lesson class in integrating traditional board and interactive board together. It consists of two parts: part one is the pedagogical terms and methodologies; the second part is the actual lesson structure.

METHODS

The quantitative research method was adapted in this research. To ascertain the added value of integrating interactive boards in classrooms to teach math and science; several related researches were analyzed. Those researches showed the advantages of using the interactive boards in schools' classrooms. The researcher focused on the Arabic related researches and several international researches.

Several training courses in the last five years were conducted to train teachers from different schools and teach different subjects to use interactive boards in their classes. The training provided best practices of interactive boards to their subjects and provided them with software applications which best fit their lessons needs. Lessons observations and follow-up interviews were carried out with group of math and science teachers to comment on which aspects of the lessons they had delivered and found helpful to their pupils.

The related researches and the researcher experience were combined and integrated to propose this research approach. The researcher has 10 years' experience in train and supervises teachers on using interactive boards in their teaching classes. Several research papers were published by the researcher on best fit approaches to use interactive boards in schools' classrooms and the important of integrating traditional board with interactive board in math and science classes.

RESULTS AND FINDINGS

The research proposed a pedagogical approach to use interactive boards in math and science class for 6^{th} grade in the Palestinian schools. The study considered the Palestinian school curricula for both math and science subjects for 6^{th} grade to propose this approach. Several interactive boards' models were used in this study in different schools to clarify the best fit model taking into consideration the schools environment and circumstance.

The approach consists of four fundamental stages: stage one focus on training math and science teachers on using and integrating interactive boards and traditional board in their classes as a pedagogical and technology tools. A 30 hours training plan was developed and well-structured pedagogically to allow teachers to understand the interactive boards as an educational tool and to integrate it correctly. The second stage is the lesson plan which consists of two main parts: the pedagogical part and the actual lesson structure. The plan proposes an integration strategy of using interactive board and white board (traditional board) in delivering the lesson for students.In stage

three, observation sessions must be conducted for teachers who completed their training by an expert in order to enhance teachers' usages of interactive boards in their classes and get the necessarily feedback.
Stage four encourages teachers to develop interactive lessons related to their subjects to improve their lessons quality.

Teacher Training Stage

The training plan was developed compatible with the Palestinian schools' teachers' needs and its environment. The plan consists of two parts: Technology part and the pedagogical part, which both parts well transfer a typical usage of the interactive board in classes. The plan is enriched with simulation application to enhance pupils understanding of the topics.

	Meeting No.	Duration	Content	Assignment

Technology Part	1	3 hours	• Introduction to interactive board(IB)
			  ○ Parts
			  ○ Operations
			  ○ Maintenance
			  ○ Safety
			  ○ Traditional board Vs. IB
			  ○ IB's advantages in class rooms
			  ○ Best practices and usages
			  ○ Installation and configuration
			• IB software
			  ○ Main tools
			  ○ Practical training on main tools
			  ○ Smart pen
				Create one slide on shapes

	2	4 hours	• Teaching tools
			  ○ Zooming
			  ○ Backgrounds
			  ○ Spotlight
			  ○ Text
			  ○ Recorder
			  ○ Stopwatch
			• Practical training on IB
			• Math tools
			  ○ Ruler
			  ○ Protractor
			  ○ Compass
			• Science Tools
			  ○ Thermometer
			  ○ Scale
			  ○ Measuring cups
			• Practical training on IB
				Create a plan lesson and illustrate the tools to be used.

	3	4 hours	• Merge images
			  ○ Images library
			  ○ Import image
			  ○ Image processing
			  ○ Internet images
			  ○ Screen shots
			  ○ Matching game
			• Merge word files
			  ○ Working on worksheets
			• Merge power point files
			  ○ Import slides
			  ○ Interact with slides
			  ○ Slides snipping
			• Merge PDF files
			  ○ Import student book
				Create 4 slides, select a topic and use different tools.

			○ Import other files	
	4	5 hours	• Building lessons ○ Identifying lessons ○ Lesson's component ○ Lesson implementation ○ Lesson section and time • Educational videos Integration • Educational flash files integration • Educational games ○ Math game ○ Science game • Create complete lesson	Create lessons folder and build your first lesson(you have to use different techniques on each slid)
Pedagogical part	5	5 hours	• Educational web application 1 ○ Kahoot.it ○ Linoit.com ○ Popplet.com • Web application integration • Create an interactive lesson	Create your second interactive lesson
	6	5 hours	• Educational web application 2 ○ Phet.Colorado.edu ○ Desmos.com ○ Areej.org • Practical training	Create your third interactive lesson
	7	4 hours	• Practical training (students on board) • Trainees presentation • Create follow up plan	

Lesson Stage

Following is the proposed lesson plan structure. The plan structured consist of two parts: the first part presents the pedagogical perspective contents of a class lesson; the second part presents the actual lesson plan.

Pedagogical Part:

	Target group(class level)			**duration**	
	Lesson title				
	Group ages				
	Lesson objectives				
	Terms				
	Critical thinking				
	21th century education tools				
	Instruments				
	Computers				
	Internet resources				
	Assessment				
	Intended learning outcomes				

Lesson part:

The abbreviation IB means: Interactive boards and WB means: White board (Traditional board).

	Lesson's section	Activity	Computer application	Board used (IB,WB)	duration
	Ice-breaking and Introduction		Multimedia app	IB	3ms
lesson structure	Explanation (understanding principles)	Theoretical part		WB	10ms
		Practical Part1		WB + IB	10ms
		Practical Part2	Web app	WB + IB	10ms
	Exercises		worksheet	IB	8ms
	Enrichment		Desmos.com	IB	3ms
	Conclusion			WB + IB	2ms
	Assignment				

The research ascertains that replacement the traditional white board with the interactive board in the Palestinian schools will affect the students' basics mandatory skills such as writing skills, spelling skills and memorizing skills. In addition, continuing using the white board only will affect students' academic enhancement, their concentration, their understanding and might affect their psychological feeling to their schools and education live as well.

The research presents a typical approach to integrate interactive board among with traditional board at the same lesson to insure high quality teaching and to be in line with the technology evolution in education process. The approach illustrates the best fit technology tool is a projector which connected to a white board and switch it to an interactive board as in figure1.

Figure 1. Typical integration between IB and WB

CONCLUSION

Most research publications illustrated the importance of using interactive boards in school classes without presenting typical pedagogical approaches to use it. In this research, I presented a typical approach to use interactive boards in math and science classes for 6th grade in the Palestinian schools. An approach which encourages teachers to integrates white board and interactive board among each other in the same lesson class by installing a special technology tool which makes any white board to be interactive. The projector is hooked above the whit board and as teacher needs, teacher can turn on the feature which switches the white board to an interactive one.

The approach combines between traditional tools and technology tools. Booth tools are needed in the Palestinian schools to insure high quality education and basics necessary education skills. Teachers must understand how to integrate interactive boards and merge it with the traditional white board as well.

The approach consists of four fundamental stages: teacher training, lesson structure plan, teacher's observations and interactive lessons development.

RECOMMENDATIONS

1. I encourage the Palestinian ministry of education to adapt the proposed approach to insure high quality in their schools education system.
2. Teachers must be well trained before they start integrating interactive boards in their classes.
3. The Palestinian ministry of education must provide guidance and supervision to their schools for implanting interactive lessons for all school levels and subjects.
4. Teachers must consider the interactive board as a pedagogical tool as well as a technology tool. Therefore they must understand the pedagogical aspects.
5. I encourage related researchers to research on merging between traditional white board and interactive boards in schools classrooms especially in elementary level.

ACKNOWLEDGEMENTS

This approach was developed from deeply experince in teaching practial Math and Science classes using the Interactive Board in parraller with traditional white board. İt combines teachers traning sessions feedbacks conducted in schools, local and global related researches and the researcher experinces in educational technology classes. In the next phase, the approach will be immplemented in 10 different schools in order to test it and improve it. In addition, the approach will reformalted to justified special needs schools.

REFERENCES

A. Heinze, J. R. Star, and L. Verschaffel, “Flexible and adaptive use of strategies and representations in mathematics education,” Mathematics Education, vol. 41, no. 5, pp. 535–540, 2009.

D. Miller and D. Glover, “Into the unknown: the professional development induction experience of secondary mathematics teachers using interactive whiteboard technology,” Learning, Media and Technology, vol. 32, no. 3, pp. 319–331, 2007.

A. H. Schoenfeld, “Learning to think mathematically: problem solving, metacognition, and sense-making in mathematics,” in Handbook for Research on Mathematics Teaching and Learning, D. Grouws, Ed., pp. 334–370, MacMillan, New York, NY, USA, 1992.

Bauersfeld, H. (1988) Interaction, construction, and knowledge: alternative perspectives for mathematics education. IN GROUWS, D., COONEY, T. & JONES, D. (Eds.) Perspectives on Research on Effective Mathematics Learning (pp.27-46). Hillsdale, N.J., Lawrence Erlbaum

Hennessy, S., Ruthven, K. & Brindley, S. (2005) Teacher perspectives on integrating ICT into subject teaching: commitment, constraints, caution and change. Journal of Curriculum Studies, 37 (2), 155-192.

Heppell, S. (2004) Interactive whiteboards are useful stepping stones to other technologies. (Interviewed by George Cole). TES Online, 8.

Kerr, S. T. (1991) Lever and fulcrum: educational technology in teachers' thought and practice. Teachers College Record, 93 (1), 114-136.

Levy, P. (2002) Interactive Whiteboards in learning and teaching in two Sheffield schools: a developmental study, Sheffield, Department of Information Studies. http://dis.shef.ac.uk/eirg/projects/wboards.htm (accessed 24.02.07).

Miller, D., Glover, D. & Averis, D. (2004) Matching technology and pedagogy in teaching mathematics: understanding fractions using a 'virtual maniplulative' fraction wall. Annual Conference of the British Educational Research Association (BERA, September 2004). Manchester.

Moss, G., Jewitt, C., Levacic, R., Armstrong, V., Cardini, A. & Castle, F. (2007) The Interactive Whiteboards, Pedagogy and Pupil Performance Evaluation: an Evaluation of the Schools Whiteboard Expansion (SWE) Project: London Challenge, London, DfES.

Tanner, H., Jones, S., Kennewell, S. & Beauchamp, G. (2005) Interactive whole class teaching and interactive whiteboards. 28th Conference of the Mathematics Education Research Group of Australasia, MERGA 28. Melbourne, Australia.

Al-Fahel, E.; Daher, W. & Abu-Hussein, J. (2012). Teachers' perceptions of the interactive boards for teaching and learning: the case of Arab teachers in Israel. The international journal of e-adoption, 4 (1), 33-50.

Daher, W.; Abu-Hussein, J. & Al-Fahel, E. (2012). Teachers' perceptions of interactive boards for teaching and learning in public and private high schools in the Arab education system in Israel. The international journal of emerging technologies in learning, 7(1), 10-18.

Latham, P. (2002). Teaching and learning primary mathematics: The impact of interactive whiteboards. Beam Education. Retrieved April 20, 2011

EVALUATION OF MATHEMATICAL GAMES IN TERMS OF EDUCATIONAL ASPECTS: ANDROID AND WEB APPLICATIONS

Ayfer Alper
Ankara University, Turkey

Tuğçe Gencoglu
Ankara University, Turkey

ABSTRACT: Nowadays interactive education is becoming widespread by using smartboards and notepad computers. In addition, it is observed that by mathematical games and game assisted teaching, the attitude and success level towards mathematics are increasing day by day. Accordingly, especially in digital platforms, as in many disciplines, many games are recently being developed also in Mathematics and the children are enabled to play. However, considering that these games are not only fun aimed and they have educational aspects, these kinds of games should have some specific characteristics. In this study, the android and web applications in Edshelf and PlayStore that can be used in mathematics education were evaluated according to various criteria.

Keywords: Game based Learning, Mathematic Education, Android applications, Web applications

INTRODUCTION

Computers with a highly flexible structure can create a rich life in the process of teaching and learning through specially prepared instructional programs (Öğüt vd. 2004). Most of the mathematical concepts are abstract concepts that require cognitive efficiency at a high level. Computers can be embodied by visualizing most abstract concepts, so that most mathematical concepts can be easily grasped and become conceivable for the student and, affecting teaching and learning positively (Baki, 2000). With the widespread use of digital gaming and applications, tablet computers and smartphones are now being used effectively in technology-assisted instruction as well as computers. Indeed, almost all the young people in the Net Generation greatly enjoy using computers and spend much of their time browsing or playing computer games (Girard, Ecalle ve Magnan, 2012). In this case, using computer games in education is an irrefutable alternative, considering the opportunities that it offers (Korkusuz ve Karamete, 2013). Kebritchi, Hirumi and Bai (2010) have come to the conclusion that computer games have contributed to mathematics success and motivation without being an important influence of the knowledge, computer and English language skills. It was concluded that the opinions of the students on the motivation and teaching of computer games were positive in Kula and Erdem's (2005) study of the improvement of arithmetic processing skills of fourth and fifth grade students of instructional computer games. Girard et al. (2013) have explained that it made possible for them to think that 'Important Games' (videogames aiming to serve a useful purpose) can be powerful tools for learning, as a result of the meta-analysis. The results of Ke's (2008) study showed that computer games were significantly more effective in increasing learning motivation when compared to paper-pen studies but there was no significant effect of computer gaming on students' cognitive test performance or metacognitive awareness development.

The benefits of using new technologies in mathematics education are seen in the development positive attitude toward mathematics, interesting enhancement, reduction of anxiety, fear reduction for mathematics lessons and more importantly developmet of effective thinking behaviors such as analytical and critical thinking, as well as increasing success (Peker, 1985). Attitudes towards the subject are important factors in student academic achievement. Educational computer games comprise motivating and entertaining features of computer games and can be used as an alternative, complementary and enrichment of other teaching methods for instructional or educational purposes (Çankaya ve Karamete, 2008). Also, Aksoy (2014) supports the idea that the digital game-based teaching environment gives students a positive attitude towards mathematics lesson and contributes to the success motives in positive direction. Öztürk (2007) examined the effects of computer games on children's cognitive and affective development and noted positive results. Yılmaz (2014) found that the use of mathematics games in the study of geometric objects increased the mathematics success of 5th grade students and positively affected the attitude toward the course.

Another important factor in effective and permanent learning is that the student is active in the learning process. Today's curriculum approves the constructivism theory and according to this constitution students should actively participate in learning activities. It is believed that the use of methods and techniques in which learners will become active and that their knowledge will be constructed at their own pace is useful for teaching mathematics (Fırat, 2011). Active learning is generally defined as any instructional method that engages students in the learning process (Prince, 2004). While there are various ways of providing active participation of the students, one of the most on the front burner of these is the technology-supported activities. The Technology-Enabled Active Learning environment was designed to support social interactions, encourage students' active learning and interest, and create a classroom climate that fosters conceptual change (Dori & Belcher, 2005). Teaching is actively involved in games as an activity that students enjoy doing in their daily lives (Fırat, 2011). Educational games ensure that learners are constantly active in the learning environment (Şahin & Yıldırım, 1999). Computer games were hypothesized to be potentially useful for instructional purposes and were also hypothesized to provide multiple benefits: (a) complex and diverse approaches to learning processes and outcomes; (b) interactivity; (c) ability to address cognitive as well as affective learning issues; and, perhaps most importantly, (d) motivation for learning (O'Neil, Wainess & Baker, 2005).

METHOD

The method of the study is determined as document analysis. A document analysis covers the analysis of written materials containing information about events or phenomena targeted for investigation (Simsek, 2009). Within the scope of this research, digital math games on Android and Web media are examined.

Study Group

The games, which can be used in Mathematics, realized with web and Android applications that covering the fractions and decimal fractions sub-learning areas constitute the working group. In total, 20 websites and Android apps on http://www.edshelf.com and the Play Store have been reviewed.

Data Collection Tools

The theoretical approaches that appear to be most relevant to mobile learning are those that involve learner control and challenge by setting an appropriate level of complexity, provoke their user's curiosity, and allow them to engage in active learning conversations. In addition to this approach, the draft secondary school mathematics curriculum and guidelines published by the Ministry of National Education of Turkey in 2017 were analyzed and the criteria to be searched were determined. Criteria have been developed to evaluate the selected educational applications and opinions were obtained from five field experts.

The obtained criteria are:

1. Grade Level and Level of Questions
2. . Inclusion of Mathematical Modeling
3. Including Different Representation of the Concept
4. Time Limitation in Games
5. Offer Clue
6. Giving Feedback
7. Hosting Motivation Source
8. Including Teacher / Parent Sections

The short introductions of the games are as follows:

1. ***Fresh Baked Fractions (https://www.funbrain.com/fract/index.html):*** In the beginning of the game four different levels are presented as options. In this game, it expected to choose the fraction among four that is not equal to the rest. The notification for the correct and wrong choices is given immediately, and when answered wrongly the correct option is shown instantly.

2. ***Braineos (http://www.braineos.com/search/tags/fractions):*** The questions include the subjects of fractions and four operations, and they are listed with headings based on their levels of difficulty. When the correct answer is congratulated, the correct answer is shown when answered wrongly.

3. ***CoolMath4kids (https://www.coolmath4kids.com/math-games/fractions):*** When classifying the games, the titles as well as the grade levels were taken into consideration. Under the title of fractions, there are five games. These five games work similarly in principle, while differ from each other in terms of game scenario and gains they deal with. Since the games are in competitive mode, speed is of importance. The sense of competition also provides motivation.

4. *Hooda Math (http://www.hoodamath.com/games/hoodamathdefense.html):* There are games classified in terms of grade level, category or topic. "Hooda Math Defense", which is unique to the website related to fractions, necessitates both reasoning and the ability to compare the fractions. When answering the questions, the timing is not performed. As a means to reinforce, money is gained when questions are answered correctly and this money is used for the purchasing of materials that will strengthen the defense at a later stage. In case the question is answered wrongly, clue is provided by showing the fractions on numerical line. Thus, the modelling of the fractions is enabled as well. While there is a teacher access to the website, there is no parent access available.

5. *Studyladder(https://www.studyladder.com/student/course/mathematics?page=*&g=9):* The fact that the games are distributed in accordance with the grade levels under the chosen titles provides great ease of use. Mathematical modeling is found in 5th grade level activities. The concept of fractions is approached for every acquisition, and meanwhile various ways of display are included. When answering the questions there is no timing, however, when returning back to the answered question the correct answer, wrong answer and the answer time are provided. The correct answer is indicated with applause and green color while the wrong answer is indicated with a warning beep and red color. In case correct answers are given and the tasks are completed, prize money is gained and with this money game character, pet animal and a home can be arranged/styled. It can be logged in with an account created by parents or teachers, and with the progress report the student can be tracked.

6. *Braingenie (http://braingenie.ck12.org/):* When 1-8 group is chosen in accordance with the grade levels, classification based on the titles appears. Though timing is seen on the screen, it is not for limitation purposes but rather recorded as statistical data. The clue is not provided based on the question. If insufficiency is felt in regard to the topic, there is a "watch video" button to provide the student with a summary course through a sample question. In case of giving wrong answer, the correct answer is provided together with its explanation. The timing and correct answer statistics of the members are listed and this list can be accepted as the motivator. Although suitable for an individual learning, this system can be used to duel with other users as well. There is a teacher session of the system.

7. *Ratio Rumble (http://mathsnacks.com/ratio-rumble.html):* The concept of fraction is deal with its "ratio" meaning, and this acquisition is provided via latent learning. Quantities that make up of the fraction as mathematical modeling are concretely displayed as elixir bottles. As one advances in the game, he is given tasks of increasing difficulty under the same acquisition.

8. *Pearl Diver (http://mathsnacks.com/pearl-diver.html):* The fractions are presented on a numerical line. In addition to that, as modeling there is an activity of dividing a whole into equal parts in between the levels. The fractions are defined as mixed fraction and compound fraction. There is a time limitation, the speed is of importance. As a clue, references on the numerical line are emphasized in the beginning of the game. When the wrong point is determined, the provision of the real value of that point can be considered both as feedback and clue. When the correct point is found, a pearl is gained. When a certain amount of pearls are gained at a predetermined period, the student levels up and saves money.

9. *Math Games (https://www.mathgames.com/fractions):* After choosing the topic to study, a selection is made among the acquisition list grouped in accordance with the grade level. Modeling is used especially in the acquisition of comparing the fractions. Different displays of the concept are used and dealt with in different aspects. Feedback is given with a star or a warning. The student is congratulated and supported even at the end of a failed stage. The student statistics are kept and the daily, weekly and monthly top 20 success list of the members is issued.

10. *Animal Rescue (https://www.mathgames.com/play/mathsmash.html):* First, the grade level then the subject to study is chosen. The purpose is to open the way by checking the boxes where the answers to the questions are and to save the animals. The decimal system is displayed as the different expression of the fractions. The correct answer saves the animals and saves money. The wrong answer does not result in correct answer or solution, only a warning is given.

11. *Adding Unit Fractions (android application):* It is aimed to create the chosen fraction by unifying three different sections of a fraction. The difficulty level of the preferred fraction is indicated with stars. The fractions are modeled and supported visually. Modeling is also the clue. It gains the skill of latently comparing the fractions. Along with that, addition and subtraction skills and equivalent fractions knowledge are used together with the fractions. The correct answers are recorded in the solution list and this can be considered as feedback.

12. ***Fraction Mastery (android application):*** It is comprised of levels in which every acquisition from basic fraction concept knowledge to operations with fractions is dealt with. There is mathematical modeling. Correct answer is not given in wrong answers, the correct answers enable the completion of tasks necessary for passing the level, and thus the next locked level is opened. If the player wishes, he can see a clue by touching the “question mark”.

13. ***Slice Fractions (android application/Turkish):*** It consists of levels grouped based on subjects with increasing difficulty. The aim is to open the elephant’s path, on which obstacles appear. The game is based on mathematical modeling. The feedback is weak and if wrong path is chosen the elephant cannot move; if the correct path is chosen then the elephant can continue its way.

14. ***How Much Pizza Ask? (android application):*** It is expected to write down how much pizza was ordered in total by stating the number of two types of ordered pizza in fractions. The fractions to be calculated can be determined manually or automatically by the player. The collected fractions are modeled with pizza. Modeling is also the clue.

15. ***EG Fractionns/DEMO (android application):*** How many questions in which level will be answered within the selected skill group is determined in the beginning of the game. It includes the representation of fractions on numerical line as well as four operations with fractions. It is modeled through the display of fractions on a numerical line and division of a circle into parts while performing addition or subtraction. When answered wrongly, the chance of re-attempts is given until the correct answer is found.

16. ***Coop Fractions (android application):*** There is no level class based on grade or age. The part directed towards guessing the result of the operations with fractions is free of charge. The result of the given operation is guessed and the nest is placed at the point on the numerical line, on which the egg will fall. Based on his level, the player determines the difficulty by arranging the time limit and the size of the nest. The fractions are modeled with a numerical line. There is the display of decimal system as another representation of fractions. There is time limitation. In case of a wrong answer, the egg is broken and the value of the correct point is shown. When answered correctly, the eggs are collected.

17. ***Ethan's Fraction Game (android application):*** It is expected to determine the fractions, which were modeled with the division of the pizzas into pieces. As correct answers are given, the child runs faster and when wrong answer is provided his speed drops. The time to reach the target is recorded but there is no time limitation. The best time is recorded and the attempt to surpass this is the source of motivation.

18. ***Multiplying Fractions (android application):*** The multiplication of two fractions chosen by the player manually is calculated. The chosen fractions are shown in circle modeling. If the result is wrong the correct answer is given and when correct answer is given the player is congratulated.

19. ***Fractions to Decimals Games (android application):*** The fractions are modeled by making use of the area. It includes the decimal representations of the fractions. There is immediate feedback but correct answer is not provided.

20. ***Fractions (android application):*** It consists of levels, each of which has different acquisitions. The questions are answered until sunset, if enough success is achieved the player moves on to the other level. At each level, new spaceship is acquired and the character is improved. If wrong answer is given, the correct one seen immediately.

Table 1. Assessment of the Games Analyzed According to Criteria

Name of Game	Level	Mathematcal Model	Diff. Rep. of Conce	Time Limit	Clue	Feedback	Motivation	General Report	Tutor/Parent
Fresh Baked Fr	Four different level options	off	off	off	off	instantly	off	off	off
Braineos	off (Become increasingly diffic	off	off	off	off	instantly	off	off	on
CoolMath4kids	grade/subject	off	off	race	off	instantly/ no correct answer	on/race	off	on
Hooda Math	grade/subject	on	off	off	on	instantly/ finding the truth	on/build-up	off	tutor
Studyladder	grade	on	on	off	off	instantly	on/avatar	on	tutor
Braingenie	subject/outcome	off	off	off	on	instantly	on/statistics	on	tutor
Ratio Rumble	off (Become increasingly diffic	on	off	off	off	instantly/ no correct answer	off	off	off
Pearl Diver	off (Become increasingly diffic	on	off	on	on	instantly	off	on	off
Math Games	grade/outcome	on	on	off	off	on (support/greeting in failure	on/statistics	on	off
Animal Rescue	grade	off	on	off	off	instantly/ no correct answer	off	off	off
Adding Unit Fra	difficulty	on	off	off	on	instantly	off	on	off
Fraction Master	outcome(Become increasingly	on	off	off	on	instantly/ no correct answer	off	off	off
Slice Fractions	subject/outcome((Become incre	on	off	off	off	off	off	off	off
How Much Pizz	off	on	off	off	on	instantly	off	off	off
EG Fractionns/1	difficulty(manuel)	on	off	off	off	on	off	off	off
Coop Fractions	difficulty(manuel)	on	off	on	off	on	off	off	off
Ethan's Fractio	off	on	off	off	off	on	on/best timing	off	off
Multiplying Fra	off	on	off	off	off	instantly	off	off	off
Fractions to dec	off	on (area)	on (decimal)	off	off	instantly/ no correct answer	off	off	off
Fractions	on(level/outcomes)	off	off	on	off	instantly	on(avatar)	off	off

Analysis of Data

The data obtained in the study were evaluated by content analysis. Data analysis can be handled in two main groups; descriptive analysis and content analysis. The main purpose of content analysis is to reach concepts and associations that can explain collected data. The meaning of the data is at the same time a subjective process, and therefore the absolute objectivity of interpretations can not be claimed (Şimşek, 2009).

RESULTS

Grade Level and Level of Questions

Of 20 games in question, 5 of them have grade selection and three of those offer subject selection. In one of them the game starts with the easy, medium, difficult and super brain selections. The difficulty in one of them is indicated with the number of stars. Three of them offer options in terms of subjects and two of those become difficult throughout the game. One of the games consists of levels, each of which aims different gains. In 2 games, the difficulty of the game is set by the player in the beginning manually. In 6 of the games (30%), there is no grade or subject selection, and three of those gets difficult throughout the game.

Inclusion of Mathematical Modeling

14 games (70%) among the ones being analyzed have mathematical modeling while 6 of them does not. The fractions are modeled through representation on numerical line in 3 of them, making use of area in 9 of them, making use of volume in 1 of them and division of a whole into equal parts in 1 of them.

Including Different Representations of the Concept

The fractions can be presented with a decimal representation via fraction bar or percentage. 16 games (80%) among the ones being analyzed do not have different representations.

Time Limitation in Games

16 games being analyzed do not have time limitation. While an answer within a limited time is necessary in three of the games, the speed is important in one of them because of a competition.

Including Clues

6 of the games provide hints to enable or make it easier to find the correct answer. In two of them the hint is given with a numerical line, and in two of them with the modeling of the fractions. In two of the games, the player can see the hint as in lecturing by pressing the button if he needs.

Giving Feedback

19 games among the ones being analyzed, a feedback is given via an indicator (sound, color etc.) that shows the answer is correct or wrong. Among four of them the correct answer is not given, in one of them the right answer is enabled to be found through elimination method and in one of them the student is encouraged via positive notifications although he fails. In one of the games there is no feedback.

Hosting Motivation Source

In 7 of the games, there are motivation resources. Motivation resources are accepted to be factors in addition to the feedbacks that connect the player to the application/game and make the game attractive. In one of the games, the competition status, in three of the games the character strengthening/developing, in two of the games the statistics are recorded and a success list is created. In one of the games, the best time is recorded and it brings the desire to break this record.

Including Teacher / Parent Sections

The usage of game and applications under the surveillance of parents/teachers and the parent/teacher platform for the tracking of student works is an important feature. However, none of the android applications in question has this feature. Two of the websites have both parent and teacher; three of them have only the teacher access.

DISCUSSIONS

Learning mathematics is getting more difficult especially in young age groups due to the difficulty of concretization. This situation causes students to build negative attitudes. Also, having active students is a point on which the teaching approaches that are accepted today are emphasizing. Game based methods are preferred so as to overcome these difficulties and due to many more aspects. In today's world, where the digital learning tools are popular, there are various math games being designed. Of course, they should be analyzed in terms of criteria in order to determine the qualifications of the educational games.

In this study, the math games with the subject of "fractions" that are present in the websites located in edshell platform and that can be accessed freely in android applications area analyzed based on the following criteria: Grade Level and the Level of Questions, Inclusion Mathematical Modeling, Including Different Representations of the Concept, Time Limitation in Games, Including Clues, Giving Feedback, Hosting Motivation Source and Including Teacher / Parent Sections.

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- Few games are categorized in terms of grade level. Considering the fact that the curricula applied in the countries are variable, it can be thought that offering choices in terms of subjects would be more suitable. Still, there are few games offering such classification.
- There is modeling in majority of the games. Because fractions are abstract concepts that indicate quantity, modeling is quite important in terms of making learning easier.
- The majority of the games being analyzed do not have different representations of the concept. "Different representation of the concept", which is significant in dealing with the concept in different aspects and perceiving it in every sense, was also emphasized in the draft education program of 2017 issued by the Board of Education and Discipline.
- There was no time limitation in almost all of the games.
- There are few games that effectively use clues, which enable the students to interpret and shape the information and are important elements of learning.
- In almost all of the games, immediate feedback (correct-wrong) is provided.
- Elements that will provide motivation so as to keep the student interest alive are present in few games.
- It is important for games to be under the surveillance of parent/teacher in terms of both safety and the tracking of the educational process. However, at this point, there are limited web games that offer this opportunity while there are no Android games in that matter.

SUGGESTIONS

In consideration with the results that emerged, it can be said that generally in the design of the educational games, the "educational" dimension is weak. It is seen that game based learning that is referenced intensively in literature and emphasized for its educational value could not keep pace with the integration of technology into the educational process. There can be studies in regard to standardizing the game criteria and it can be suggested to make designs suitable to those criteria in question.

REFERENCES

Aksoy, N. C. (2014). Effects of Digital Game-Based Mathematics Teaching on 6th Grades Students' Achievement, Motivation, Attitude and Self-Efficacy, PhD Thesis, Gazi University, Ankara.

Baki, A. (2000). Mathematical Learning in Computing Environment. Hacettepe University Journal of Education, 19, 186-193.

Çankaya, S., & Karamete, A. (2008). Influence of educational computer games on students' attitudes towards mathematics and educational computer games. Mersin University Journal of Education Faculty, 4 (2).

Dori, Y. J., & Belcher, J. (2005). How does technology-enabled active learning affect undergraduate students' understanding of electromagnetism concepts?. The Journal of the Learning Sciences, 14(2), 243-279.

Fırat, S. (2011). The effect of mathematics teaching with computer aided educational games on conceptual learning. Master Thesis, Adıyaman University, Adıyaman.

Girard, C., Ecalle, J., & Magnan, A. (2013). Serious games as new educational tools: how effective are they? A meta-analysis of recent studies. Journal of Computer Assisted Learning, 29(3), 207-219.

Ke, F. (2006, June). Classroom goal structures for educational math game application. In Proceedings of the 7th international conference on Learning sciences (pp. 314-320). International Society of the Learning Sciences.

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. Computers & education, 55(2), 427-443.

Korkusuz, M. E., & Karamete, A. (2013). Educational Game Development Models. Necatibey Faculty of Education Electronic Journal of Science & Mathematics Education, 7(2).

Kula, A., & Erdem, M. (2005). Influence of instructional computer games on the development of basic arithmetic processing skills. Hacettepe University Journal of Education, 29 (29).

O'Neil, H. F., Wainess, R., & Baker, E. L. (2005). Classification of learning outcomes: Evidence from the computer games literature. The Cirriculum Journal, 16(4), 455-474.

Öğüt, H., Altun, A. A., Sulak, S. A., & Koçer, H. E. (2004). Computer-aided, e-education with internet-accessible interactive education CD. The Turkish Online Journal of Educational Technology, 2(4).

Öztürk, D. (2007). An examination of the effects of computer games on children's cognitive and affective development. Master Thesis, Dokuz Eylül University, İzmir.

Peker, Ö. (1985). Problems of Mathematics Teaching, Mathematics Teaching and Problems in Secondary Education Institutions. Ankara : TED Press, 52.

Şahin, T.Y., Yıldırım, S. (1999). Instructional Technology and Material Development, Anı press, Ankara.

Şimşek, H. (2009). The Problem of Method in Education History Surveys. Ankara University Journal of Educational Sciences, 42(1), 33-51.

Yılmaz, D. (2014). The effect of the use of mathematical games on student achievement and attitude in the teaching of geometric subjects in the 5th grade math class in Secondary school. Master Thesis, Gazi University, Ankara.

EVALUATION OF THE USE OF FLIPPED CLASSROOM BASED TUTORIALS IN "MATHEMATICS FOR CHEMISTS" COURSE FROM STUDENTS' PERSPECTIVE

Ahmad Aljanazrah
Birzeit University, Palestine

Franz Josef Schmitt
Technische Universitaet Berlin, Germany

Thomas Friedrich
Technische Universitaet Berlin, Germany

ABSTRACT: Use of "Flipped Classroom" is gaining more and more interest in chemistry education. Within a project "educationZen" to enhance the quality of chemistry education using digital technologies at the Technische Universität Berlin, "Mathematics for Chemists I and II" courses have been implemented based on targeted flipped teaching approach. Students have been provided with online instructional videos about some of the topics addressed in the lecture and the face-to-face (tutorials) real time was used for other student-centered activities like cooperative problem solving and peer marking. The purpose of this study was to evaluate this experiment of applying flipped-classroom based tutorials to those courses from students' perspectives and to explore those views within the frame of their digital habits and attitudes toward the use of educational technologies in teaching and learning of chemistry. In order to achieve the purpose of the study a combined quantitative–qualitative approach has been applied. The first part focuses on measuring students' digital habits and their attitudes toward the use of educational technologies. It was based on quantitative analysis of data that was gathered through online and face-to-face questionnaires. Qualitative evaluation was used to explore and examine the students' perceptions through focus group interviews. Findings have shown that 95% of the students are using internet more than one hour a day and most of the students liked to use online videos to support their studies. Students' attitudes were positive toward the use of digital technologies to enhance their chemistry learning but not to substitute the role of the lecturer. Most of students still value face-to-face interaction and do not see online learning environment as a total substitution to the traditional lecture even in the future. Study findings strongly recommend applying the online instructional videos in chemistry education and to extend this model to other courses and topics.

Keywords: flipped classroom, chemistry education, online videos, blended learning, technology in university teaching.

INTRODUCTION

There is a growing evidence in the literature, indicating that the use of Information and Communication Technologies (ICTs) has the potential to enhance the quality of science teaching and learning in both school- and higher education levels (Slavin, Lake, Hanley & Thurston, 2014 and Lee, S. et al., 2011). According to the International Association for the Evaluation of Educational Achievement (IEA) Second Information Technology in Education Study (Law, N., & Chow, A., 2008), ICT-use in teaching and learning brings a stronger 21st-century orientation to pedagogy in both mathematics and science classrooms. In addition, younger generations of students are becoming more and more dependent on the different forms of electronic devices such as smartphones, tablets and computers as well as online resources (Cassidy, et al., 2014). One of those most common technologies is the use of online instructional videos. Instructional videos, sometimes called tutorial videos or lecture videos, are usually made up of instructors' audio narrative added to Microsoft offices screens that display topic content (Brecht, 2012). Other technologies allow producing tutoring videos that are based on voice and handwriting which are similar to the traditional face-to-face tutoring using writing and explanation (He, Swenson and Lents, 2012). It has been found that instructional videos can increase learner engagement, control of learning and independence. Chemistry students can access and watch those videos whenever they want and wherever they are if they have internet access; and more important they can listen to them repeatedly as needed depending on their own pace of learning (Zahng et. al., 2006; Simpson, 2006). Use of video and multimedia can capture students' interest and demonstrate events, internet can provide rich environment of resources and online communication and support, and virtual experimentation can enhance what is so-called "minds-on" activities, which can enhance higher order cognitive skills (Wellington, J. & Ireson, G, 2012).

In a traditional lecture set, an instructor goes usually with all students with the same pace, trying not to be too fast for slow learners and not too boring for fast ones assuming that they all can follow him or her on this average mode. The cognitive school of learning recognizes the importance of taking into account individual differences in designing learning environments (Ally, 2004). As a result, the flexibility of repeating in-class activities in a form of instructional video offers an overwhelming advantage by enabling the students' control of passing information transfer to fit their pace of learning rather than in a traditional lecture setting. The constructivist school of learning sees learners as being active rather than passive and one of its' implications to online learning that learning should be interactive to promote meaningful and deep learning (Ally, 2004, p. 20). Online instructional videos provide learner-content interactivity by allowing proactive and random students' access to video content.

Integrating educational technologies in learning settings may initiate new pedagogy. Blended or hybrid learning in which face-to-face sessions (traditional lectures) are mixed or replaced by online sessions is an example of this new form of pedagogy and/ or training (Aljanazrah, 2005) Other forms include what is called "flipped or inverted classrooms". Although there is no one specific form of flipped classrooms, the core idea of this form is that instruction which used to take place in class is accessed in advance at home (or another place where internet is available) through teacher pre-created/ recorded online videos; while, in-class time is used for doing other student-centered activities such as solving problems, deepen concepts or working out cooperative assignments (Tucker, 2012). Following this approach, watching online videos in advance can enhance students' preparation and allow for investment in the real time lecture (face-to-face instruction) for scaffolded-practice and applied learning (Christiansen, 2014). According to Schultz et. al. (2014) flipped-class chemistry students' performed better and even had a favorable perception about this approach, that is learn at home and practice in class.

It has been reported, more than 45 years ago, that students view chemistry as a subject area that can only be understood by talented students (Scheible, 1969). This view about the complexity of chemistry continued until current days (Chen, 2013). This can be explained not only because of many concepts studied in chemistry are very abstract but also many students usually fail to connect the macroscopic phenomena with the microscopic world of atoms and molecules (Gellespie, 1997) and teaching chemistry occurs predominantly on the most abstract level (Gabel, 1999). In order to reduce this level of abstractness and complexity, there has been a continuous trend to use Information and Communication Technologies (ICTs) in teaching and learning chemistry. According to UNESCO (2007) ICT "refers to forms of technology that are used to transmit, process, store, create, display, share or exchange information by electronic means". Promising examples of those electronic tools are the different forms of multimedia and molecular visualization. According to the cognitive theory, meaningful and deeper learning is more likely to occur when students are able mentally to connect both verbal (words) and pictorial (pictures, models, animations…) representations simultaneously (Robinson, 2004).

Research Problem and the educationZen Concept

Mathematics courses offered for chemistry (science) students at the Technical University of Berlin (TU-Berlin) usually are accompanied with tutorials (lecture and discussion model). Those tutorial sessions supplement the regular lecture and are conducted by teaching assistants who summarize and clarify important lecture materials and discuss and answer required homework problems. As in lectures, tutorials tend to emphasize teaching rather than learning using the so called "Chalk Talks" format (Hudson & Luska, 2013) but with smaller numbers of students and more space for question-answer discussions.

With the aim of enhancing the quality of chemistry students' learning by moving to a more student-centered learning environment, a new form of tutorials within the frame the educationZen project has been created. The new structure is based on a partial flipped teaching approach in which students will be provided with online instructional videos about some of the topics addressed in the lecture and thus, has the opportunity to use all the tutorial (face to face) time for other student-centered activities like cooperative problem solving and peer marking, as seen in Figure 1.

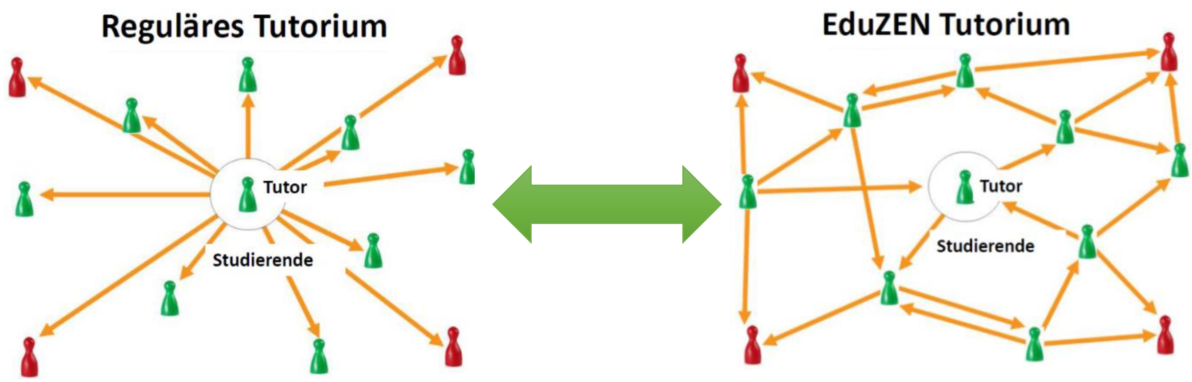

Figure 1: Shifting From Teacher-Centered Toward More Student-Interactive Approach.

The aim of this research is to evaluate the implementation of a newly developed targeted flipped form of tutorials from students' perspectives. In this form, students will have the opportunity to access online learning materials in form of educational videos before coming to the face-to-face tutorials. One of the ideas behind this format, as indicated above in the literature, is to allow students to have more time for applications and cooperative problem-solving activities when they meet in face-to-face sessions (tutorials).

METHODS

In order to achieve the purpose of the study the following research questions have been formulated:

1. What are the digital habits of students attending "Mathematics for Chemists" course?
2. What are students' attitudes toward the use of educational technologies in teaching and learning chemistry?
3. How do students experienced the new form of flipped classroom based tutorials?
4. How do students evaluate the provided online instructional videos?

Quantitative descriptive methodology was used to answer the first two research questions in order to identify students' digital habits and their attitudes toward the educational uses of digital technologies. While qualitative research methodology was followed to answer the third and fourth research questions which represent the core aim of this research. More specifically, qualitative illuminative evaluation (Savin-Baden and Major, 2013)

Research Tools

The quantitative part of the research was addressed through a questionnaire that has been developed to answer the first and second questions of the research. This questionnaire consists of three main components: personal data, students' digital habits and students' attitude toward the use of Information and Communication Technologies in education. The evaluation of the use of flipped-class tutorials including online videos and other provided online learning resources and communication, took place through focus group interviews, accompanied with one-page checklists and written questions. The selection of focus group interviews as an evaluative method is because they can help us to gather information about students' perceptions related to the new structured tutorial and online resources in a more deep and flexible environment. It was important to know what the students think about those issues and to try to understand why do they think so (Savin-Baden and Major, 2013, p. 375). While the checklists/ written questions asked about information that students may tend not to answer it in public but very relevant to the evaluation.

Content validity was used with the questionnaire that was developed in the light of previous literature and the focus group interviews was given to different instructors of the course "Mathematics for Chemists" and was modified according to their feedback. In addition, the focus group interview questions were modified again after piloting an interview to a group of students.

The questionnaire was sent to all students of the course, a total number of 170 students, and the number of received questionnaires was 73, the response rate was 0.43. Descriptive statistical analysis was applied to the data collected by the questionnaire. Five focus group interviews took place including the first one as a pilot. The interviews were administered by the main researcher and assistant, recorded and then transcripted as text. During the interviews voting was used to seek for agreements and common ideas. Thematic analysis was used to analyze qualitative data through the interviews.

Online videos were developed by the course tutors, uploaded and announced to the students through the course portal (ISIS: a learning management system adapted from MOODLE especially for the Technical University of Berlin) one week before session. The video used a simple technology in which the instructor voice and writing were synchronized.

RESULTS AND FINDINGS

Exploring the digital habits of students showed heavy rely on technology, 95% of the students are at least one hour and more than half of them are at least 3 hours online per day, as well as high rate of access 98.3%, figure 2 and 3. Such results are very much supported in the literature; according to Cassidy et al. (2014) 99% of the students had access to Internet at home. The results also indicated that most of the students watch online videos, which come in line with what was in the same research of Cassidy, et al. above in which 98.8% of the students ranked YouTube as the most popular technology.

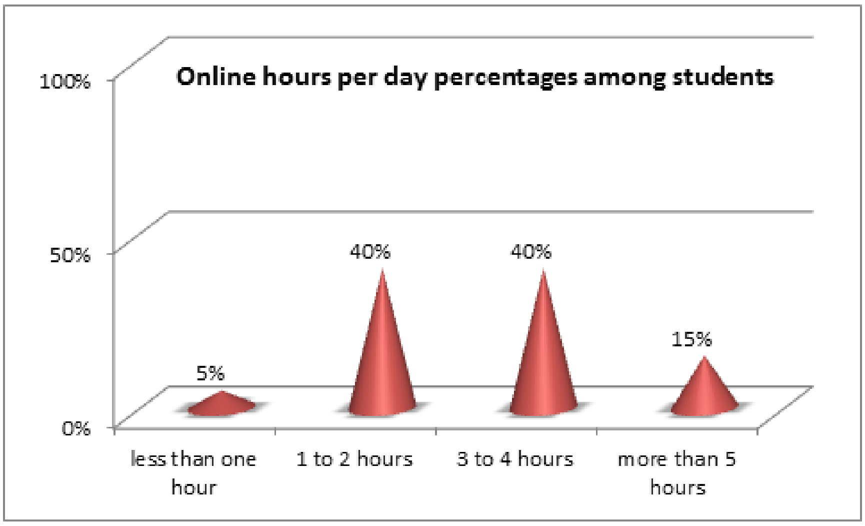

Figure 2: Students' Usage of Internet per Day

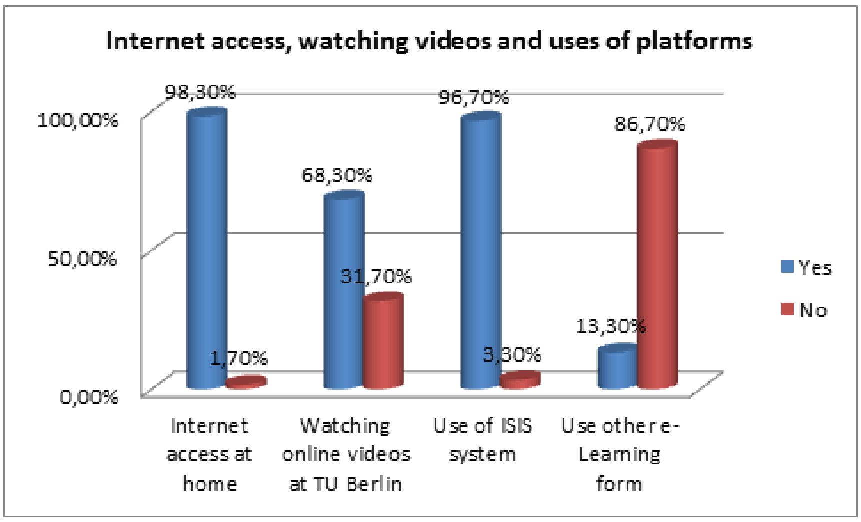

Figure 2: Students' Access and Uses of Internet

Students expressed positive views regarding technologies. If we add the agree and totally agree percentages, best results go to the use of online videos as support for students' studies, the first and last statements in figure 3, explains this results since many students think that those videos and illustrations have helped them to better understand chemistry topics. The best totally agrees result shows that students, despite their heavy use of digital technologies, still tend to prefer face-to-face interactions with their colleagues when compared to online interaction.

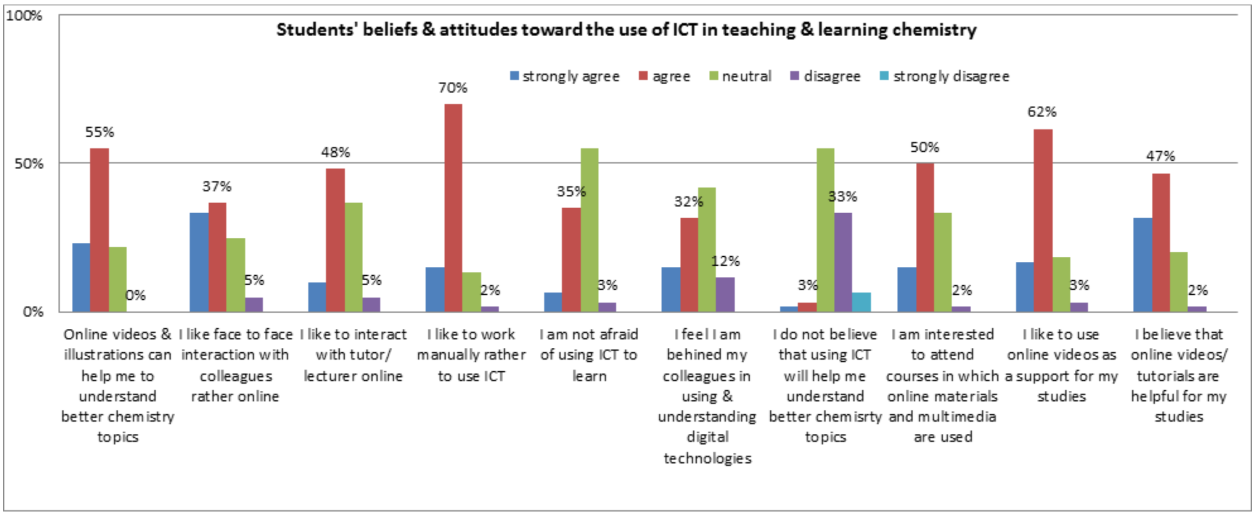

Figure 3: Students' Attitudes toward Educational Uses of Technologies

The results of the focus group interviews confirmed the positive role of the online videos *"...gut gemacht, man kann gut folgen..., praktisch*", even more students mentioned examples how those videos where of benefit when they missed their tutorials. One of the examples, students who were sick found the videos helpful as sources for learning *"... weil ich den einen Tag Krank gewesen bin, habe ich die Videos angeguckt, es war hilfreich…*" The content of the videos and how it was delivered affected evaluations of those videos. Students found those videos more helpful when their content was easy. When the level of difficulty/complexity of the videos' content increased, students lost their interest to watch them".

Students indicated that the use of videos made the tutorials more effective and quicker. This was very beneficial, especially that the students are under big study load form other courses "*Man macht echt richtig alles schneller*", "*weil es erstens schneller geht und man effektiver in einem kuerzeren Zeitraum die Sachen verstehen kann*". Many students used the online videos for preparation for the tests and found them of great value in this regard "*Ich denk mal die Videos sind auch richtig praktisch vor der Klausur, wennn man da eine Menge Stoff hatte, und man anfaengt und dann die ersten Aufgaben nicht mehr Weiss, dass man da vielleicht nochmal sich die anschauen kann*"

Many students rated highly the new format of (inverted targeted) tutorial. Students studied at home through the online videos and when they come to the face-to-face tutorial they worked in small groups on solving problems and getting deeper understanding of the materials "*…das ist das beste Tutorial dass ich gehabt habe, weil wir zu Hause die Videos angeschaut und dann arbeiten wir in kleinere Gruppen zusammen…*". Some students mentioned that they prefer the traditional way of the tutorials and felt that inverted form of tutorials sometimes represented a repetition for the materials and felt more confident when the tutor explained in face-to-face the mathematical solutions of the problems. They mentioned the huge traffic of emails and that many of them should not be published to all students on the portal, especially the answers to students' questions that should not be also important for the others.

In general, the students tend to advise their colleagues to attend courses of similar targeted-inverted format because of the high online support they receive by tutors more than in other similar courses.

CONCLUSION

Inverted classroom represents a promising pedagogy in Higher Education. It represents a response to the changing characteristics of the new generations of the students who rely more and more on digital technologies. Results of this research confirmed the benefits of using online videos that helped students not only to prepare for their tutorials but also for their exams; they overcome the limitations of time and place and provided more time for active learning and applications during the face-to-face tutorials. At the same time, some students expressed their uncertainties regarding the new form of pedagogy but nearly all of them like to have technology supporting lectures and tutorials but substituting them. Further exploration of this inverted approach is needed to other topics and other contexts as well as evaluation of this model from tutors/ teachers' perspectives.

RECOMMENDATIONS

The positive evaluation of the inverted-model of the tutorials suggests that it has the potential to enhance the quality of chemistry and math education at the university level. Those results recommend using more online learning resources like videos combined active learning applications. Results also recommend the blended model and not the total substitution of face-to-face interaction by online videos. In addition, extension of model implementation and evaluation to other courses, topics and contexts in higher education is recommended. This is important to uncover new advantages and/ or limitations of the targeted-inverted classroom model.

REFERENCES

Aljanazrah, A.M. (2006). *Development, implementation and evaluation of a new chemistry teacher in-service training model based on Blended Learning*, Shaker Verlag

Ally, M. (2004). *Foundations of educational theory for online learning.* In: Anderson T., Elloumi, F. (Eds.) Theory and practice of online learning, Athabasca University, pp. 1-31

Baker, J. W. (2000). The “Classroom Flip”: Using web course management tools to become the guide by the *side. In J. A. Chambers (Ed.), Selected papers from the 11th International Conference on College Teaching and Learning (pp. 9-17). Jacksonville, FL: Florida Community College at Jacksonville.*

Berrett, D. (2012). How 'flipping' the classroom can improve the traditional lecture. The chronicle of higher education, 12.

Brecht, H.D. (2012) Learning from Online Video Lectures, Journal of Information Technology Education: Innovations in Practice, 11.

Cassidy, E. et al., (2014) Higher Education and Emerging Technologies: Shifting Trends in Students’ Usage, *The Journal of Academmic Librarianship* 40, pp. 124-133

Gabel, D., Improving teaching and learning through chemistry education research: a look to the future. Journal of Chemical Education, 1999. 76 (4): p. 548-554

Gellespie, R. (1997) The great ideas of chemistry. J*ournal of Chemical Education*, 74 (7), p. 862.

Guy, R., & Marquis, G. (2016). The flipped classroom: A comparison of student performance using instruc-tional videos and podcasts versus the lecture-based model of instruction. *Issues in Informing Science and Information Technology*, 13, 1-13. Retrieved from http://www.informingscience.org/Publications/3461

He, Y., Swenson, S., & Lents, N. (2012). Online video tutorials increase learning of difficult concepts in an undergraduate analytical chemistry course. *Journal of Chemical Education, 89*, 1128-1132.

Law, N., & Chow, A. (2008). Pedagogical orientations in mathematics and science and the use of ICT. In N. Law, W. J. Pelgrum, & T. Plomp (Eds.), *Pedagogy and ICT use in schools around the world:Findings from the IEA SITES 2006 study (pp. 121–179).* Hong Kong: CERC and Springer.

Lee, S. et al. (2011) Internet-Based Science Learning: A review of Journal Publications. *International Journal of Science Education* 33(14) pp. 1893-1925

Robinson, W. (2004). Cognitive theory and the design of multimedia instruction. Journal of Chemical Education, 81(1), 10–12.

Scheible, A., *Ist unser Chemieunterricht noch zeitgemäß?* MNU, 1969. 22 (8): p. 449

Schmitt, F.J. et. al. (2015): *Targeted inversion, a case study*. Global Learn, April 2015 in Berlin, Germany Publisher: Association for the Advancement of Computing in Education (AACE).

Schmitt, F.J., Schönnemann, T., Kruse, F., Egbers, F., Delitzscher, S., Weissenborn, J., Aljanazrah, A. & Friedrich, T. (2015). *Targeted Inversion of the Tutorials in “Mathematics for Chemists”, A Case Study*. In Proceedings of Global Learn Berlin 2015: Global Conference on Learning and Technology (pp. 191-200). Berlin, Germany: Association for the Advancement of Computing in Education (AACE).

Slavin, R., Lake, C., Hanely, P. & Thurston, A. (2014) Experimental Evaluations of Elementary Science Programs: A Best-Evidence Synthesis, *Journal of Research in Science Teaching* 51(7) pp. 870-901

Tucker, B. (2012). The flipped classroom. *Education Next*, 12(1), pp. 82-83.

Zahng, D. et al. (2006) Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. Information & Management 43, pp.15–27.

PRE-SERVICE TEACHERS' TECHNOLOGY INTEGRATION AND THEIR TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPCK)

Feral Ogan-Bekiroglu
Marmara University, Turkey

Ozge Karabuz
Marmara University, Turkey

ABSTRACT: How technology is integrated to the lessons is important because what is meant by teachers' use of technology varies widely. Therefore, the purposes of this study were to determine pre-service physics teachers' TPCK and to examine their technology integration skills during their practices. Technological pedagogical content knowledge frames this research. The participants of the study were senior pre-service physics. In order to measure the participants' true knowledge, ability, and practice about TPCK, data were collected by using mixed-methods including observations, lesson plans, and interviews. Results of this study conclude that pre-service physics teachers can reflect technology integration to their practices more successfully than to their lesson plans. They can behave like an expert while using CBL technology in their teaching. Although they know how to use technology effectively, some of them need to improve their knowledge and realize that technology is not a vitamin whose mere presence catalyzes better educational outcomes. In addition, pre-service physics teachers have high level TPCK; hence, they have tendency to use technology and have a coherent knowledge about technology, pedagogy and content. This study suggests that various technologies should be introduced in teacher education programs and teacher candidates should use these technologies as tools to gain progress in advancing their TPCK.

Keywords: Pre-service teachers, TPCK, Technology integration.

INTRODUCTION

Technology has begun to take a crucial role in education; therefore, there has been substantial investment on technological tools in order to integrate technology to the science teaching. However, how technology is integrated to the lessons is important because what is meant by teachers' use of technology varies widely (Bebell, Russell & O'Dwyer, 2004). According to Inan and Lowther (2010), technology integration can be grouped into following three broad categories;

- Technology for instructional preparation,
- Technology for instructional delivery,
- Technology as a learning tool.

Teachers use technology for preparing instructional documents and some materials, or making lesson plans. When technology is used for instructional delivery, the students or teachers can use it during the class. Teachers may present instruction of the lecture through a projector or via power point presentation or students may use computer applications such as simulations or animations. The third category, technology as a tool, contains usage of basic software; such as Micro-Computer Based Laboratory (MBL) and Calculator Based Laboratory (CBL) (Inan & Lowther, 2010).

Teachers should have necessary training about technology usage. The lack of teachers' technology integration skills has an important effect on frequency usage of technological equipment in lessons (Palak, 2004). Besides, even though schools have enough technology, it is observed that these opportunities cannot support the improvement in science teaching (Lawther, Inan, Strahl & Ross, 2008). Therefore, the purposes of this study were to determine pre-service physics teachers' TPCK and to examine their technology integration skills during their practices.

THEORETICAL FRAMEWORK

Theories, frameworks, or models can be seen as conceptual lenses through which to view the world. Technological pedagogical content knowledge frames this research.

Using technology in learning process requires teacher competences in technology. To be successful, the new technologies call for the use of advanced pedagogies. Teachers should need to have a coherent knowledge about technology, pedagogy and content. Hence, the understanding of relationship between three components of knowledge is an important point in order to integrate technology to the lesson effectively. Technological Pedagogical Content Knowledge, known as TPCK or TPACK, has become theoretical framework of teacher knowledge for technology integration. TPCK framework allows us to make sense of the complex web of relationships that exist when teachers attempt to apply technology to the teaching of subject matter (Mishra & Koehler, 2006). In recent years, researchers described TPCK within Schulman's (1987, 1986) framework description of Pedagogical Content Knowledge (PCK). TPCK is an extension of PCK and is achieved when a teacher knows (Graham and others, 2004);

1) How technological tools transform pedagogical strategies and content representations for teaching particular topics,
2) How technology tools and representations impact a student's understanding of these topics.

According to Koehler and Mishra (2008), TPCK has three components: PCK, TPK (Technological Pedagogical Knowledge) and TCK (Technological Content Knowledge). PCK is the connection and relation of pedagogy and content knowledge. TPK represents the integration of technology with general pedagogical strategies. It is related to engage students with technology effectively in the learning process. TCK represents knowledge of technological tools that are used by teachers within content. Consequently, TPCK, that is center of the model, represents the usage of technology to provide content and pedagogical strategies (see Figure 1).

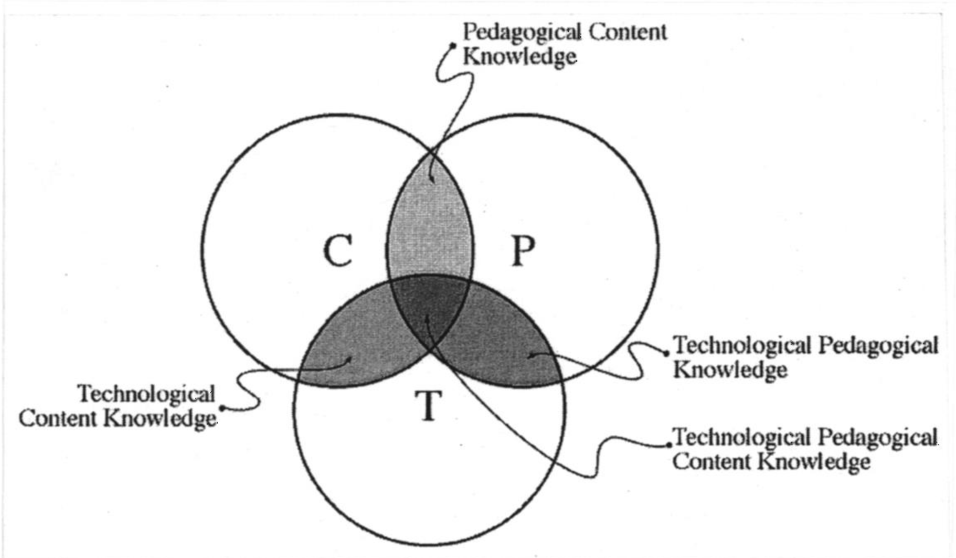

Figure 1. Koehler and Mishra's (2008) components of Technological Pedagogical Content Knowledge

TPCK approach is not completely new. Knowledge about technology cannot be treated as context-free and that good teaching requires an understanding of how technology relates to the pedagogy and content (Alayyar, Fisser and Voogt, 2012).

LITERATURE REVIEW ON TPCK AND TECHNOLOGY INTEGRATION

Teachers must not focus on the technology itself, but rather on the learning outcome that is supported by technology (Millen, 2015). Teachers' knowledge to integrate content, pedagogy and technology has become important. As a result, a quite number of studies have been focused on to examine how teachers and teacher candidates integrate technology into their teaching and to determine their TPCK.

For example, Archambault and Crippen (2009) performed a study which examined a national sample of 596 K-12 online teachers and measures their knowledge with respect to three key domains as described by the TPCK framework: technology, pedagogy, content, and the combination of each of these areas. Findings indicated that knowledge ratings were the highest among the domains of pedagogy, content, and pedagogical content, indicating that responding online teachers felt very good about their knowledge related to these domains and were less confident when it came to technology (Archambault & Crippen, 2009).

Forssell (2011) explored the relationship of accomplished teachers' TPCK confidence to their use of technology with students and to their teaching and learning contexts. The analyses focused on the responses to an online survey by 307 teachers. Analyses showed that these accomplished teachers' confidence in their knowledge of how to use new technologies for teaching was different from their confidence in using technologies more generally. Further, TPCK confidence related to student use of computers in the classroom (Forssell, 2011).

Jang and Tsai (2013) explored TPCK of 1210 secondary school science teachers using a new contextualized TPCK model. The results indicated that experienced science teachers tended to rate their content knowledge and pedagogical content knowledge in context (PCKCx) significantly higher than did novice science teachers. However, science teachers with less teaching experience tended to rate their technology knowledge and technological content knowledge in context (TPCKCx) significantly higher than did teachers with more teaching experience (Jang & Tsai, 2013).

Liang, Chai, Koh, Yang and Tsai (2013) applied TPCK survey to explore 366 Taiwanese in-service preschool teachers' technological pedagogical content knowledge. The correlation analyses revealed that more senior preschool teachers might show a certain degree of resistance toward technology-integrated teaching environments and also preschool teachers with higher education qualifications tended to have more knowledge of technology use and ICT integration in their teaching environment namely in the TK and TPCK scales. The scores of the university graduates were significantly higher than those with lower qualifications. The preschool teachers' age was negatively related to the TK and TPCK scales therefore older teachers need continuous professional development activities to help them grow with the advancements of technology (Liang, Chai, Koh, Yang, & Tsai, 2013).

Due to the fact that self-report instruments were used to discover teachers' TPCK in the studies mentioned above, the results might not reflect what TPCK these teachers actually would perform during their practices.

Because confidence in TPCK is different from confidence in using technology more generally, it is important to create opportunities for teachers to learn how new technologies support their specific goals in the grade, subject area, and school context in which they teach (Forssell, 2011). Therefore, Mudzimiri (2012) studied the development of connections between technology, content and pedagogy by using three courses that are offered in collaboration. Five pre-service teachers participated in the research data gathered by TPCK survey, teaching philosophy statements, lesson plans, student teaching episodes, and weekly instructor meeting notes. Results of the study showed that the development of TPCK in pre-service teachers was not the same as the development of TPCK in in-service teachers. Furthermore, there was a mismatch between the enacted TPCK and the self-reported TPCK of the participants. For each participant, the self-reported TPCK scores were higher than enacted and observed TPCK behaviors. Results of this study suggested that TPCK could be influenced by the grade level or type of curriculum and whether the lessons were developed by a group of teachers or by individual teachers (Mudzimiri, 2012).

In a study performed with 82 graduate teacher education students to investigate their knowledge and practice of teaching with technology as well as how that knowledge and practice changes after participation in an educational technology course, significant gains in reported and demonstrated TPCK constructs were found by using mix-methods (Sabo, 2013).

Lowder (2013) developed a teacher education course to support the growth of TPCK among pre-service teachers within a science methods course. The impact of the course and how it might be improved for future semesters were evaluated by doing action research. The course included nine females between the ages of 18 and 34 years old. TPCK surveys, learning activities, and an assessment rubric were used and pre-service teachers were introduced to the TPCK framework in an effort to guide their lesson plan development. The teaching strategies and learning activities that supported TPCK development among the pre-service teachers in the course included assigned readings, videos, specific content resources, scaffolding of class activities, and the introduction of the TPCK lesson plan format. Results showed that the students' TPCK knowledge increased in key TPCK areas (Lowder, 2013).

In a design-based research project, Koh and Divaharan (2013) implemented an instructional process to facilitate pre-service teachers' TPCK development as they learn to integrate information and communication technology (ICT), specifically interactive whiteboard (IWB), in their teaching content subjects. The courses provided them with opportunities to explore the pedagogical uses of ICT tools. The findings revealed that strategies such as tutor modelling and hands-on exploration of ICT tools appeared to be more advantageous for fostering technological knowledge and technological pedagogical knowledge (Koh & Divaharan, 2013).

Some research investigated teachers' technology integration. For instance, Inan and Lowther (2010) pointed out the direct and indirect effects of 1382 teachers' individual characteristics and perceptions of environmental factors that influence their technology integration into classrooms. They presented that teachers' demographic characteristics such as years of teaching and age affect their computer proficiency. Teachers' demographic characteristics negatively and teachers' computer proficiency positively affected their technology integration. Furthermore, teachers' beliefs and readiness and school-level factors such as availability of computers and technical support positively influenced teachers' technology integration. Moreover, teachers' beliefs and readiness mediated the indirect effects of school and teacher level factors on teachers' technology integration (Inan & Lowther, 2010).

In a case study research done by Stoilescu (2011), three teachers over 10 years of experience in teaching mathematics in secondary schools at an urban public school were observed in their classrooms and interviewed about their experiences of teaching mathematics and integrating computer technology in their day-to-day activities. Although teachers displayed a high degree of integration of technology, they had difficulties in purchasing and maintaining the computer equipment. They had some difficulties in trying to integrate new technologies as these required time, preparation, and dedication (Stoilescu, 2011).

The review of research on TPCK suggests that more research is needed to explore how science teachers integrate specific technology in their teaching practices by collecting data from various methods including observing and interviewing.

PURPOSES OF THE STUDY

Assessing TPCK requires focus on a specific technology using in a particular context and in support of a clear set of curricular objectives, and it will require some measure of teachers' PCK as well (Forssell, 2011). Thus, the research questions put a light on this study are as follows:

1. What is pre-service physics teachers' technological pedagogical content knowledge?
2. How do pre-service physics teachers integrate calculator-based laboratory (CBL) technology into their practices?

METHODOLOGY

Case study design (Stake, 1995) was guided to the research. The participants of the study were 10 senior pre-service physics teachers, three of whom were male. In the previous semester, they had learned the fundamental learning and teaching theories related to physics education in K-12 settings through readings, explicit teaching and activities, and they had designed and implemented a lesson plan based on the constructivist philosophy. Science teachers could develop their TPCK through using technological tools in science teaching (Jang & Tsai, 2013). Therefore, the participants enrolled in a course titled as "Technology Integration in Physics Teaching". One of the researchers was the instructor of the course. Since teaching with technology requires complex skills and understandings, the participants had opportunity to learn and integrate Calculator-Based Laboratory (CBL) technology into teaching of various physics subjects in this course. Then, they again designed and implemented a lesson plan about the same physics concepts they got prepared in the previous semester. However, this time they were required to use the CBL technology in their practices. The CBL system is a portable, handheld, battery-operated data collection device for gathering real-world data with the help of sensors. Data collected with a CBL device can be retrieved and analyzed by graphing calculators. Before starting to implementation, the participants' CBL knowledge and skills were measured to make sure that all the participants learned this technology. The participants were given a list consisting of the physics concepts measured by using CBL sensors and they chose the concept they would teach from the list. Pseudonyms names of the participants and the concepts are presented in Table 1.

According to Forssell (2011), surveys have limitation because they involve the reference points used by respondents to rate their own knowledge. Consequently, the degree to which teachers agree with statements in the TPCK confidence scale may depend on their perception of the abilities of others. Interviews and observations may allow us to surface evidence of pedagogical content knowledge, and to understand how teachers see the relationship between technology and PCK (Forssell, 2011). On the other hand, lesson plans scored with a rubric are a suitable proxy for teacher practice, but do not replace observations of teacher behavior in the classroom (Sabo, 2013). For that reason, in order to measure the participants' true knowledge, ability, and practice about TPCK, data were collected by using mixed-methods including observations, lesson plans, and interviews.

Table 1. Participants and The Concepts They Thought

Name of the participant	Concepts
P-1	Heat and temperature
P-2	Polarization of light
P-3	Waves
P-4	Alternative current
P-5	Energy
P-6	Momentum and collisions
P-7	Motion in an inclined plane
P-8	Colors
P-9	Capacitor
P-10	Spring pendulum

The pre-service physics teachers' skills while they were integrating the CBL technology into their teaching were observed by two researchers. Science Classroom Observation Rubric (SCOR) developed by Burry-Stock and Oxford (1994) was filled out by the researchers separately for each participant. A constructivist, student-centered perspectives underlies SCOR. The four categories that form the SCOR are facilitating the learning process with the help of constructivist approach, content specific pedagogy, contextual knowledge, and content knowledge. The rubric is based on the following 18 criteria each has a rating score from 1 to 5:

- Teacher as a facilitator (C1)
- Engagement of students to the activities in classroom (C2)
- Attending of the students to the experiences (C3)
- Innovation (C4)
- Frequency of textbook usage (C5)
- Conceptual understanding of students (C6)
- Interest of students to the lesson (C7)
- Variability of teaching methods (C8)
- The capability of the students' high-level understandings (C9)
- The integration of content and process skills (C10)
- The relationship between concepts and evidence (C11)
- Dissolution of misconceptions (C12)
- The relationship between teacher and students (C13)
- The change in teaching methods in order to facilitate understanding (C14)
- The usage of model and metaphor (C15)
- The consistency of lesson (C16)
- The balance of depth and content of lesson (C17)
- Accuracy of content (C18).

Another data source was the pre-service physics teachers' lesson plans they prepared in detail. Moreover, interviews were conducted with the participants just after their practices to understand their thoughts about technology integration and to evaluate their practices. They were asked how they integrated the CBL technology in their practices, what else they would have done during their practices, how they preferred to use technology in their teaching, and what they could do to provide students for reaching and producing knowledge while using technology. The interviews were done in the researcher's office and lasted 10-15 minutes.

The highest score one can get from SCOR is 90. Mean values of SCOR's scores given by two researchers were calculated for each criterion. Internal consistency computed by Cronbach's Alpha formula was high, with reliability coefficient of .91. The researchers of this study compared their scores and were able to reach 92% agreement. The reliability measured by Cohen's κ was .80. There seems to be general agreement that Cohen's κ value should be at least 0.60 or 0.70 (Wood, 2007). Consequently, the coding done for the participants' skills had adequate reliability. Five-point scoring rubric was created by the researchers to analyze the participants' lesson plans. Some of the items in the rubric are:

- Identification of lesson objectives correctly,
- Determination of appropriate technology for the purpose of the lesson,
- Integration of technology in accordance with constructivist approach,
- Specifically writing of the questions asked during the lesson and their answers.
- Having Plan B in case of any technology inconveniency.

One more five-point rubric was generated to analyze transcripts gathered from the interviews. The rationale behind the rubric was integrating and using technology as a tool consistently with the constructivist approach. The following items can be given as examples from the rubric:

- Technology is a tool for learning by doing hands on science,
- Technology is used to provide students for showing their understanding,
- Technology is used to increase students' thinking by providing social constructivist environment,
- Technology is a tool to help students construct hypothesis,
- Technology is used to help students give scientific explanations.

The pre-service physics teachers' TPCK was determined by calculating the mean of the mean values of their scores collected from the five-point rubrics used for SCOR, lesson plans, and interviews and labeled based on the differentiation given in Table 2.

Table 2. Categories for The Participants' TPCK Based on The Mean Values

Mean	Category
1 - 2	Needs improvement
2,01 - 3	Medium
3,01 - 4	Good
4,01 - 5	Sophisticated

RESULTS AND DISCUSSION

Table 3 shows the mean scores of the pre-service teachers' teaching practices given by two researchers while they were using technology. The columns in the table illustrate the criteria of SCOR. High scores represent that the pre-service physics teachers could integrate the CBL technology in their practices successfully. Relationship between teacher and students (C13) was the skill that all the participants got the highest score. This skill was under the contextual knowledge category. The teacher candidates established a good relationship with their students and did not make any discrimination among them. All the participants, apart from P-3, were accomplished the Criterion 5, frequency of textbook usage (C5). That is, the pre-service physics teachers' practices did not depend on textbooks and they prepared their materials and worksheets by considering the students' needs. The reason for this finding is that CBL applications were not part of the curriculum and the participants had to become creative in their preparations. Criterion 5 was under the category of facilitating the learning process with the help of constructivist approach. On the other hand, the participants got the lowest scores in the criteria of dissolution of misconceptions (C12) and change in teaching methods in order to facilitate understanding (C14), both of whom were under the category of contextual knowledge. Their scores in these skills were good but not sophisticated. When students' misconceptions came out, the teacher candidates could almost resolve them by promoting discussions among the students and encouraging to collect evidence. Additionally, the pre-service teachers were generally aware of students' understanding and made changes in their practices if it was necessary.

Table 3. Mean Scores of The Pre-Service Teachers' Teaching Practices

	Criteria of SCOR																	
P	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**
P-1	4	4	5	5	5	4	5	4	4	4	3	4	5	3	5	4	4	4
P-2	3	4	4	3	5	3	3	3	3	4	3	3	5	4	4	4	4	4
P-3	4	3	4	4	4	4	4	4	4	5	4	3	5	3	4	4	3	4
P-4	4	4	4	5	5	4	5	5	3	5	5	3	5	3	5	4	5	5
P-5	4	4	5	4	5	4	5	4	5	5	5	4	5	4	4	4	5	5
P-6	5	4	5	5	5	5	5	5	4	5	5	4	5	5	5	5	5	5

P-7	4	4	5	4	5	4	3	3	3	4	4	3	5	3	3	4	5	4
P-8	4	2	5	3	5	4	3	4	4	5	4	3	5	3	5	4	5	5
P-9	5	5	5	5	5	5	5	5	4	5	5	4	5	4	5	5	5	5
P-10	4	4	4	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5

To sum, role of the teacher was facilitator by providing students more active participation in the learning process and the class environment was suitable with student-centered teaching when the CBL technology was integrated into the lesson. These results were similar with the result revealed by Wetzel (2001), who found that technology had positive influence on pre-service teachers' practices positively.

Table 4 demonstrates the participants' TPCK levels and their levels in knowledge about technology integration, lesson plans, and technology integration skills. According to the table, a half of the participants sophisticatedly knew how to use technology as a tool in the constructivist approach. However, P-6 and P-9 needed to improve their knowledge in this issue. P-6 could not distinct the difference between using technology according to student-center strategies and teacher-centered strategies. P-9 thought that if there was technology in the instruction in one way or other, the instruction was already congruent with constructivism. 70% of the participants prepared either good or sophisticated lesson plans. Some of them had difficulties in reflecting technology integration to their lesson plans. They could allocate the time necessary for the activities. Nevertheless, they neither considered time loss due to technology settings nor paid attention to the time spent for student applications with CBL. Moreover, a few of them (P-5, P-5, and P-7) did not specified any teaching methods and did not mention how to assess students.

Except for P-7's practice, all the participants' teaching skills were sophisticated while using technology. The participants made demos by themselves before real application of the CBL technology with the students. They started their practices with a short summary of what they would do, following that they divided the students into groups and distributed the worksheets. Then, they encouraged the students to work in groups, collect data and reach conclusions. Sometimes they demonstrated the experiments to the students if it was necessary. The pre-service physics teachers could provide active student participation by using the CBL technology, facilitate learning, apply content specific pedagogy and have both contextual and content knowledge. The reason of the participants' sophisticated skills might be their familiarity with laboratory experiments because they used the CBL technology to do experiments.

Table 4. The Participants' TPCK Levels and Their Levels in Knowledge About Technology Integration, Lesson Plans, And Technology Integration Skills.

Participants	Knowledge about Integration of Technology	Lesson Plan	Technology Integration Skills	TPCK
P-1	Sophisticated	Good	Sophisticated	Sophisticated
P-2	Medium	Good	Sophisticated	Good
P-3	Sophisticated	Sophisticated	Sophisticated	Sophisticated
P-4	Sophisticated	Good	Sophisticated	Sophisticated
P-5	Sophisticated	Medium	Sophisticated	Good
P-6	Needs improvement	Medium	Sophisticated	Medium
P-7	Medium	Medium	Good	Medium
P-8	Good	Sophisticated	Sophisticated	Sophisticated
P-9	Needs improvement	Good	Sophisticated	Good
P-10	Sophisticated	Good	Sophisticated	Sophisticated

While a half of the participants had sophisticated TPCK, 30 % of the participants' TPCK had in good level. These high levels illustrate that the pre-service physics teachers had tendency to use technology and did not struggle to integrate technology into their practices. While they were using technology, they felt sure of themselves and had self-efficacy. Therefore, they could promote constructivist learning environment. Teachers having sophisticated TPCK choose and apply student centered teaching strategies (Niess, 2005) and explore a greater breadth of activities related to 21st century skills with their students (Forssell, 2011). Archambault and Crippen (2009) and Tokmak, Yelken and Konokman (2012) also revealed high TPCK among teachers in their studies.

TPCK is a dynamic concept. Context influences both teacher knowledge and practice, teacher knowledge influences practice, and practice influences which types of knowledge are used more in the classroom (Doering, Miller, Scharber, & Veletsianos, 2009). Moreover, the knowledge needed to effectively use technology to support student learning varies greatly depending on the students' developmental stage, the subject and topic being taught, and the technological tool being used (Forssell, 2011). Therefore, the results of this study may not be obtained if different technology is used and the participants teach different concepts.

CONCLUSIONS AND SUGGESTIONS

Teachers must not focus on the technology itself, but rather on the learning outcome that is supported by technology (Millen & Gable, 2016). Students' learning may depend on teachers' TPCK. Accordingly, this study explored pre-service teachers' TPCK. Research suggests that disappointing outcomes are frequently associated with lack of the necessary teachers' skills to integrate technology into their classes (Russell, Bebell, & O'Dwyer, 2003; Van Braak, 2001). By taking this suggestion into account, pre-service teachers' technology integration was also examined in this research.

Results of this study conclude that pre-service physics teachers can reflect technology integration to their practices more successfully than to their lesson plans. They can behave like an expert while using CBL technology in their teaching. Although they know how to use technology effectively, some of them need to improve their knowledge and realize that technology is not a 'vitamin' whose mere presence catalyzes better educational outcomes (Dede, 2001). In addition, pre-service physics teachers have high level TPCK; hence, they have tendency to use technology and have a coherent knowledge about technology, pedagogy and content.

Using technology might stimulate teachers' confidence and self-efficacy, so that they become more successful in their teaching. Future research must expand on this possibility.

There is no single technological solution that applies for every teacher, every course, or every view of teaching (Koehler & Mishra, 2008). The technology used in this study was limited with calculator-based laboratory (CBL). This study suggests that various technologies should be introduced in teacher education programs and teacher candidates should use these technologies as tools to gain progress in advancing their TPCK.

The current study contributes to the field by examining pre-service physics teachers' CBL technology usage in their teaching practices.

REFERENCES

Alayyar, G. M., Fisser, P., & Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service science teachers: Support from blended learning. *Australasian Journal of Educational Technology*, *28*(8), 1298-1316

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, *9*(1), 71-88.

Bebel, D., Russell, M., & O'Dwyer, L. (2004). Measuring teachers' technology uses: Why multiple-measures are more revealing. *International Society for Technology in Education*, *37*(1), 45-63

Burry-Stock, J. A., & Oxford, R.L. (1994). Expert Science Teaching Education Evaluation Model (ESTEEM): Measuring Excellence in Science Teaching for Professional Development. *Journal of Personal Evaluation in Education*, *8*, 267-297.

Dede, C. (2001). Creating research centers to enhance the effective use of learning technologies. *Testimony to the Research Subcommittee, Science Committee, US House of Representatives.* Committee on Science. Harvard University, Cambridge, MA.

Doering, A., Miller, C., Scharber, C., & Veletsianos, G. (2009). Using the technological, pedagogical, and content knowledge framework to design online learning environments and professional development. *Journal of Educational Computing Research*, *41*(3), 319-346.

Forssell, K. S. (2011). *Technological pedagogical content knowledge: Relationships to learning ecologies and social learning networks*. Unpublished doctoral dissertation. Stanford University, Stanford, CA.

Graham, C. R., Burgoyne, N., Cantrell, P., Smith, L., St. Clair, L. & Harris, R. (2009). TPACK development in science teaching: Measuring the TPACK confidence of inservice science teachers. *TechTrends*, *53*(5), 70-79.

Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research Development*, *58*(2), 137–154

Jang, S. J., & Tsai, M. F. (2013). Exploring the TPACK of Taiwanese secondary school science teachers using a new contextualized TPACK model. *Australasian Journal of Educational Technology*, *29*(4), 566-580.

Koehler, M.J., & Mishra, P. (2008). Introducing TPCK. AACTE Committee on Innovation and Technology (Ed.), *The handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 3-29). Mahwah, NJ: Lawrence Erlbaum Associates.

Koh, J. H. L., & Divaharan, S. (2013). Towards a TPACK-fostering ICT instructional process for teachers: Lessons from the implementation of interactive whiteboard instruction. *Australasian Journal of Educational Technology*, *29*(2), 233-247

Lawther, D. L., Inan, F. A., Strahl, J. D., & Ross, S. M. (2008). Does technology integration “work” when key barriers are removed? *Educational Media International*, *45*(3), 195-213

Liang, J. C., Chai, C. S., Koh, J. H. L., Yang, C. J., & Tsai, C. C. (2013). Surveying in-service preschool teachers' technological pedagogical content knowledge. *Australasian Journal of Educational Technology*, *29*(4), 581-594.

Lowder, L. S. (2013). *Building technological pedagogical content knowledge (TPACK) among pre-service teachers in a science methods course using action research*. Unpublished doctoral dissertation. University of Florida, Gainesville, FL.

Millen, R. A. (2015). *Closing the gap between technological and best practice innovations: Teachers' perceived technological pedagogical content knowledge and self-efficacy towards differentiated instruction*. Unpublished doctoral dissertation. Johnson & Wales University, Providence, RI.

Millen, R. A., & Gable, R. (2016). Closing the gap between technological and best practice innovations: TPACK and DI. *K-12 Education*, Paper 33.

Mishra, P., & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge. *Teachers College Record*, *108*(6), 1017-1054.

Mudzimiri, R. (2012). *A study of the development of technological pedagogical content knowledge (TPACK) in pre-service secondary mathematics teachers*. Unpublished doctoral dissertation. Montana State University, Bozeman, MT.

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, *21*, 509 -523.

Palak, D. (2004). *Teachers’ Beliefs in Relation to Their Instructional Technology Practices*. Unpublished doctoral dissertation. West Virginia University, Morgantown, WV.

Russell, M., Bebell, D. & O’Dwyer, L., (2004). Measuring teachers’ technology uses: Why multiple-measures are more revealing. *Journal of Research on Technology in Education*, *37*(1), 45-63.

Sabo, K. (2013). *A mixed-methods examination of influences on the shape and malleability of technological pedagogical content knowledge (TPACK) in graduate teacher education students.* Unpublished doctoral dissertation. Arizona State University, Phoenix, AZ

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1-22.

Stake, R. (1995). *The art of case-study research*. Thousand Oaks, CA: Sage

Stoilescu, D. (2011). *Technological pedagogical content knowledge: Secondary school mathematics teachers’ use of technology.* Unpublished doctoral dissertation, University of Toronto, Canada.

Tokmak, T. S., Yelken, Y. T., & Konokman, Y. G. (2012). Examination of pre-service elementary teachers’ perceptions about TPCK in term of various variables: A case of Mersin University. *Kastamonu Education Journal*, *21*(2). May.

Wetzel, D.R. (2001, June). *A model for Pedagogical and Curricula Transformation with technology*. Paper presented at National Educational Computing Conference, “Building on the Future”, Chicago, IL.

Wood, J. M. (2007). *Understanding and computing Cohen’s Kappa: A tutorial*. WebPsychEmpiricist. Available from http://wpe.info/papers_table.html. Accessed 3 October 2007

Van Braak, J. (2001). Individual characteristics influencing teachers’ class use of computers. *Journal of Educational Computing Research, 25*(2), 141–157.

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ISBN 978-605679512-1

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