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Fifth Graders' Views on STEM Activities: A Case Study

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Abstract

Aim of this study was to investigate fifth graders' views on STEM activities. Thus, a three-week case study was introduced in this paper. The sample consisted of ten students (five girls and five boys). Study was carried out in two phases. In first phase, science and mathematical knowledge was introduced to students. In second phase, students were asked to design materials by applying engineering design process skills. Study was carried out with respect to case study design which was one of the qualitative research methods. Participants were recruited using convenience sampling, which was a purposive sampling method. Data were collected using a semi-structured interview questionnaire having five questions. The data were analyzed using content analysis. Content analyzes were carried out in four stages. Inter-rater reliability was calculated and found as 84.37%. Participants stated that STEM activities contributed significantly to science and math classes. Positive views stated by the students also indicated that students were able to make concrete learning from abstract topics. They acquired knowledge through experiencing. On the other hand, they also noted that they had faced numerous challenges during STEM activities. Conclusion drawn from the study implied that by taking necessary measures to avoid of negative aspects identified by the study, STEM activities would benefit fifth grade students.

Keywords: STEM, students' views, case study

INTRODUCTION

Countries focus on novel approaches to transform their education systems because they need qualified people with the right skills to face the challenges of ever-intensifying global competition (Karakaya, Ünal, Çimen & Yılmaz, 2018; Kızılay, 2018). One of those novel approaches is STEM education, which integrates science, technology, engineering, and mathematics and relates them to everyday life (Çakır & Altun Yalçın, 2020; Çakır, Altun Yalçın & Yalçın, 2018; Yıldırım, 2020).

Many countries (USA, Canada, UK, etc.) have integrated STEM into their education systems from primary school up to university level (Pehlivan, & Uluyol, 2019) because it helps students develop twenty-first-century skills (1), fosters successful collaboration between schools and industries (2), promotes vocational training (3), changes students'

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interests and attitudes for the better (4), facilitates science and math literacy (5), and contributes to the economic development (6).

STEM education should start early (Gonzalez & Freyer, 2014) because half the students lose their interest in STEM fields before they reach eighth grade (Allen, 2016). STEM education should start in early childhood to arouse students' interest and motivate them to pursue careers in those fields (Karakaya, Avgın & Yılmaz, 2018). Research shows that preschoolers who receive STEM education develop more positive attitudes towards those fields and are more interested in pursuing related careers (Yamak, Bulut & Dündar, 2014).

We provided fifth graders with a three-week program and then interviewed them. This study is important because we think its results will lay the foundation of STEM education tailored to fifth graders. There is only a small body of research on STEM education for fifth graders (Eker, 2020; Gülhan & Şahin, 2016; Yamak, Bulut & Dündar, 2014). Therefore, this paper investigated fifth graders' views on STEM education. The main research question was, "What do fifth graders think about STEM activities?"

METHOD

Design

This paper adopted a case study research design to obtain valid and reliable results on the effect of STEM education on students. A case study is a qualitative research design used to investigate and interpret a phenomenon within a real-life context (Merriam, 2009). It was the methodology of choice because we aimed to identify students' views on STEM education holistically.

Study Group

Participants were recruited using convenience sampling, which is a non-probability purposive sampling technique. Convenience sampling is a time- and cost-efficient method by which researchers select participants most suited to the research purpose (Patton, 2002). The sample consisted of ten students (five girls and five boys). Participants were assigned pseudonyms (Ahmet, Gül, etc.) to assure anonymity.

Data Collection Tool

Data were collected using a five-item semi-structured interview questionnaire developed by the researchers. Experts were consulted to check the questionnaire for intelligibility and relevance. It was finalized based on their feedback before data collection.

Data Analysis

The data were analyzed using content analysis in four steps: (1) transcribing the interviews, (2) starting the content analysis, (3) developing themes, categories, and codes, and (4) interpreting them. Two independent experts performed the content analysis. Each of them developed themes, categories, and codes. Afterward, interrater reliability was calculated using the formula [Reliability = (number of agreements) / (number of agreements + number

of disagreements)*100] suggested by Miles and Huberman (1994). The interrater reliability was ((27/27+5)*100)= 84.37%.

Stages of Intervention

Participants performed STEM activities for three weeks. We presented the activities in three stages. First, we provided science and math information to participants. Second, we presented a case and asked them to create designs by applying engineering design processes. Third, we interviewed them after the intervention.

RESULTS

Participants' Views on STEM Activities

Table 1. *Participants' views on stem activities*

Theme	Code
Views on activities	Learning new things (n=4)
	Fun (n=2)
	Related to everyday life (n=2)
	Learning by doing and living (n=1)
	Concrete learning (n=1)
	Learning retention (n=1)
	Promoting teamwork (n=1)
	Critical thinking (n=1)
	Contributing to career choice (n=1)

Participants had different opinions on STEM activities. However, they all talked about the advantages of STEM activities (Table 1). The following are some quotes from participants:

Erhan: I learned how to set up an electrical circuit by doing and living. I also think that the STEM activities facilitated concrete learning and learning retention by letting us use our hands.

Buket: It was like the STEM activities helped me with my possible career choice in the future.

Halil: I can say that I enjoyed doing the STEM activities.

Challenges of STEM Activities

Table 2. *Challenges of stem activities*

Theme	Code
Challenges	Inability to use materials (n=5)
	Communication problems (n=3)
	Not fulfilling personal responsibilities (n=2)
	Too much noise (n=2)
	Inability to share the workload (n=2)
	Lack of materials (n=1)

Participants' views of the challenges of STEM activities were grouped under six codes. They stated that they had faced different problems when performing the activities (Table 2). The following are some quotes from participants:

Buket: I had a hard time communicating with my teammates. Some of them did their part, but some others did not do any research at all.

Dilek: Each group was talking at the same time; it was too loud.

Erhan: I had a hard time stripping off the connecting wires and connecting the wires of the DC motor and the switch.

Contribution of STEM Activities to Classes

Table 3. *Contribution of stem activities to classes*

Theme	Code
Contribution of STEM activities to classes	Science (n=9)
	Math (n=6)
	Technology design (=1)
	Biology (n=1)
	Handcraft (n=1)

Participants noted that the STEM activities contributed to different classes (Table 3). The following are some quotes from participants:

Gülhan: The STEM activities contributed to science and math classes.

Halil: The STEM activities contributed to science and handicraft classes.

Medine: The STEM activities contributed to science and math classes, and also biology because it's about nature.

Integration of STEM Activities into Lectures

Table 4. *Integration of stem activities into lectures*

Theme	Code
Integrating STEM activities into lectures	Always (n=7)
	Often (n=1)
	Once a week (n=1)
	Sometimes (n=1)

Most participants stated that lectures should always include STEM activities. Other participants noted that STEM activities should be integrated into classes often, sometimes, or once a week (Table 4). The following are some quotes from participants:

Ahmet: I would like to have STEM activities from time to time because they take too much time.

Gül: I would very much like to have STEM activities once a week.

Mehmet: I wish all lectures were like that.

Favorite Parts of STEM Activities

Table 5. *Favorite parts of stem activities*

Theme	Code
Favorite Parts of STEM Activities	Designing (n=4)
	Learning science subjects (n=3)
	Doing teamwork (n=1)
	Girls can do it too (n=1)
	Thinking like an engineer (n=1)

Participants liked different parts of the STEM activities. However, they mostly liked the fact that the activities allowed them to make designs and learn science subjects (Table 5). The following are some quotes from participants:

Halil: Setting up an electric circuit was my favorite activity because I enjoyed doing it a lot.

Mehmet: I enjoyed working like an engineer.

Gül: Ma'am, it seems like girls can also make helicopters; it was my favorite activity, I mean, making a helicopter.

DISCUSSION and CONCLUSION

This paper looked into what students thought about STEM activities and discussed the results in reference to the literature.

The first research question investigated participants' views of STEM activities. Participants stated numerous benefits of the activities. They found the activities fun and noted that activities helped them learn new things and apply new knowledge to life. They also remarked that the activities promoted concrete learning, learning retention, and learning by doing and living. These results are consistent with the literature (Alıcı, 2018; Aydın, Saka & Guzey, 2017; Karışan & Yurdakul, 2017; Karslı Baydere, Hacıoğlu & Kocaman, 2019).

The second research question addressed the challenges of STEM activities. Participants stated that they had faced different problems when performing the activities. For example, they had difficulty using materials and communicating with their teammates. Some complained that their teammates did not fulfill their responsibilities. They also had a hard time performing the activities because they lacked some materials. This result is consistent with the literature (Alıcı, 2018; Yıldırım, 2016).

The third research question looked into how much students thought STEM activities contributed to classes. Participants stated that the activities contributed to science, math, technology design, biology, and handicraft classes. This result is consistent with the literature (Alp, 2019; Çetin, 2019; Güven, Selvi & Benzer, 2018).

The fourth research question investigated how often students thought STEM activities should be integrated into lectures. Most participants stated that classes should always involve STEM activities. The fifth research question addressed what parts of STEM activities students liked the best. Participants stated that they enjoyed making designs, learning science subjects, and collaborating with teammates. Literature on STEM activities presents similar findings (Kızılay, 2018; Tekerek & Karakaya, 2018; Yıldırım, 2016)

Limitations and Suggestions

The study had three limitations. First, the results are sample-specific and cannot be generalized to the whole population. Therefore, future studies should recruit students from other grade levels. Second, the STEM activities were completed in three weeks. Consequently, we do not have any data regarding their long-term effects. Researchers should conduct longitudinal studies to better understand the long-term impacts of STEM activities. Third, the data was based on self-report. Future studies should adopt mixed research designs to approach the topic from different perspectives.

Participants experienced some problems as they performed the STEM activities. Researchers should take those problems into account and design better activities. Participants demanded that lectures involve STEM activities. Therefore, lecturers should integrate different STEM activities into classes.

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