Analyzing the Views of the Science Teachers about in-Class Integration of STEM Applications

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ABSTRACT

Taking into account the Science, Technology, Engineering, Mathematics (STEM) integration, it is important to investigate teachers' understandings, perceptions about STEM and how STEM practices should be incorporated into the classroom in order to explore the perceptions of science teachers on this subject and provide important information to teachers and researchers in connection with how STEM applications can be applied at high quality. The purpose of this study is to analyze the views of the science teachers about in-class integration of STEM applications. 5 science teachers working in the province of Denizli participated in the study. The teachers received STEM training for 5 days in 2015-2016 school year. The training provides instructional strategies to assist Science Teachers in the implementation of STEM integration in the classroom environments and in the development of an understanding of the connection between the various STEM domains. All five teachers in this study have participated in the training given. A case study was conducted to describe the teachers' views on STEM integration and the situations related to the in-class practices on this topic. Teachers in general have described STEM integration as a way of problem solving, and stated that the They also think that the STEM integration will give students a variety of 21st century skills they can develop. They think that when solving a real life problem, these skills provide them to create their own methods instead of the things given to them. Moreover, teachers have identified STEM integration as an approach that develops problem-solving skills.

Key words: *STEM Education, STEM Integration, Teacher Education*

INTRODUCTION

As the scientific knowledge gradually increase, technological innovations move at a great speed, and the effects of science and technology are clearly seen in all areas of our lives nowadays, it is clear that science and technology education play an important role in the future of the societies. It is therefore seen that all societies, including developed countries, are constantly making an effort to improve the quality of science and technology education (MEB, 2005). STEM education which aims to educate students holistically and give them twenty-first century skills is one of these new approaches. In particular we can say it has been pointed out here that from the early ages the students need to be given the skills of the twenty-first century. At this point, the question whether the trainers who are going to upskill the students are sufficient for these skills becomes the main topic of conversation.

Our country's 2023 Vision and the aims of the Ministry of National Education (MEB) strategic documents demonstrate the necessity of defining science-technology-engineering-mathematics STEM education across our country (Corlu, Adıguzel, Ayar, Corlu, Ozel, 2012).However, studies done in this field are on the onset (Cavas, et al., 2013; Corlu, at al., 2012; Marulcu&Sungur, 2012).Therefore, the scope, theory and practice of science-technology-engineering and mathematics education, which is at the center of reforms aimed at raising a generation capable of innovation, should be studied at the level of schools and universities(Corlu, et al.,2012).In this sense, it may be seen important for teachers to fully understand the content and scope of the STEM and to have knowledge and experience of how to implement it in the class. Hernandez (2014) at his study towards determining the teachers' self-efficacy perceptions on STEM disciplines, he stated that teachers need professional development courses for STEM in order to give qualified STEM skills to students, such professional development courses have improved the teachers' self-efficacy perceptions and this is effective on students gaining the Stem skills. Hence, teachers' knowledge and experience in this field can be considered important both for their professional development and for their students to gain twenty-first century skills. For

example, in a study by Avery (2009) that aimed to investigate the impact of teachers participating in STEM professional development courses to their students' academic achievement, he ascertained that the students of teachers who integrate STEM activities into the curriculum have a higher perception of competence of their academic achievement and STEM disciplines than other students. In another study paralleling this one, Satchwell and Loepp (2002) reached the conclusion that when the content taught with STEM-based projects a significant increase has been seen in the learning level of students. Likewise, Thompson (2009) suggests that STEM-based learning reflects a positive change in mathematics and science education. As a result of the study done by Farior et al. (2007) it has been concluded that students experiencing design-based problems had some difficulty in transferring knowledge and that they succeeded in achieving the potential to use and retain knowledge when encountering problems through STEM-based training. Gallant (2010) concluded that if students work together in a collaborative group on real-world problems their interest towards STEM education and success would increase. Also, Fantz and Grant (2013) and Stohlman, Moore and Roehrig (2012) state that focusing on mathematics and science subjects to expand students' interests and awareness towards the school will be beneficial. In this context, when examined the studies conducted, Venville, Wallace, Rennie and Malone (2000) researched the implications of the integrative teaching of science, mathematics and technology in traditional discipline-based school environments, and the effect of integrative teaching on students' learning. Therefore, they have provided a learning environment in which the students can apply what they learn in science, mathematics and technology through "Solar Boat (Boat using solar energy)." As a result of the study, it has been revealed that the students raise their interests to learning and the integrative approaches of STEM lessons should be applied in the environments of constructivist education rather than the traditional discipline-based school environments. Bingolbali, Monaghan and Roper (2007), at their study, determined that the implementation of project-based learning activities integrated with STEM have a significant influence on the positive attitudes of students to STEM and their choices of profession in the future. The study carried out by Dewaters (2006) showed that the students are pleased with the lessons of STEM integration and these lessons assist to solve the daily life problems. In this study, the students asserted that STEM [lessons] integration have up-skilled their learning. The results showed that the students need to learn many types of advanced STEM disciplines in order to meet the engineering and technology needs in the future. Additionally, several counties, currently, by drawing attention to the students' learning environments, hope that STEM teaching can be improved with appropriate environment designs. Thus, we are in need of effective teachers. Accordingly, Cunningham, Knight, Carlsen and Kelly (2007) designed an in-service training program for teachers. Teachers have had knowledge and experience about the engineering design and then become experienced in how to use and incorporate the engineering design into the lessons plans during the program. The priority aim of STEM initiatives is to increase the number and quality of STEM teachers. In this way, well-trained teachers can help students up-skill and increase their innovativeness capacities in the twenty-first century (Corlu et al. 2014). In this regard, it is probably not possible to expect teachers to carry out activities for up-skilling the students' STEM without having their own skills or taking education for improving these skills. As a result, Taking into account the Science, Technology, Engineering, Mathematics (STEM) integration, it is extremely important to investigate teachers' understandings, perceptions about STEM and how STEM practices should be incorporated into the classroom in order to explore the perceptions of science teachers on this subject and provide important information to teachers and researchers in connection with how STEM applications can be applied at high quality. It is seen that countries such as America, England and South Korea are the leading states where the studies on the implementation of STEM education for teacher training and primary institutions are conducted. It is tried to make the concepts including in the education programs of these countries more understandable with the courses, congress and symposium activities for prospective teachers and teachers. Therefore, it can be easier to implement STEM activities in schools. In the countries having such good applications, determining the position of STEM concept in education programs, how it is reflected to teacher training, and with what kind of activities are trying to provide students with skills, attitudes and behaviors during the lesson in secondary schools will help to eliminate the problems. Taking into account teaching STEM disciplines as an integrated approach, science teachers need to develop new teaching strategies and techniques, and upskill in order to have content knowledge about STEM subjects and apply STEM integration in the classrooms. The studies show that using of integrated approach in education has a positive effect on students' success. Ozdilek and Ozkan (2009), at their study, researched the effect of instructional design prepared by an integrated approach with many teaching strategies on the students' learning levels and determined that the students who are applied to the instructional design developed as a result of the

research had a higher achievement compared to the students who are educated with the current program. Developing an integrated program and creating an environment suitable for STEM education in our schools provide students to establish a connection among disciplines, be enthusiastic about learning, increase their success of mathematics and science, and improve STEM education and learning (Gallant, 2010; Riskowski et al., 2009; Satchwell and Loepp, 2002). In a study performed by Elliot, Oty, McArthur and Clark (2001), integrating mathematics with science, technology and engineering has enabled students to create meaningful connections with these disciplines. Hartzler (2000) specified that science and mathematics which are taught based on an integrated understanding have enhanced students' success, interest, eagerness to learn and self-efficacy in a meta-analysis study that he conducted among his thirty individual studies related to effect of integrated teaching on students' achievements. In this sense, continuing vocational education of science teachers in order to gain information and experience to teach STEM integration is considered as a crucial reform emphasizing the problems about implementing Science, Technology, Engineering and Mathematics integration in the science classrooms (Loucks-Horsley, Love, Stiles, Mundry and Hewson, 2003). It is important to investigate teachers' understandings, views about STEM and how STEM practices should be incorporated into the classroom in order to provide important information to teachers and researchers in connection with how STEM applications can be applied at high quality. Other researchers placing importance on this study needed to emphasize the effects of these trainings after the education of STEM practices for teachers. In this sense, the results of this study are important with regard to give information to the future teachers with the professional development programs aiming sustained changes in science classrooms. This study focuses to answer the following two research questions:

1. What are the general views of teachers about STEM integration after receiving STEM education?
2. Is there any connection between the views of teachers about in-class STEM practices and STEM integration?

METHODOLOGY

A case study was conducted to describe the teachers' views on STEM integration and the situations related to the in-class practices on this topic. Yin (2011) explains that case studies are appropriate when the research questions address a descriptive inquiry (e.g., "What is or has happened?") or an explanatory question (e.g., "How or why did something happen?").

Techniques to establish credibility consist of members checks and the triangulation of the survey instrument, focus individual interviews. Member checking consists of allowing participants to review the transcription of the interview and correct any errors in interpretation (Creswell, 1998). Triangulation of data consisted of comparing the three data sets: the survey data, interviews from individuals. Through the triangulation of sources, we can determine the consistency of the data sources (Angen, 2000). Triangulation makes it possible for the researcher to learn and fully understand what is being studied. In addition, the researcher communicated with the participant teachers to check whether the interpretations brought to themes and themes were correct in order to further enhance the reliability of the study.

The interviews were carried out, analyzed and thematically coded by the researchers.

Data collection was carried on in order as follows: 1) training teachers about STEM integration before interviews and classroom observations, 2) having pre-interviews with teachers before starting in-class STEM integration lessons, 3) making teachers' classroom observations when they start to STEM integration lessons, 4) having interviews again with teachers after completing STEM integration lessons. Two interviews, one of which is pre-interview and the other post-interview, were conducted with the participants.

Each interview lasted about 40 minutes. The pre-interview is a semi structured interview carried out before the participants start STEM integration lessons. The pre-interview questions focused on five significant areas. 1) The views about STEM (Science, Technology, Engineering, Mathematics) disciplines, 2) The views about STEM integration, 3) The past experiences on STEM integration, 4) Preparation the students for 21st century skills and 5) The challenges and obstacles of STEM integration.

The final interviews were conducted after the participants completed STEM integration lessons. The aim of final interviews is to enable teachers to explain and detail STEM integration applications in the classroom and to clear the connection between teachers' views and in-class practices.

Participants

Five teachers were purposefully selected for STEM integration training. All five participants were middle school science teachers. Participant acknowledged that they did not have experience STEM integration.

The Application of STEM Activities

A story emphasizing the STEM activities about Electrical Unit, lesson plans, worksheets and engineering design process steps at the beginning of the Unit was prepared in this study. It was provided STEM training for 5 Science teachers working in three different schools located at Denizli and was asked to integrate these applications into this unit. The applications have taken totally 48 hours, including intra-and out of lesson and intra-class observation has been conducted.

In this study, 6 different STEM activities have been used. The activities have been prepared in accordance with the engineering design process.

1. Series Circuits
2. Parallel Circuits
3. Toy Workshop
4. Wind Turbine Work
5. Electricity Saving Work
6. Poster Preparation

Classroom observations

The principal focus of classroom observations was to observe in-class practices that the teachers used STEM integration. For this purpose, the classroom observations were made during STEM integration lessons of the participants. In order to provide the recording of classroom observation data, detailed field notes have been used. The purpose of field notes is to provide the detailed description of classroom practices including the contents such as lessons' content, and teacher-student interaction. The data analysis method in this study can be summarized briefly as follows: (1) open coding, (2) description of templates and categories and (3) setting themes and models for cross-case analysis.

During open coding, data sources were tried to be organized by taking the frequently-used words into consideration. The purpose of using open coding is to explore each participant's views about STEM integration.

STEM Integration Training

STEM integration training has been given to 5 science teachers working in the province of Denizli. The training provides instructional strategies to assist Science Teachers in the implementation of STEM integration in the classroom environments and in the development of an understanding of the connection between the various STEM domains. All five teachers in this study have participated in the training given. The general purpose of STEM integration training is to enable teachers to understand the subjects they have taught thoroughly and analyze the relationship between STEM disciplines. STEM education lasted 5 days in 2015-2016 school year. The training activities have been designed for teachers to think deeply about what they learn during the training and to share experiences they have learned while applying in the classroom. The training subjects and content have been given at Table 1.

Table1

Title	Content
What is STEM?	STEM education in Turkey and in the world, the importance of STEM training, the nature of STEM
What is engineering? And what is engineering design process?	Engineering as a separate discipline, the relationship of engineering between Science and Mathematics and Engineering Design Process
Mathematics, Science and Design	The points making engineering different from Mathematics and Science
Problem solving, Project-based and Problem-based learning	The relationship of STEM between Problem Solving, Project based and Project based learning
Preparation of STEM lesson plan	Preparing STEM activity and its integration with current units
Technology Integration	Technology integration in teaching of Science, Mathematics and Engineering

The STEM training given to the teachers emphasizes on the integration of STEM disciplines and the quality of these disciplines.

Study Findings

Five major themes emerged from an analysis of the interview data. These themes were the following:

1. Understanding of STEM integration
2. Challenges and obstacles
3. 21 st century skills
4. Learning outcomes
5. Implementions of STEM integration

The researcher further refined these themes, which came from textual descriptions (see Table 2).

Table 2

Themes	*Textual Descriptions*
Teacher's understanding of STEM integration	STEM integration is problem solving (Real world problems) STEM integration is like a way in which scientific process skills Engineering desing process Creating their own product
Challenges and Obstacles	Time constraints
	Experiences for STEM
	Students' STEM ability
	Units
21st century skills	Solving problems
	Learning from failure
	creavity
	Defining, Formulating and Solving Problem
Learning outcomes	become independent thinkers
	Use engineering design process.
	Opportunity to use their theoric knowledge
	Relate to real World problems
Implementions of STEM integration	Problem solving is a component in a STEM integration lesson
	Content knowledge is important for STEM integration Engineering design

Teacher's understanding of STEM integration

The problem solving has become the most common concept that the teachers use to define STEM integration. As P1 stated, one of the teachers, "STEM integration is to use Science and Mathematics in order to solve the real life problems, and in my opinion, STEM integration is a way to use problem solving skills and develop these skills." On the other hand, P2 defined STEM integration as follows;"STEM integration is a solving problem which mixes the current theoretical information related to Science and Mathematics with Engineering design processes."And, P3 stated as following;"STEM integration means that different disciplines come together in order to solve an existing problem."

The teachers have associated STEM integration with the problems faced in real world. For instance, P1 mentioned about this subject as the following;

"We are speaking about a situation related to real life in a STEM activity. There is a real problem that should be solved. The students face this problem and try to produce a solution for this situation."

And, P2 said as follows:

"STEM integration brings students together with the problems of real life. It provides them to use the information of Science and Mathematics in order to produce ideas about these problems and come up with the solutions."

Most of the teachers (P1, P2, P4 and P5) believe that solving a problem using STEM integration will assist the students to understand better about what engineers work in fact.P1 said "The engineering, all by itself, is a STEM integration. This provides students to develop a point of different views to real life problems and use the theoretical information that they have learned in the lesson."

And P2 said "Personally I think, STEM integration is like a way in which scientific process skills are used. It exhibits almost real life situations about what the engineers do depending on their carriers since each subject of science is, indeed, a field of study of the engineering discipline."

P2, on the other side, said "I ask the students to create a product in a STEM activity because I want them to use their imaginations and creative ability in order to create a product. The fact that the students create a product is extremely important for their permanent learning."

And, P2 described the application method of engineering in the activities as follows; "Engineering have existed in all activities including the series and parallel circuits." P3, also, stated about incorporating the engineering into the activities; "Engineering have been suitable for 7th grade acquisitions and is an activity including engineering design process." And, P5 said "Engineering is in the last part which the students have created products." P4 defined this as the following "It was important that the concepts which the students learned about the subject connected to the engineering design process."

When asked about the focus point of STEM integration, P1,P2 and P3 mentioned about the engineering design process. P1, demonstrating Wind Turbine activity as an example, said "In my opinion, the engineering design process is highly important in teaching STEM integration. The Engineering design process allows us to solve the problem. P2 stated her opinions as follows "Using the engineering design process on behalf of organizing the information for a problem solution and allowing for testing and retesting is the basis of STEM integration."

And, P3 said "In my opinion, the engineering design processes are pretty valuable for STEM integration. This is relatively important with regard to emphasizing the engineering discipline and presenting its relationship with the other disciplines."

P1, P2 and P3 believe that the students should learn the engineering design process and practice on this subject. According to them, what makes STEM different is the design processes. Also, since the students are accustomed to immediate information, they have emphasized that the students should solve the problem using and applying their own views. This is also related to the fact that the teachers desire to help the students to develop their own independent thinking abilities.

For instance, P1 said "In order that the students can design their own products and transform their ideas into products and find creative solutions to the problem, the problems should be open-ended, since the students were always conducting experiments like prescription before."

At this point, P3 said "The engineering design processes assist the students to carry out the problem solving by using their own ideas."

On the other hand, P5 and P4 have not directly mentioned about the engineering design during the interviews. On the contrary, they have emphasized the importance of integrating the engineering into STEM integration. One of the biggest reasons that P5 believe that the activities are accomplished is to try to integrate both science and engineering into the activities. He said "I feel that the activities are successful STEM integration due to incorporating the engineering by emphasizing its difference from the other disciplines. According to P4, she also believes that engineering is a part of STEM integration. Considering the basic concepts of science in STEM integration, P4 has asserted that and the engineering integration process and mathematics are the means providing quantity assurance and the technology is the thing finally acquired. In order to conduct a STEM activity, all STEM activities should be integrated into all units. She also said "As far as I am concerned, integrating STEM completely is also to systematize it. Therefore, when talking about STEM integration, it has not only made any special effort to mention about engineering.

Studying based on product-focused is another concept including the engineering design. Most of the teachers believe that they allow the students to transform their ideas into real and concrete products by applying STEM integration. For instance, P1 said about this subject "Conducting engineering type works or doing projects are that it is because the students have to practice those again and again. In this way, they can use what they have learned about science and mathematics in order to do something related to engineering and to build something.

P2 had asked her students to create and present a poster in the activity about electricity saving. We are discussing instead of testing in the engineering design process and the students are sharing and discussing the data they have acquired. Of course, what everyone has done is not necessarily be similar to each other. Everyone can share their ideas and data. P4 thinks that existing of a problem to be solved in product-focused activities is the crucial point. According to P4, the "testing" areas, such as testing different materials or solutions, is substantially important in order to find the best solution in a project of STEM integration. She said "The students should design a product that can be tested physically for STEM integration. This provides them to learn, and in my opinion, the children should learn to think. They should touch something, play with something, and reach to a solution trying their ideas or conducting an experiment with materials.

Teachers' views of STEM integration and their application in the classroom and the role of problem solving in STEM activities are strong links. Findings also show that teachers believe that helping students to think independently and work on the project as a true engineer is a valuable feature in an STEM event. Both teachers' views and classroom practices suggest that teachers see STEM integration as one of the most important factors in problem solving.

All teachers have given an engineering design problem or challenge to their students to solve. In this case, it can be referred to as a context without problem solving. On the other hand, they also expressed that students want to be independent thinkers using their own ideas to solve a problem. For this reason, problem solving is also used as a process in STEM activities.

Challenges and obstacles

We will discuss the difficulties that the teachers have faced in applying STEM activities in this theme. This theme, unlike the others, has not been presented by following the models, since the difficulties or problems that the teachers have met after applying STEM activities in this theme have been particularly discussed. This theme is related to the teachers' views, however, they have not been ever observed in the applications of STEM activities. This theme will be handled using the reflections of all teachers after practicing STEM activities. There are four issues or problems especially related to STEM integration that the teachers mentioned about after applying STEM activities. Firstly, most of the teachers (P1, P2, P3 and P5) agree that the students' abilities on STEM subjects have a big effect on how they design and apply STEM activities. Also, the same teachers suggested that the students who have a highest academic achievement have not volunteered in STEM activities; on the contrary, the students who have a low academic achievement are at the forefront in the STEM activities. P1, P2 and P3 are concerned about determining how the students ask for support in order to comprehend and complete the project of STEM integration. Secondly, all of the teachers believe that some science units/subjects such as energy, force and speed are easy to use those with STEM integration. However, the other teachers, like P1 and P5, think that the science units/subjects such as biology or chemistry are not too easy. Thirdly, most of the teachers (P1, P2 and P3) STEM integration felt uneasy because they did not have experience. They have stated that this situation is threatening the classroom management. Additionally, time, material and curriculum are the ones of biggest problems affecting the application of STEM activities.

The teachers are also worried about how they give instructions to their students in order to describe STEM activities. P1 said "The students try to correlate all the information with what they desire and do. I should directly teach all of the theoretical information required for the students. And, P2 said "Since the students are not exactly sure about what they will do in what phases, the situation is getting complicated. While introducing such an activity, mostly, I have to assist. P3, on the other side, said "The students need to be guided too much. It seems like what we do for STEM integration, even partly, depends on your students' levels. I am only a secondary school teacher. My students needed to be guided much more in order to complete their activities. Also, engineering requires to write and to design for drawing. My students do not like writing and drawing. They want to try the ideas in their mind. Another concern related to the students' abilities is that some teachers (P2 and P5) believe that some students need more time than others to complete the STEM projects. And this has made planning much more difficult for the teachers. P2 mentioned the followings "Some groups can carry out the activities early but other groups have not started yet. Therefore, I have difficulty in balancing between them. P5 said "The [students] study in different periods of time. It is quite difficult to tell them "Be fast, you fell even further behind." Some of them cannot use the time well. And, some are unaware about what they will do. In general, STEM activities were complex. The students talked with their group friends about their designs, walked around the classroom to test their products or wasted time, and did not do anything that they had to do. One of

the contradictory subjects in STEM integration lessons was the “fun learning” factor.” The teachers thought that this factor overshadowed the students’ learning required to complete the lesson. P1 said that “The students liked STEM activities. For some reason, they did not study the worksheets despite being motivated and if they had not written their views and notes, I would not have known what they did learn on that day. I thought that they tried to join the parts together without thinking in detail.”

P2 believed that she thought the [students’] ideas in detail and did not want to move carefully. They do not want to talk about the strengths and weaknesses of the products. They like to finish the products as immediate as possible and compare their products with the other group. P3 stated that the greatest difficulty was to have the [students] do unfunny parts such as having them write their ideas. The measurement part is not funny for them. Therefore, they take half measures. The time was a big problem for the teachers to apply STEM activities. P2 asserted that she needed time rather than regular lessons for STEM integration. Time is always a difficulty for me.” She said “The students need much time than I expected from them.” In order to carry out STEM integration, much more time is required. P1, P3 and P4 stated that they really had to think how much time is needed for the lesson while planning STEM integration lessons. P3 and P4 pointed out that if they had much more time for STEM integration lessons, they could have taught the lesson more comprehensively.” P4 said “Time is a big factor. I would like to give theoretically information; however, time is the biggest problem.

The teachers have mentioned about how materials could change STEM lessons. P1 and P3 explained the subjects related to the materials. P1: “In my opinion, the most difficult part I faced in STEM integration was materials, since there are not enough materials in our school.” P3: There were not enough resources that I can use in our school. P4 particularly stated that the materials have affected what she desires to do in STEM activities. She said “The materials are a big problem for such activities. I need materials which are easy to access and use.

Also, the teachers have stated that the curriculum is complied with STEM integration. All of the teachers have agreed on this subject. They have expressed that they have to manage the curriculum and do not show tolerance on this subject, and according to this, the curriculum should be organized in order to carry out STEM integration without having a problem. Moreover, all of the teachers have stated that they will not apply STEM integration due to 8th grade TEOG exam.

21st century skills

All of the teachers believed that STEM integration could teach the students a number of 21st century skills to need out of the science class. The teachers think that the students are more eager to try their ideas since they know that the students do not know the correct answer, but search the best answer. P3, P5 and P4 are of the opinion that STEM activities especially assist the students to look at their mistakes from different aspects. P3 suggested “Learning from the errors/mistakes is a 21st century skills for the students. If something does not work, it is highly important to keep going without giving up and understand that mistakes are human. A STEM activity is extremely important in teaching students not to give up when they have failed.” P5 said “The students do not realize that if things are not going well at their will, they can find out its value and benefit from this situation. This is the most crucial problem of the children, personally I think. And, STEM activity assists the students to understand the value of re-trying. P4 stated “I want [my students] to recognize that when they reach an answer they do not expect, this is an ordinary situation, and ask them to try. This is a process to assist them. These things are those that the students should understand even after finishing the school. When considering P2 and P1, they have suggested that the students feel disappointed when they cannot solve a problem. P1, on this subject, said “The students really got disappointed, but when they started to accomplish in fact, the victory they gained is the most important. P2 said “Stem integration is like life skills, such as overcoming a problem or disappointment. STEM integration is a study conducted with the levels of the students’ disappointment. P1 and P2 believe that the problem solving in STEM integration assists students to understand how to study using different ideas in spite of their disappointments.

Most of the participants stated (P1, P2, P5) that STEM integration improves the problem solving skills and creativity of the students. In this regard, P1 said, "STEM integration offers students the opportunity to solve problems through creative ideas." In short, "STEM integration suggests that students develop creative thinking." P5 says, If you want to educate a creative generation, you must achieve STEM integration in your courses. "

From the teachers' viewpoint, these themes are very closely related to helping students to think independently. Teachers have encouraged students to use their ideas and try different solutions when solving problems at all STEM events. They believe that the problem-solving part of STEM activities enables students to realize that

even the methods they think are wrong can come to the right conclusion. Students also see the value of making mistakes. They need to keep trying to be successful and not be afraid of it even if they get an answer they do not want. This is especially observed in the practice of teachers. For example, P1 said that "when designing a toy car for his students, it is completely natural and correct to create many different ideas. You will also decide on how to act your P1 students in the same activity. So check your materials well and make your decision on how to play your game. P3 also encouraged his students to examine materials provided to them before deciding how to design the Turbine in the event of the Wind Turbine. This is what he says: "If you want to look at materials before you start designing turtles, you can come here and look at the ingredients. In the redesign part of the Wind Turbine effect, he again encouraged students to think about different design methods; -Maybe your turbine is very durable, but its wings are too small to generate energy. How can you make changes to your design to produce more energy? P4 encouraged his students to think about different solutions to the Toy car event. He reminded his students that they should design their car as cheap as possible. And then - the very thoughtful group generally gets better results. You have to plan ahead and that's what you need to work on. In another example. After a group of students completed their design, P4 told the situation, and he said: "Think about how you can make changes in your design."

In general, all teachers also think that an STEM effect naturally creates a learning environment that helps students insist on continuity and continuity while trying to solve a problem. Dealing with failures and mistakes is an important life skill that students need to master and develop, even if they do not choose an STEM area as a career in the future.

Learning Outcomes

According to the participants, the integration of STEM provided many opportunities for learning to learners.

P3 raised concern about this point "One of STEM integration purposes is to provide students to really understand about what the engineers practice in their works and to become self-aware about vocational career related to this fields. And therefore, when you provide an environment which is authentic and connected about what the engineers work, you can awaken students' interests and provide students to face to the fields of this discipline."

P4 build STEM integration on the idea about how the students gather the information that they have learned. She, also, mentioned on this subject "In this way, the students actually practice what they have learned rather than reciting or repeating. STEM integration allows the students to use the information obtained theoretically instead of reciting them."

The teachers think that incorporating the problem solving into STEM integration makes a big contribution to students to think independently. The fact that the students can produce their own ideas through brainstorming and respect to the ideas of their group friends has been also valuable for the teachers.

As P1 emphasized "I enable the students, on their own, to find the solution of real life problem given in the scenario at the beginning of the lesson through brainstorming.

P2, on the other side, said "I ask the students to create a product in a STEM activity because I want them to use their imaginations and creative ability in order to create a product. The fact that the students create a product is extremely important for their permanent learning."

Also, P3 said "Using the problem-solving skills in STEM integration allows the students to try new things. The students' learning by trial and error makes the learning more permanent. STEM integration gives students the chance to be a part of the scenario and motivates them to solve the problem."

P4 build STEM integration on the idea about how the students gather the information that they have learned. She, also, mentioned on this subject "In this way, the students actually practice what they have learned rather than reciting or repeating. STEM integration allows the students to use the information obtained theoretically instead of reciting them.

P5 believed that the teachers should encourage the students to think autonomously and emphasized that the students should become independent and be creative instead of guiding them, and then said about this subject as follows, "While the students find solution to the existing problem, instead of giving instructions, we should tolerate and not restrict them in order to put their own ideas into practice. This provides the students to produce authentic products which are independent and different from each other."

Teachers' views correspond to classroom practices in this theme. They want to think among different solutions for a problem that their students need to solve. In classroom practice, teachers encourage their students to try their own ideas to solve a problem / challenge. Students are asked to think about different ideas and solutions

even when they produce a product that meets or addresses the difficulty. Teachers think that thinking and experimentation, which are closely related to the engineering design of an STEM-enabled one, can help students approach their mistakes differently. These teachers' hopes helped them learn how to cope with the situations they perceived as failures in their lives by implementing STEM integration.

Implementions of STEM integration

According to P1, STEM integration is a teaching strategy that students can use to teach problem solving. It focuses on problem solving skills or problem solving processes from theoretical knowledge or STEM topics. I am emphasizing in my lessons that STEM is composed of problem solving processes which are the common goal of all, not in the way that different disciplines come together.

An open-ended real-life problem is a necessary component of P5 and P4 STEM integration course. P5 says: "I do not give answers [to students] when we do problem-solving work, even though students are accustomed to doing prescription experiments. We solved the problem for them. "And at these STEM events we brainstormed about real life issues and problems and tried to solve real life problems, not just at school or textbooks.

According to P2, “The STEM integration indicated that the way of use depends on how it fits with the content that it wants to teach. The implementation of the STEM integration also required consideration of science and engineering disciplines. He said: "Look at the content I want to teach. Then I think of whether to incorporate STEM activity into "and" STEM activities or integration is a tool that can be used by me to relate the learning of my students to what I can adapt to the content. In other words, STEM integration is an approach that contains many methods and techniques and I use it as a tool to teach content.”

Most of the teachers (P1, P2, P3) emphasized that the engineering design process is important for STEM integration. According to P2 “Successful completion of the application was due to the full implementation of the engineering design process” In this regard, P3 said: “The most important feature that distinguishes STEM integration from other approaches. It is necessary to follow the steps of the engineering design process to make a successful integration.”

Teachers' views correspond to classroom practices in this theme. They want students to use engineering design processes at all activities.

Conclusions

The purpose of this study is to analyze the views of the science teachers about in-class integration of stem applications. A series of interview questions addressed the teachers’ views of STEM integration and views of teachers about in-class STEM practices.

The participants believed that problem solving real life problems played an important role in STEM integration. All of the teachers thought that engineering design process were key of STEM integration. When the researcher compared the participants’ responses, the following terms were frequently identified from the analysis: STEM integration is solving real world problems, STEM integration is like a way in which scientific process skills, Engineering design process, creating their own product. For example, P1 described “STEM integration is to use Science and Mathematics in order to solve the real life problems”. P2 defined “STEM integration is like a way in which scientific process skills are used.” P3 defined this as the following “the [engineering design processes] are pretty valuable for STEM integration.” P4 thinks that “existing of a problem to be solved in product-focused activities is the crucial point.” The literature reviews supported these findings for example 3 teachers, participating in STEM program in this setting understand the STEM integration and how STEM integration is applied to the classroom (Wang, Moore, Roehrig and Park, 2011) the researchers have identified similar themes.

Teacher’s challenges and obstacles are time constraints, Experiences for STEM, Students‘ STEM ability. In support of these obstacles, time was a key factor reported by Gencer and Ozel’s (2012) study, which identified problems teachers faced during the implementation of STEM instructional process.

All of the teachers believed that STEM integration could teach the students a number of 21st century skills to need out of the science class. That strategy should include all the STEM disciplines and address the need for greater diversity in the STEM professions, for a workforce with deep technical and personal skills, and for a STEM-literate citizenry prepared to address the grand challenges of the 21st century Vann (2013) contended that teachers are a critical key to preparing students for the future workforce. Therefore, teachers need practical experience with STEM integration in the form of real-life, problem solving experience, so they can better encourage the students and help them develop the 21st century skills.

According to the teachers an open-ended real-world problem, problem solving process, and Engineering design process are necessary components of STEM integration. As outlined in the literature review. Examples of relevant definitions, as determined in the literature review. The National Research Council (2011) believes increasing the visibility of engineering and technology in STEM education is vital for the interconnections of teaching and learning. The outcome of integrative teaching by using engineering design is transdisciplinary learning through an authentic context that promoting student STEM literacy and readiness for STEM-related employment, which contributes to their own economic success as well as the nation's (NRC, 2011).

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