Contextual Learning and Teaching Approach in 21st Century Science Education

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Introduction

> What is the purpose of school? A student may respond, "to get good grades." A parent may say, "to educate." A teacher may add, "to prepare students for their futures." The purpose is an intertwined expectation of all three, with a focus on contributions to society. In many countries today, people believe that improving and maintaining a high-quality offering of education is the key to unlocking the society's economic and creative potential (Kaufman, 2013, p.78).

The role and importance of science education in school is undoubtedly indisputable in revealing the economic welfare and creative potential of a society. Science teaching is a strategic necessity for a country to meet the basic needs of its people (UNESCO, 2014, p.47). Children need to be equipped with 21st century skills in order to overcome the challenges of the new century in science and technology, learn deeply to understand life, solve real life problems, and be individuals who can take responsibility in society. It is important to understand the role of science education in providing a qualified education that can provide 21st century skills and shaping the new world people. In today's world, where the role and power of science is an undeniable fact in the economic development and development of countries on the axis of the formation of productive societies, the value that individuals attribute to science is also important. Therefore, there is a need for an understanding that will distract students from the idea of "why do I learn science students, where will this information be useful for me?" This understanding should aim that the child can use science to make sense of life, see science as a tool in transferring it to the situations he encounters in life, and should have the nature of developing 21st century skills. From this point of view, nations are reconstructing science curriculum and practices, which aim to close the gap between science and real life in the best way possible, based on real-life contexts.

Real-Life Contextual Learning and Teaching Approach

Real-Life Contextual Approach is a learning-teaching approach in which teaching is carried out on the basis of the need to know (Bulte et al.,2006) and is based on shaping the teaching process with a context that includes daily life situations familiar to the student. This approach is based on social constructivism and situational cognition approaches

(Berns & Erickson, 2001; Crawford, 2001; Nentwing et al., 2007; Taasoobshirazi & Carr, 2008). According to Finkselstein (2001), students develop an understanding of the content in context, and this context mediates the student's understanding of the content. It is impossible to separate learning from its context. Context does not provide a basis for learning. Rather, the context shapes learning and is shaped by both the learner and the content. The Real Life Based Learning Approach is based on the principle of choosing an event, situation, a living entity or an inanimate object that the student is familiar with in daily life as a context and starting and shaping the learning process around this context (Aydin-Ceran, 2018). According to Whitelegg and Parry (1999), people are more successful in daily life than the problems they encounter in formal settings, and they cope better with problems in daily or familiar content than scientific ones. According to King (2011) in her study, context-based learning has been successful in increasing student interest, making science lessons more enjoyable, making learning knowledge a necessity in order to interpret the context, and associating the student's daily life with science. To support this situation, Gilbert (2006) emphasizes that science lessons should be conducted with a Life-Based Approach in order to develop students' science literacy and high-level thinking skills and to overcome the problems encountered in the teaching process.

Context is the basic and organizational structure that forms the core of the life-based learning approach and the backbone of the teaching process. Teaching starts with a context that the student is familiar with from his/her socio-cultural environment, concepts are taught within this selected context, and the effectiveness process is increased by associating the taught concepts with other contexts (Aydin-Ceran, 2018). McDermott in his article in 1993 "Guest comment: How we teach and how students learn—A mismatch?" He likens the context to an empty slot in which other things are placed, such as a soup bowl. For this reason, he states that the context shapes the boundaries of the content and its effect is only within the boundaries of the examined phenomenon. Another analogy that can be offered for context is Birdwhistell's rope analogy. A rope consists of fibers. The rope is not something that surrounds the fibers, but rather the collection of fibers and their interrelationships. It is not possible to remove all fibers from the rope and examine the rope and fibers separately. Similarly, learning and context shape each other; neither can exist without the other (cited in McDermott, Finkelstein, 2001). Gilbert (2006, p.958) stated that the education model that embodies the meaning of the context should be such that it provides an effective response to the relevant curriculum and social problems. The context triggers a "need to know" necessary to explain the scientific phenomena the students are studying (Bulte et al. 2006; Gilbert 2006; Gilbert et al., 2011). The students "need to know" the concepts and underlying principles in order to clarify questions triggered by the context. The "need to know" promotes that the students are actively engaged in their learning process (Vogelzang & Admiraal, 2017).

Real-Life Contextual Approach in 21st Century Science Lessons

The contextual approach is more than just including real-life contexts in a lesson. Considering the contextual dimension of physics in determining a curriculum is not the same as the implementation of physics concepts. Including the contextual dimension of physics in the program requires seeing the context as the center for learning related concepts. Using contexts is to start teaching with a reality, and then to provide a launch pad for teaching the concepts in the curriculum by using the aspects of this reality (Wilkinson, 1999 as cited in Gunstone). It is clear that the harmony of the quality and nature of the context with the content is an important element in the Real-Life-based learning approach. However, preparing a suitable teaching environment in which the context will act as a launching pad is as important as the function of the context. In the Real-Life-based learning approach, learning happens when students need information to better understand real-world context. The framework of teaching should prioritize learning with students' questions/research/inquiries, and the context should be shaped to be associated with the concept learned and other contexts by employing the "need-to-know" principle, which makes learning meaningful (Beasley & Butler, 2002; Bulte et al., 2006; King, 2009). It is seen that establishing a concept-context relationship and transferring the learned concept-context to other contexts is one of the aims of a teaching environment based on Real Life-based learning approach. As a matter of fact, Gilbert et al. (2011) state that the main idea of Real-Life Based Science Education is to deal more clearly with the relationships between concepts and contexts. When the studies conducted with the Life-Based Learning Approach are examined, it is seen that the researchers use different methods or strategies. For example, King (2009b) chose a creek near the school as the context for the teaching of the "Water" unit and developed a lesson plan that aims to teach the water unit in the context of "Water Quality in Yabbie Creek". King (2009) revised and used the model that shows the stages of a life-based lesson developed by Beasley and Butler (2002) in context-based lesson plans. This model is presented in Figure 1. In the lesson plans, especially the context is at the center of the teaching, laboratory activities based on open inquiry, reports written by the students to establish the concept-context relationship, and student-student interaction.

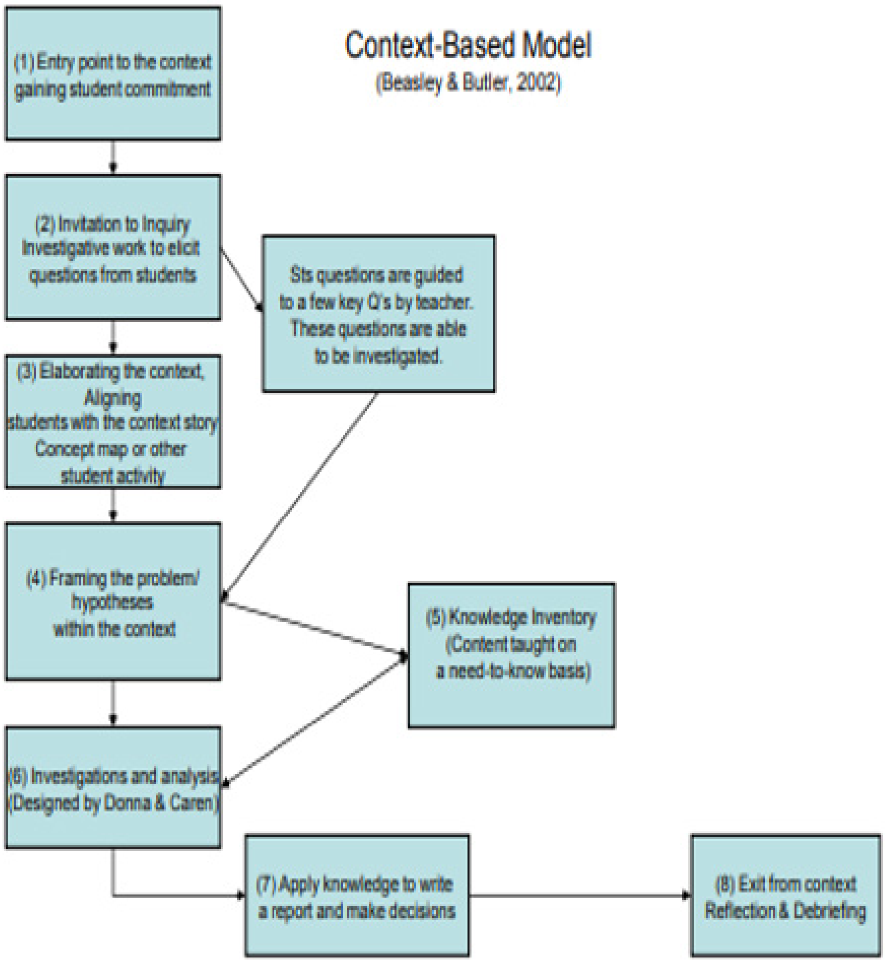

Figure 1. The Model Showing Possible Steps of a Context-Based Unit

Another implementation for the real-life contextual teaching and learning approach to be used in lessons is the ChiK Project, which was developed by being influenced by the Salters Approach in England, in order to re-evaluate Secondary Education Chemistry programs in Germany in line with Trends in International Mathematics and Science Study (TIMSS). results. The project brought together teachers and field educators in the conduct of Life-Based Science Education (Parchmann et al., 2006; Pilot & Bulte, 2006) and developed a method for how a unit should be conducted with this understanding. The cyclical process in teaching a unit in ChiK (Nentwig, et.al., 2007 p., 1442) is presented in Figure 2.

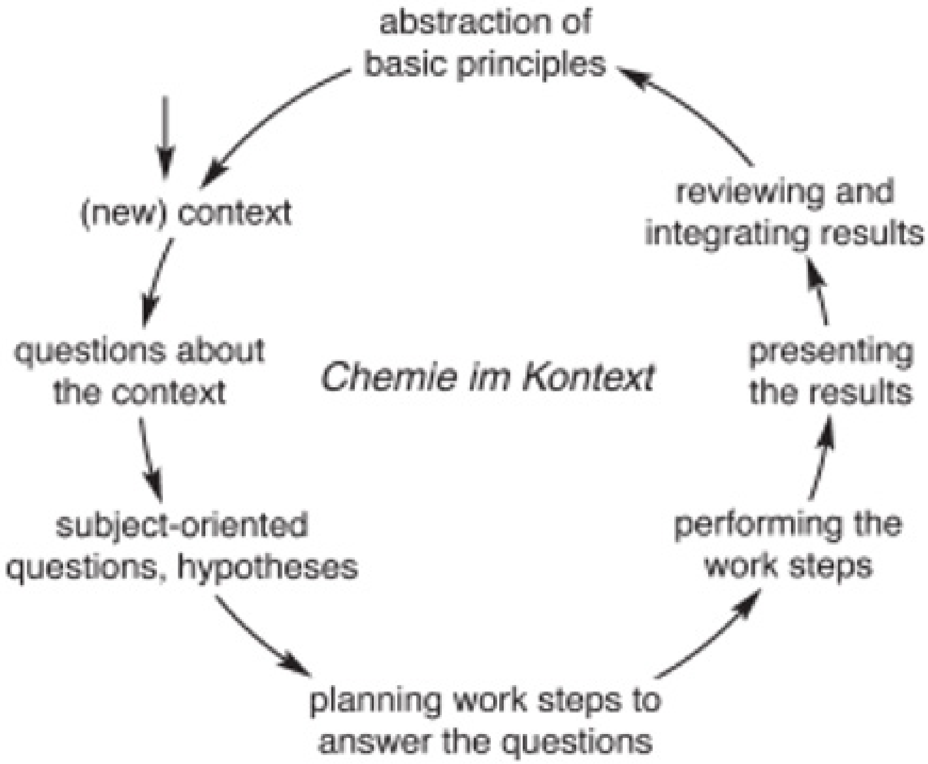

Figure 2. The Process Circuit of Chemie in Kontext

Another example is ChemCom from the USA. A model similar to the ChiK Model was used in the teaching of Life-Based Science courses with ChemCom. According to this model (Ware & Tinnesand, 2005, p.99);

- Introduce students to a social theme involving chemistry;
- Lead students to realize that need to understand chemistry in order to evaluate ways of addressing the issue in an informed fashion;
- Develop the relevant chemistry showing its connection to the issue; and,
- Use chemistry knowledge in decision-making activities related to the scientific technological aspects of the theme.

Another method preferred by researchers in teaching science lessons with the Real Life Based Learning approach is the REACT strategy (Coştu, 2009; Crawford, 2001; Demircioğlu, et al., 2012; Deveci & Karteri, 2020; Ingram, 2003; Karslı & Yiğit, 2016; Ültay & Çalık, 2011). REACT, one of the implementation strategies of the Real Life Based Approach; It consists of five basic stages: Relating, Experiencing, Applying, Cooperating and Transferring (Crawford, 2001). REACT strategies become the method based on students' daily life experiences and create a lively classroom atmosphere (Rohayatı, 2013). Another model used in teaching science lessons with Real Life Based Learning approach is 5E (Aydin-Ceran, 2018; Sunar, 2013). 5E is a learning-teaching model based on the Constructivist Approach. The model consists of five stages. These stages are; They are Entry-Participation (Engage), Discovery (Explore), Explanation (Explain), Elaborate and Evaluate (Carin & Bass, 2005). Aydin-Ceran and Ates (2019) developed the Life-based 5E Model on a research-inquiry basis by reflecting the stages of contextual constructivism (Finkelstein, 2005) and King's (2009) model to the steps of the 5E Method. In addition, a diagram containing the organization of the context in the stages of 5E has also been developed by Aydin-Ceran (2018). The diagram is presented in Figure 3.

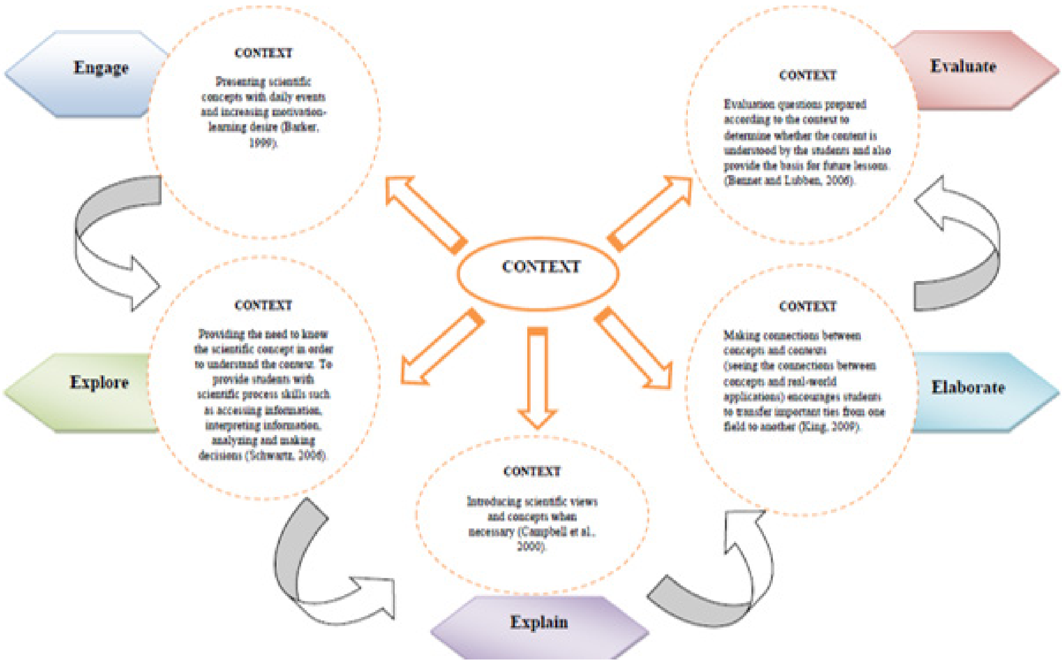

Figure 3. Organization of the Context in the Stages of the 5E Method

As stated by the studies in the literature, real-life contextual approach is a teaching and learning approach. Teaching begins with a context from the real life of the student. The role of context in the lesson's organization is important. Context is not given as an example of concept. Concepts are taught in context. Studies show that science teaching practices based on real-life contextual approach are effective in students' learning of scientific concepts (Bennet & Lubben, 2006; Stolk et al.,2016; Finkelstein, 2005; King et al, 2007; King, 2012; King & Henderson, 2018; Nentwig et al, 2007; Podschuweit & S Bernholt, 2018) and students' science achievement, interest, attitudes and motivations towards science (Broman et.al, 2020; Glynn & Koballa, 2005; King & Ritchie, 2007; Park & Lee, 2004; Uitto et al., 2006). Briefly, Context-based approaches can bridge the gap between abstract, difficult science concepts and the world students live in (Swirski et.al., 2018).

Contextual Teaching and Learning Approach Implementation in 21st Century Science Education

The approach that reveals how science is related to real life with a teaching philosophy can be called real-life Contextual Learning. In order to close the gap between science education and real-life, various projects and curricula in which "real-world contexts" are widely used have been initiated, especially in England and later in many countries, since the 1980s. The most well-known of these projects and programs are; Physics Curriculum Development Project (PLON), The Large Context Problem (LCP), Supported Learning in Physics Program (SLIPP), Victorian Certificate (VCI), Salters Advanced Chemistry Project, Salters' Science Course, Salters Horners Advanced Physics, Salters Nuffield Advanced Biology , Physik im Context in Germany (PiKo), Chemi im Kontext in Germany (ChiK), Chemistry in Community (ChemCom), Chemistry in Practice - ChiP, The Relevance of Science Education - ROSE), Science, Technology, Environment in Modern Society – STEMS is Chemistry in Context: Applying Chemistry to Society - CiC (Aydin-Ceran, 2018). These pioneering studies have contributed to the field in shaping the Real-Life-Based Learning Approach and have contributed to the reform of real-life context-based curricula in many countries (Aikenhead, 2005; Bulte et.al, 2006; Millar, 2006; Sevian et.al, 2018) have been a source of inspiration. For example, Physik im Kontext (PiKo) was established in Germany in 2004 with the aim of increasing science literacy, developing a new learning-teaching culture (constructivist approach), developing skills of working and thinking like a scientist, using physics in daily life contexts (Duit et al., 2007) was implemented. Another project, Chemistry in Practice (ChiP), is context-based chemistry education practices developed in the Netherlands-based on the need to know principle in response to the understanding of teaching chemistry without being associated with the abstract and real world (Bulte et al., 2006). With these practices, a curriculum understanding that includes real-life practices on the basis of the need to know has developed and it has been tried to ensure consistency between real-life contexts and concepts encountered in society (Pilot & Bulte, 2006). From this point of view, a reform was made in the chemistry curriculum in the Netherlands in 2015 and a curriculum based on the real life-contextual learning approach was developed (de Jong, 2015).

The science literacy dimension of the PISA research conducted every three years by the Organisation for Economic Co-operation and Development (OECD), which is an international education indicator, gives important clues about the science education understanding of countries. When the science education programs of the countries that were successful in the PISA research are examined, the existence of the understanding of "using science in real life and adopting it as a key in solving real life problems" draws attention. As a matter of fact, the PISA research explains its perspective on this issue as follows;

In contemporary societies, an understanding of science and of science-based technology is necessary not only for those whose careers depend on it directly, but also for any citizen who wishes to make informed decisions related to the many controversial issues debate under today – from personal issues, such as maintaining a healthy diet, to local issues, such as how to manage waste in big cities, to global and far-reaching issues, such as the costs and benefits of genetically modified crops or how to prevent and mitigate the negative consequences of global warming on physical, ecological and social systems (OECD, 2019, p.112).

When South Korea, which is one of the most successful countries in PISA science literacy dimension, is examined, it is observed that the general framework of the program emphasizes "to use the ability to determine the basic rules of science and scientific nature in solving problems in daily life and to develop a scientific behavior to solve problems in daily life" (Güneş & Aksan, 2015). According to the Hong Kong PISA research, the reason why they changed the Science curriculum with a new reform despite being the second in "science success" in the world in 2012 and the third in 2018 is "Our students are successful in exams, but they do not know how much science and mathematics are relevant to their lives" announced (Kwok, 2018, p.533). The contextual learning philosophy of science for science literacy on the basis of 21st century skills of PISA research also inspires curriculum reforms in many countries. For example, Hungary made a reform in the Physics Education Curriculum in 2020 (primary-secondary education). Hungarian Curriculum (NCC2020) follows the principles by the OECD. The areas of development and the learning outcomes of the new NCC2020 in physics have been developed in support of the introduction and implementation of novel methods including active, context based, and phenomenon-based learning. It's aim was to create a curriculum that ensures Hungarian pupils to have an up-to-date knowledge and the possibility to improve the important skills for a successful life in the 21st century, like collaboration, communication, creativity, critical thinking (Egri et al., 2021).

In recent years, different studies on the implementation of real-life context-based learning approach in science lessons continue. For example, Kang et al. (2019) aimed to develop a measurement tool of scenarios and validate it in order to design relevant scenarios for context based learning in science education. They aimed to develop and validate a scenario evaluation instrument to examine students' perspectives on science career-related scenarios through the lens of relevance and interest. For this purpose, 25 career-related scenarios and a measurement tool, Scenario Evaluation with Relevance and Interest (SERI), were developed by a team of researchers for the EU funded MultiCO project. Then, lower secondary school students from three different countries, Estonia, Finland, and the UK, were asked to respond to the newly developed instrument after reading the scenarios. These international participatory researches are promising in terms of developing and disseminating the real-life contextual approach in line with the needs of the 21st century. A research conducted by The World Economic Forum (WEF) in the "Schools of the Future" report in 2020 offers ideas about the applications and importance of the contextual approach in the 21st century. WEF launched a global crowdsourcing campaign in the second half of 2019 to find inspiring examples of Schools of the Future (2020, p.12). In this context, when the selected 16 schools are examined; It is noteworthy that these schools, which aim to develop key skills in the 21st century, essentially establish an important link between school and real life. For example, one of these schools is the Green School. Students at the Green School apply learning to the real world through a global citizenship and sustainability lens, and truly take advantage of the natural world to tap into their curiosity, empathy, and creative thinking skills. And the other one is Kabakoo Academies. Kabakoo's curriculum focuses on ensuring employability among their students and immediate applicability of content to the local context. Part of their approach is to help students rapidly develop market-ready protypes to solve relevant local problems through a sustainability lens. Students freely choose the local issues that most resonate with them, and then take part in courses and group projects to develop innovative solutions to those issues. Students are currently developing, for example, West Africa's first citizen platform to fight ambient air pollution and have designed and prototyped a low-cost tool for monitoring air quality (WEF, 2020, p.17). These are just two of the 16 schools presented in the report. From this point of view, it is correct to state that; Today, schools that provide the skills of the future should have the perspective of "knowledge is meaningful if it works in real life".

According to Avargil et al. (2012) Two of the major goals of science education are to develop students' scientific literacy and their higher order thinking skills. Achieving these goals should account for learning science in context (Gilbert, 2006) as well as learning scientific concepts and processes through dealing with real-world problems and adapted scientific articles. The OECD Scenarios for the Future of Schooling report has stated that "In a complex and quickly changing world, this might require the reorganization of formal and informal learning environments, and reimagining education content and delivery. In an aging world, these changes are likely to apply not just to basic education, but to lifelong learning as well " (OECD, 2020). Correctly structuring science education is an important mechanism for societies in being ready for or building a future that we cannot foresee. In many industries and countries, the most in-demand occupations or specialties did not exist 10 or even five years ago, and the pace of change is set to accelerate. By one popular estimate, 65% of children entering primary school today will ultimately end up working in completely new job types that don't yet exist (World Economic Forum [WEF]), 2016). In such a rapidly evolving employment environment, the ability to anticipate and prepare for future skill requirements is increasingly important. Considering the power of science education to direct and shape the jobs of the future, the Context Based Learning Approach can be an important driving force for 21st century science education with its solid foundation, both conceptual and practical.

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