New Trends in Science Education within the 21st Century Skills Perspective

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Introduction

Today, we are facing more problems in real world that we live. These problems can be illustrated such as climate change, new terminal diseases, natural disasters and so on. To be able to solve those mentioned problems we must firstly know our World. Science and science education makes this possible for people. Human meets science when he/she is born. At that time his/her lungs fill with Oxygen and starts to cry. As it can be understood from this scientific event we are not strangers to science. Herein a question is very significant to be learnt science in 21st century. Many indications show us students science knowledge's level. For instance Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) results give us deep information about countries' level in the scope of science education. The PISA examines what students know in reading, mathematics and science, and what they can do with what they know. OECD (2019), science score mean is 489 in PISA 2018. According to the results is found in 2018 PISA shows us that 14 OECD countries' science scores mean is under OECD average. While some countries are successful in science education, most are not. TIMSS (2015), science achievement results are reported as average scores and distributions on the fourth and eighth grade science achievement scales. Within this context, 33 countries' science score means is under 500 (centerpoint) for fourth grade among 47 countries and 20 countries' science score means is under 500 (centerpoint) for eight grade among 47 countries. The most important questions which should be answered is that are ~~our~~ schools adequately prepared to educate students for future challenges? Besides this it can be argued that many students are not able to access to high quality science education they need. Becuase during Covid pandemic crises many students are not able to Access to face to face education. United Nation (2020), the Covid-19 pandemic created the largest disruption of education systems in history, affecting nearly 1.6 billion students in more than 190 countries. Closures of schools impacted 94 per-cent of the world's student population, up to 99 per cent in low and lower-middle income countries. It implies many students from both poor and developing countries can not acess to the educaion. This result show us the importance of 21st century teaching tools for successful science education. With the effect of technology and engineering science is making progress everyday.

21st Century Skills and Science Education

Education systems have been changin in accordance with the changes in science and its disciplines. The Partnership for 21st Century Skills (2011), defines 21st century's skills as criticial thinking, collaborating, communication, and creativity. National Research Council (2010), defines as they are nonroutine problem solving, self-development, systematic thinking, adaptability and complex communication skills. İdin (2018), adds innovation, employability and efficient team working within the scope of 21st century's skills.

Today, we have been talking about Industry 4.0. and it can be thought as smart industry since its philosophy. İdin (2018), its elements are big data and analytics, autonomous robots, simulation, horizontal vertical system integration, additive manufacturing, augmented reality, the cloud, the industrial internet of things and cyber-security. These elements are seen that they are directly related to technology and to be able to achieve succsess in those fields 21st century skills are mcu more paid attention. World Economic Forum (2020a), states that technological change is happening faster than before. According to a research if it is right, in 2022 while the rate of automation looks like 42% (human workforce will be %58) and in in 2025 it will be 52% (human workforce will be %48) of total workforce.

Saavedra & Opfer (2012), summarize the science of learning as it relates to teaching and learning 21st century skills and suggested general courses that other education systems may apply to move toward similar outcomes. These are *make it relevant, teach through the disciplines, simultaneously develop lower- and higher-order thinking skills, encourage transfer of learning, teach students to learn to learn, address misunderstandings directly, understand that teamwork is an outcome and promotes learning, exploit technology to support learning and foster students' creativity.*

World Economic Forum (2020b), states that there have been similarities across industries when looking at increasingly strategic and increasingly redundant job roles. It also estimates that by 2025, 85 million jobs might be displaced by a change in the division of labour between humans and machines. 97 million new roles may emerge that are more adapted to the new division of labour between humans, machines and algorithms. It is also seen that those given jobs are directly related with Industry 4.0 fields and STEM, as well. Those given jobs are needed to work in collaboration efficiently when a problem occurs. In a efficient team working it is able to create a solution of a problem. Because it is not so easy to find a solution by a just person in 21st century. Systems, machines, content of them are not simple today. These reasons take us to think much more about 21st century skills.

Efficient Science Teaching and Learning Methods within Trends in 21st Century

There have been using some kind of educational teaching and learning methods and techniqs. Four of them is given here: Problem solving based learning, Project based learning, Inquiry based learning and STEM Education. Kyza et al (2014) state that there has been widely distributed interest in the development of innovative inquiry learning materials to answer to societal demands and improve the learning of science. Lin, Lin, Potvin & Tsai (2019) revealed that STEM Education is one of gradually emphasised educational approaches.

Problem Solving Based Learning: One of the most significant method is Problem solving Based Learning Approach which is first applied in case W. University Medical Shool in US in the 1950s. Aydoğdu (2003) Then, nearly thirty years ago, it was started to be practiced in a remarkablem few medical schools. Problem-solving learning constitutes one of the most important applications of constructivist learning environments. It is thought as a strong classroom process that motivates students in defining the problem, directs them to research concepts, provides a collaborative work environment, increases communication skills, uses real-world problems, and a strategy that supports lifelong learning habits. Problem-based teaching strategy; It is a whole that includes educational strategies that include problem solving, research and event-based learning. The important thing in all of these different strategies is that students who are in the process of answering some questions and solving some problems are successful.

Project Based Learning: Project Based Learning (PBL) is a typical of collaborative, inquiry-based learning, engagement of students and PBL enables students work together ro resolve a given problem create a product and later assess both Project output and the process (Loyens, Kirschner & Paas, 2010; Kokotsaki, Menzies & Wiggins, 2016; Thomas, 2000, Tsybulsky & Muchnik- Rozanov, 2019).

Inquiry Based Learning; Some terms are used to identif inquiry based learning including enquiry-based learning, guided-inquiry, problem- based learning, undergraduate research and research-based teaching Spronken-Smith & Walker (2010). The basic content of an inquiry based learning approach can be given below (e.g. Justice et al. 2007; Kahn and O'Rourke 2004; Weaver 1989): Learning is stimulated bu inquiry, student centered, active research and involving learning by doing, learning is supported by previous learning and a move to self-directed learninn with learners having more responsibility for their learning process.

STEM Education; STEM education has been mentioned since 2000s first ten years. It is seen that there can be given some STEM explanations. Gonzales and Kuenzi (2012), states that the term (STEM Education) refers to teaching and learning in the fields of science, technology, engineering, and mathematics. Isabelle and Valle (2016) state that

STEM are viewed as separate domains of knowledge, connected together mainly for the role they play in the job market of the 21st century global world.

Akerson (2018) states that teachers would need to know the natures of the disciplines they are to teach. But if they haven't been successful in the past in helping teachers better conceptualize nature of science, as well as teach it, how can we help them better conceptualize all four disciplines, plus the connections among them, and then teach these ideas to students? These points are cticital to teach STEM to the students.

At thi point, Bybee's (2013) some suggestions of STEM definition can be seen which are given below:

- Knowledge, attitudes, and skills to identify questions and real World problems and to explain evidence-based results about STEM based issues.
- Understanding of the fundamental features of STEM disciplines
- Awareness of how STEM disciplines shape our material, intellectual, and cultural environments
- Voluntarily engage in STEM issues in accordance with 21st centruy skills.

It is necessary to mention the relationship between STEM Education and twenty-first century skills in revealing the future of science education. The relationship between STEM Education and 21st century skills is given in a model created by İdin (2018) at Figure 1.

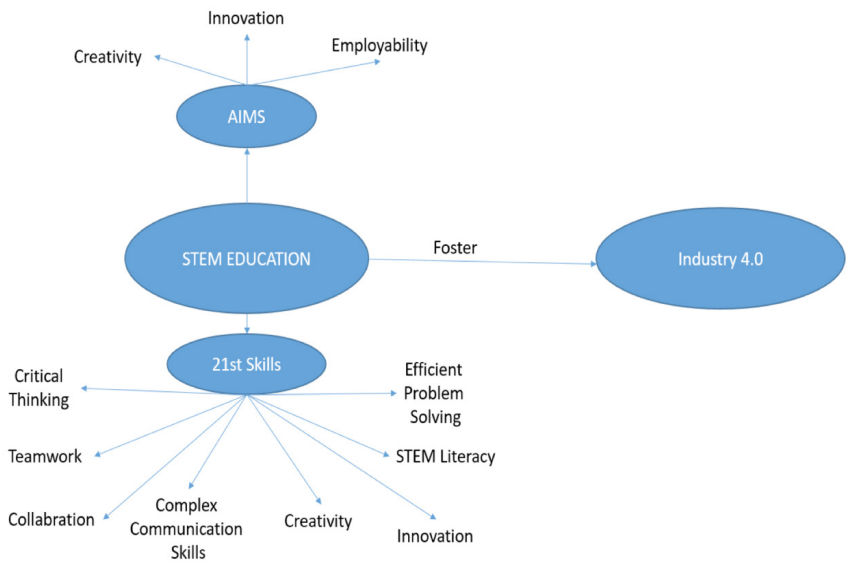

Figure 1. The relationship between STEM Education and 21st Century Skills

In the model, it can easily be seen that STEM Education and 21st century skills are connected to each other and foster themselves.

Science Education in 21st Century

These sections are given under experiments, technology based apps and distance teaching strategies.

Experiments: From Face to Face to Online

Science experiments are significant for learning science in science courses. Students learn science process skills via science experiments in laboraties. NARST (2020), these skills are titled under basic science process skills and integrated science skills. Basic science skills are observing, measuring, classifying, communicating, inferrring, predicting. Integrated science skills are controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting and formulating models. Experiments have been using for decades to teach scientific concepts to students in laboratories. Glass material, microskope, slide, coverslip, cylindir, plant models, DNA model and many concrete tools are used in laboratories during science experiments. To be able to learn science science experiments have much significant. But it is also known that some schools may not have well equipped laboratories since to set up a laboratory can be expensive. In this age we are in, different laboratories are needed. Within this perspective there can be seen some applications have been developed to be used in virtual laboratories during doing science experiments. In this labs virtual and augmented reality issues are mostly used. To illustrate this GO-LAB (2020), can be given as an example. Scientific concepts are taught with this project. Digital interactive experiments from scientific fields (chemistry, biology and physics, engineering, math, technology, astronomy) are implemented by students under guidance by their teachers. Students are able to create chemical reactions by using given matters, measure their weight via digital scales, can formulate the reaction and reveal results.

Students and teachers think themselves as they are in classes while conducting experiments. Both students and teachers must not be at the laboratories while conducting experiments in science course. Augmented and virtual reality based experiments support students within some aspects. Students have more opportunity to access scientific experiments and they must not use dangerous chemical contents.

Technology Based Apps

Recent years, tech based apps are more used in science courses. Specially, in vocational high schools and science centers these apps and applications can be seen in science based courses. 3D printers, CNC machines, robotic tools and apps, augmented reality tech,

electronic programme and the things of internet are some of these. Pedaste, Kori, Maeots & Jong (2016), revealed that how a complex technology-enhanced learning environment should be designed. They found that in students' general inquiry knowledge, transformative inquiry skills, and domain- related knowledge in using a complex technology-enhanced learning environment SCY-Lab. Another technology based learning environment, Future Lab Classrrom (FCL), was created by European School Net. FCL is formed by six different learning spaces (EUN, 2012). Each space highlights specific areas of learning and teaching and helps to rethink different points: physical space, resources, changing roles of student and teacher, and how to support different learning styles with 21st centruy skills via new technology. Many kind of technological equipments are used. Some of them are flip camera, animation software, podcast software, online publication tools, OER content for IWB, Mind-mapping software etc.

In a near future we will see more technological tools in science education for students and teachers. Artificial intelligence and cyber security based apps will be more seen in science education. Students will use their own software while learning science subjects such as physics, chemistry and biology. For instance, some physics issues are really difficult to be learned. Density, force, gravity, mass, buoyant force (Archimeds' principle) can be given to illustate those issues. Students will see all possibilities while learning these issues without having difficulties or less diffilcuties.

Distance Teaching Strategies

Human have been facing many negative situations since its exist. Natural disasters, deseases, wars are some of them. Last of them is Covid-19 which we have been fighting for our health. Because of Covid-19 schools were closed for months and students and teachers could not go to classes. This is the first time that too many students and their teachers were not able to go to their schools for long time. Before Covid pandemic, TV, Youtube and some softwares were already used in science learning but not for millions of people. Herein distance teaching strategies are significant and its tools undertook responsebility. We actually learned that these tools would work or not. These educational applications, platforms and resources aim to help teachers and educators facilitate student learning and interaction during periods of school closure. Zoom, Adobe Connect, Paddle, Edpuzzle, Google meet, Padlet and Flipgrid can be given as examples in which we use in science teaching process. UNESCO (2020), classify these under "digital learning management systems, systems built for use on basic mobile phones, systems with strong offline fuctionality, massive open online course (MOOC) platforms, self directed learning content (Code Week, Code.org Discovery Education, LabExchang etc.) mobile reading applications (StoryWeaver), Collaboration platforms that support live-video communication (Skype, Zoom, Hangouts Meet) and tools for teachers to create of digital learning content (EdPuzzle and Trello)". It is seen that some companies,

institutions created online courses for teachers to support their distance educatino during school clousure. For instance European School Net (2020) creates MOOCs within Project Based Learning, STEM Education. These freee online courses support teachers, who are around European countiries, to enhance their teaching practise. It is important and can be understood from a report by UN (2020), teachers across the globe were largely unprepared to support continuity of learning and adapt to new teaching methodologies in their teaching process. Besides this, it also emphasist that teachers were immediately tasked with implementing distance learning modalities, often without enough guidance, training, or resources. Within the light of all these given tools, it can be saşd that these tools may be efficiently used to get students towards science during school clousere. Scientific content should be prepared in accordance with science and its elements. Within both formal and non-formal science education these apps can be applied to the distance learning.

Conclusion

In 21st century we are in has taught us that we have to awere of technology and its use in science education. Since we have been facing the Covid-19 pandemic, more attention is needed to tackle inequalities in science education. Considerable attention should be more given to the use of technology to provided learning and teaching science continuity. Students should have free and open Access science educational resources for their learning science process. All students must Access to science education's instruments during learning science. In this age, it can not be claimed that science education basicly depends on technology but it is necessary that science education should be benefied from tehcnology and its resources. For having a global success in science education in 21st century, research and international engagement are necessary.

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