Journal of Social Sciences of Mus Alparslan University

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Araştırma Makalesi ● Research Article

STEM Activities Integrated with Drama: STEM+drama

Drama ile Bütünleştirilmiş STEM Uygulamaları: STEM+drama

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Öz: Bu çalışmanın amacı, ortaokul 7. sınıf matematik öğretiminde drama ile bütünleştirilmiş STEM uygulamalarının (STEM+drama) kullanımına yönelik öğrenci görüşlerini ve uygulama deneyimlerini incelemektir. Nitel araştırma desenlerinden olgubilim deseninin kullanıldığı araştırma, 22 ortaokul 7. sınıf öğrencisiyle yürütülmüştür. Araştırmanın etik kurul izni, Muş Alparslan Üniversitesi Bilimsel Araştırma ve Yayın Etiği Kurulu Başkanlığının 28.02.2022 tarihli, 42206 sayılı kararı ile alınmıştır. Verilerin toplanması amacıyla, araştırmacı tarafından geliştirilen yarı yapılandırılmış görüşme formuyla gönüllü 8 öğrenciyle odak grup görüşmesi ve süreç boyunca gözlemler yapılmış; elde edilen veriler tümevarımsal içerik analizine tabi tutulmuştur. Çalışmanın sonuçlarına göre; ortaokul matematik öğretiminde soyut kavramların daha ilgi çekici, zevkli ve eğlendirici biçimde somutlaştırılması ve eğlenerek öğrenme boyutlarında STEM+drama uygulamalarının etkili olduğu görülmüştür. Ayrıca elde edilen veriler ışığında öğrencilerin STEM+drama uygulamalarıyla matematik dersinde kendilerini aktif hissettikleri ve bu uygulamaların diğer derslerde de olmasını istedikleri söylenebilir. Uygulanan programla öğrencilerin merak duygularının, araştırma, sorgulama ve öğrenme isteklerinin tetiklendiği, sosyal ve akademik yönden geliştikleri, ilgi ve motivasyonlarının arttığı gözlenmiştir. Elde edilen bulgular literatür ışığında tartışılmış ve sonuçlar doğrultusunda gelecek araştırmalar için önerilerde bulunulmuştur.

Anahtar Kelimeler: STEM, Drama, Ortaokul, Disiplinler arası yaklaşım.

Abstract: This study aimed to determine secondary school students' views of STEM activities integrated with drama (STEM+drama) in seventh-grade math teaching. The study adopted phenomenology, which is a qualitative research design. The sample consisted of 22 seventh-grade students. Ethics Committee Report of the Research; It has been taken from the Muş Alparslan University Scientific Research and Publication Ethics Committee, with the decision number 42206, dated 28.02.2022. Data were collected using a semi-structured interview form. A focus group discussion was held with eight participants. Observations were made throughout the process. The data were analyzed using inductive content analysis. STEM+drama activities turned abstract math concepts into interesting and fun representations and helped participants enjoy learning them. STEM+drama activities made participants feel actively engaged in their own learning. Participants suggested that similar activities be integrated into other courses. STEM+drama activities stimulated participants and made them more enthusiastic about searching, questioning, and learning. STEM+drama activities also helped them

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Cite as/ Atıf: Öcal, E. (2022). Stem activities ıntegrated with drama: Stem+drama. *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, *10*(2), 665-679. http://dx.doi.org/10.18506/anemon.1096761
Received/Geliş: 31 March/Mart 2022
Accepted/Kabul: 26 May/Mayıs 2022
Published/Yayın: 30 August/Ağustos 2022

e-ISSN: 2149-4622.

develop social and academic skills and improve their interests and motivation. The results were discussed in light of the literature, and recommendations were made for further research.

Keywords: STEM, Drama, Secondary school, Interdisciplinary approach

Introduction

Societies that want to prosper in this age need citizens with problem-solving and teamwork skills who are bias-free and open to new things. They should also be able to provide work integrity and enjoy producing new things. These are all 21st-century skills, which are creativity and innovation, social and intercultural skills, flexibility and adaptability, initiative and self-management, productivity and accountability, leadership and responsibility, critical thinking and problem solving, communication, collaboration, media literacy, and information-communication-technology literacy (Akgündüz et al., 2015). Educational programs should help students develop these skills (National Science Teaching Association, 2011).

STEM education plays a key role in providing students with the opportunity to develop 21st-century skills (Asigigan & Samur, 2021; Çorlu et al., 2014; Tseng et al., 2013; Yıldırım & Altun, 2015). STEM education integrates science (S), technology (T), engineering (E), and mathematics (M). It is an interdisciplinary educational approach that can be applied at all levels of education (Özsoy, 2017). STEM is mostly applied in science and math courses, supported by technology and engineering (Asigigan & Samur, 2021). STEM education is popular because it helps students establish relationships between at least two disciplines, develop different perspectives, and put theoretical knowledge into practice (Akgündüz et al., 2015). STEM is an educational model that allows students to design things, organize data, make inferences, analyze, and learn permanently (Wang et al., 2011). STEM education is based on the premise that students use their existing knowledge to look for solutions to problems they encounter for the first time (Şahin et al., 2014; Wang et al., 2011).

Such approaches as STEM employ bi- or interdisciplinary perspectives to find unique solutions to problems (Klaasen, 2018). However, research shows that interdisciplinary approaches that integrate science and art help students develop positive attitudes towards science (Graham & Brouillette, 2016; Green et al., 2018; Öcal et al., 2021). Scientific culture and technology affect art, affecting STEM education (Herrmann et al., 2016). Art (A) has been integrated into STEM, and therefore, the concept of "STEAM" has been popular in recent years. The inclusion of art in STEM education promotes design and creativity skills (James, 2016; Wilson, 2018). Art should be integrated into STEM education to help students meet the needs of the 21st century and make them more interested in science. Therefore, curricula should offer STEAM activities (Braund & Reiss, 2019; Land, 2013).

Like STEM education, drama is a visual, auditory, and motion-based learning method that helps students develop 21st-century skills (Movassaghi & Growe, 2019). Therefore, drama can be a vital tool to grow students' interest in STEM fields (Walan, 2021). Drama makes learners more engaged, curious, and motivated and helps them develop academic and social skills and positive attitudes towards science and art (Öcal et al., 2021). Drama encourages learners to develop science-specific dialogues, generate ideas about the nature of science, and acquire profound perspectives (AnnBurke et al., 2018). Drama also promotes conceptual and interactive learning (Borrow & Russo, 2015; Dorion, 2009; Hendrix et al., 2012). Drama has artistic and educational dimensions that allow learners to participate in enjoyable learning processes actively and think creatively, critically, multidimensionally, and freely (McGregor, 2012). Drama brings together different disciplines and allows learners to establish interdisciplinary connections (Kolovou & Kim, 2020; Walan, 2020). Drama, which makes the symbolic language of science more understandable and accessible (Braund, 2015), can also contribute to meaningful learning in STEM activities.

STEM activities involve three stages: a well-organized preparation process (needs analysis and planning), design process (development activities and project planning), and implementation process

(Yılmaz et al., 2017). In this sense, drama is similar to STEM education. From a different perspective, the common goal of STEM and drama is to get learners to develop critical and creative thinking and problem-solving skills. Therefore, drama is an effective teaching tool that enriches STEM education (Özsoy & Özyer, 2018). STEM activities integrated with drama (STEM+drama) help students develop creative thinking and scientific process skills (Çilengir Gültekin, 2019). In addition, STEM+drama group activities can help students develop communication and cooperative learning skills and develop a sense of responsibility. The enactment and evaluation stages of STEM+drama lesson plans help students create products by blending creativity and math skills with technology and engineering skills. This allows students to develop problem-solving skills and collaborate to design products.

From the middle school years on, students become more aware of STEM professions (Knezek et al., 2013). The more positive attitudes they develop towards STEM fields, the more likely they will pursue careers in STEM fields (Christensen et al., 2015; Gülhan & Şahin, 2016; Wyss et al., 2012). STEM activities also help them perform better in math and science lessons and develop positive attitudes towards those courses (Çavaş et al., 2020; Herdem & Ünal, 2018; Stinson et al., 2010; Yamak et al., 2014; Yıldırım & Selvi, 2018).

The topic of "rational numbers" is a conceptually rich and complex math subject. Therefore, middle school students develop misconceptions about them and have difficulty learning them (Alacaci, 2014; Biber et al., 2013; Charalambous & Pantazi, 2007; Gökkurt et al., 2013; Işık, 2011; Işık & Kar, 2012). Such students also have difficulty learning decimals, equations, percentages, etc. (Alacaci, 2014). This study aimed to determine whether STEM+drama activities helped seventh-grade students learn rational numbers.

There is only a small body of research on STEM+drama activities. Özsoy (2017) conducted a study on STEM+drama and reported three results. First, the STEM activity process is similar to drama's planning and implementation processes. Second, STEM and drama have common goals. Third, STEM+drama helps learners develop 21st-century skills. Mathematics is a difficult subject to learn. STEM+drama activities enrich the affective aspect of math education and thus can be an alternative in math teaching. In the literature, there are studies in which STEM and Drama are used together (Villanueva Baselga et al., 2022; Özsoy, 2017; Özsoy & Özyer, 2018). However, no studies were found in which STEM and Drama were integrated with mathematics education. This situation reveals the originality of the study. We planned and implemented STEM+drama activities and asked students' opinions about them. The goal was to provide students with a student-centered, social, interactive, fun, and powerful learning environment and help them learn rational numbers and develop 21st-century skills.

The main research question was, "What do middle school students think about the STEM+drama activities tailored to seventh-grade math teaching?"

The subquestions are as follows:

1)What are middle school students' positive or negative views of the STEM+drama activities tailored to seventh-grade math teaching?

2)What do middle school students recommend regarding the STEM+drama activities?

Methodology

Research Model

The study adopted phenomenology, a qualitative research design (Merriam 2015). A phenomenological study explores and describes participants' lived experiences with a phenomenon (Creswell & Poth, 2016). This study focused on seventh-grade students' views of STEM+drama activities.

Study Group

The sample consisted of 22 students (five girls and 17 boys) of Hasköy Fatih Sultan Mehmet Imam Hatip Secondary School in Muş/Hasköy in the fall semester of the 2021-2022 academic year. Participation was voluntary. Eight participants (three girls and five boys) were interviewed. Interviewees were recruited using criterion sampling.

Data Collection Tools

Focus Group Interview

Focus group interviews are used to elicit data from a small group of people on a specific topic (Yıldırım & Şimşek, 2016). A focus group interview is a dynamic and creative tool to access deeper and richer data about a research problem (Krueger & Casey, 2000). The present study conducted a focus group interview with eight participants to determine their views of the STEM+drama activities tailored to maths teaching. She developed a 3-item semi-structured interview questionnaire. A STEM educator and a science educator checked the questionnaire for intelligibility and relevance. The researcher revised the questionnaire based on expert feedback and conducted a pilot study with three students. She revised the questionnaire again based on the pilot study results and conducted the main focus group interview.

First, the researcher checked the technical devices and then posed general introductory questions and reminded the interviewees of the focus group interview rules. The first question addressed the interviewees' positive or negative views of the STEM+drama activities tailored to math teaching. The second question elicited their recommendations regarding the STEM+drama activities. Before the focus group interview, the researcher briefed the interviewees about the research purpose and procedure. She also informed them that she would record the interview, keep their names confidential, and would not share the data with third parties. She posed follow-up questions to seek clarification and further information. She assigned a code to each interviewee (P1, P2, P3.....P8).

Observation Notes

Observations help us draw a comprehensive picture of certain behaviors and phenomena (Yıldırım & Şimşek, 2016). The researcher observed all participants and took notes throughout the process to confirm the data through multiple methods. She also recorded the interview to refine the observational data and examine the participants' behavior more deeply and repeatedly. She studied each recording to enrich the field notes. The observations supporting the interview data allowed her to explain the interviewees' views in-depth.

Data Collection Process

In the first stage, the researcher conducted a literature review on STEM, drama, STEM+drama, and math education. In the second stage, she developed a four-plan program on the topic of "rational numbers" with STEM+drama activities suitable for seventh-grade students' age and developmental levels. She used one of the plans each week.

The researcher developed a focus group interview questionnaire to determine the effects of the program and the experiences of the participants. She conducted observations and took notes throughout the process. This study was conducted between July 2021 and February 2022. The program lasted four weeks and 12 hours in total. The researcher drew up a report for the data from the interviews and observations. Table 1 shows the research process.

Table 1. Research Process

Date	Implementation
10.07.2021-15.08.2021	Literature review
16.08.2021-31.10.2021	Planning lessons for the topic of "rational numbers" using STEM+drama activities
01.11.2021-14.11.2021	Developing a focus group interview questionnaire
16.11.2021	Plan -1 (three hours)
23.11.2021	Plan -2 (three hours)
30.11.2021	Plan -3 (three hours)
07.12.2021	Plan -4 (three hours)
09.12.2021	Focus group interview (one hour)
10.12.2021-25.12.2021	Data Analysis
26.12.2021-20.02.2022	Reporting

Data Analysis

The focus group interview, observation notes, and video recording data were analyzed. The data were analyzed using inductive content analysis, involving coding, categorizing, identifying relationships between the categories, and creating themes (Patton, 2014; Saldana, 2019). An inductive content analysis, the researcher interprets data by associating themes, making sense of them, and making future inferences (Yıldırım & Şimşek, 2016).

The researcher transcribed the focus group interview, read the field notes multiple times, and watched the video recordings repeatedly. She brought together the common views under the same codes, such as "enjoying learning," "motivating," "interesting," and "time-consuming." She turned the codes into categories and then developed themes suitable for the research and constituted a meaningful whole. The researcher read the whole data repeatedly and checked the codes and themes. For reliability, an academic specialized in STEM generated codes and themes independently. The researcher and the academic discussed their codes and categories and generated new themes and categories. They selected the most recurrent codes and also revised some others. For example, they replaced the code "fear of making mistakes" (generated by the researcher) with the code "lack of self-confidence." They identified the relationships between the themes and organized them under the research questions. They reached a consensus, defined the findings, and turned them into tables. For internal reliability, the researcher provided direct quotes for each theme and code (Tables 3, 4, and 5).

Ethical Considerations

This study adhered to the rules specified by the Higher Education Institutions Scientific Research and Publication Ethics Directive. None of the actions specified in the second section of the Directive were conducted. Participation was voluntary. Parents were briefed about the research purpose, procedure, and confidentiality, and informed consent was obtained from those who agreed to have their children participate in the study.

Table 2. Ethics Committee Information

Board	Muş Alparslan University Scientific Research and Publication Ethics Committee

Decision Date	28.02.2022
Decision No	42206

Results

Participants' Views of STEM+Drama Activities Tailored to Math Teaching

The first research question addressed the participants' positive or negative views of the STEM+drama activities tailored to math teaching. The findings were grouped under the themes of "positive views" (Table 3) and "negative views" (Table 4).

Table 3. Participants' Positive Views of STEM+Drama Activities Tailored to Math Teaching

Category	Code	Participants	Quotes
Learning	Enjoying learning	1,2,4,5,6,7,8	**P1:** "*…It was a nice activity. We had so much fun. We played nice games, we had a nice time, and meanwhile, we got to learn math."*
	Learning retention	2,3,4,6,7,8	**P6:***"…We learned so well that we can figure out the same problems even when we see them next year."*
	Visual	1, 2, 3, 4, 8	**P8:***"…Lively and instructive figures and pictures help us learn better."*
	Applied	1, 3, 6	**P3:***"…My teacher would solve problems on the board, but I just couldn't understand the operations. But, I've figured out what is what thanks to the activities.*
	Effective	1, 2, 3	**P2:** *"… I think it was very effective. It helped us a lot, what with the lively figures and roles. The activities helped us learn math much much better."*
	Fast	7, 8	**P7:***"…I think that these activities (STEM+drama) are more effective and fun activities promoting learning retention. They helped us learn much faster.*
	Active	3	**P3:** *"…In the traditional method, the teacher does the math teaching. But the activities let us paint and learn both drama and math. We also got to tell things. My classmates who did not used to participate in class ended up doing it thanks to the activities.*
	Easy	4	**P4:** *"…It is fun and makes math easier to learn."*
Process	Engaging/ Motivating	3, 4, 6, 7, 8	**P6:***"…Our teachers would teach math like they told us fairytales. I would sometimes fall asleep during class. But now I understand rational numbers better, and I don't fall asleep. I listen to my teacher more carefully now.*
	Material use	2, 5, 6, 7	**P2:***"…For example, in traditional classes, we used to draw legos on the board, but with STEM, we can touch the legos. So, we got to learn better this way.*
	Teamwork/ Sharing	3, 6, 8	**P8:***"…It was nice because I got to work with my classmates. We shared what we knew with our classmates, and we learned much more quickly."*

A quiet working environment	8	**P8:***"... More students participated in class. Loud students turned quiet and started to participate in class."*

Participants' positive views were grouped under the themes of "learning" and "process." The theme of "learning" consisted of the codes of "enjoying learning," "learning retention," "visual," "applied," "effective," "fast," "active," and "easy" (Table 3). The observation notes supported the code of "enjoying learning:"

The students liked the activities. I didn't think they would be so enthusiastic. Even uninterested students participated in class. They were more eager. They loved the enactments. It was obvious that they enjoyed them…They were 100% focused. One of the students was cross with her classmates and tied her hands because she couldn't take as much part in the design process as the others. At the end

of the process, one of the students who were not interested in class asked me "Ma'am, are we going to have more of these activities?" which made me so happy. (Field notes: 16.11.2021)

The category of "process" consisted of the codes of "engaging/ motivating," "material use," "teamwork/sharing," and "a quiet working environment." The field noted supported the code of "engaging/ motivating:"

The students were prejudiced against and uncertain about the method before the activities. They warmed up to them and loved them after a certain point. The second activity: The students are very enthusiastic about the activity. They are much more comfortable, which helps them produce things. There was this activity about dramatization, and one of my students offered to be a customer, although there was no such role in the play. So, he played the role of a customer. During the enactment, he came up with his own lines. The students are more confident and enthusiastic about the second activity. They also improvise without getting too far from their roles. They ad-lib. (Field notes: 23.11.2021)

Table 4. Participants' Negative Views of STEM+Drama Activities Tailored to Math Teaching

Category	Code	Participants	Quotes
Process	Disruption of order in the classroom	1, 2, 3, 5, 7, 8	**P8:** *"...It's all a mess. I mean, everybody is walking around while we work in a group. I think it would've been better if it'd been more organized. There was chaos during the game. I felt bad when my classmates were talking to one another when I was doing my enactment.*
	Lack of material	1, 4, 8	**P4:***"...It'd have been better if there were more Legos and everybody participated in the game. A friend of mine had to borrow my scissors. There should have been more scissors.*
Individual	Inability to take part equally	3, 4, 5, 6, 7	**P7:***"...My friends wouldn't let me do anything during group work. It'd be better if there were an equal number of hardworking students in every group. I think I could have gotten a better role.*
	Lack of experience	1, 2, 3, 5	**P5:***"...We could have done better with the enactment if we'd learned about drama before. I had a difficult time because I didn't know anything about drama.*
	Lack of self-confidence	2, 4	**P2:***"... I was afraid of making mistakes. I was so stressed out by the thought that I was gonna say something wrong.*
Application	Time-consuming	2, 3, 4,6	**P3:***"... It's good that we can keep things in mind, but it's too time-consuming. If that's the case, we won't be able to do anything.*
	Challenging activities	2, 3, 5, 7	**P2:***"... I had a difficult time during the game of "guess what!" It'd have been better if it was easier. I had difficulty setting up the bridge. The legos should have been bigger.*
	Stealing ideas	4, 7	**P7:***"...We'd come up with a better design during the game of Lego, but some classmates from other groups checked out our design and made the same thing, which I didn't like at all.*
	Limited time to get ready	3	**P3:***"... We could've acted better if we had had more time, but we had limited time.*

Participants' negative views were grouped under the themes of "process," "individual," and "applied." The category of "process" consisted of the codes of "disruption of order in the classroom"

and "lack of material" (Table 4). The field notes supported the code of "disruption of order in the classroom:

When I presented the Legos, all students were so curious that they stood up and came up to me. I realized that they sometimes wouldn't listen to my warnings. (Field notes: 16.11.2021)

The students were too loud, including during the first activity. I sometimes felt like I lost control of the classroom. During the warm-up stage, I got students to do an activity with a pair of scales. I asked them to get in line, but despite my constant warnings, they were pushing and shoving one another, and some tried to cut in line. (Field notes: 23.11.2021)

The category of "individual" consisted of the codes of "inability to take part equally," "lack of experience," and "lack of self-confidence." the field notes showed that participants had a difficult time and could not participate in the activities equally:

They had a hard time using the materials to come up with stuff. I used the directives to help them out. There were far too many students, so not every student was able to participate in the activities equally. Some only had the chance to say what they were thinking. They seemed like they wanted to participate, but the limited time, space, and scenario stopped them from doing that. (Field notes: 30.11.2021)

The category of "application" consisted of the codes of "time-consuming," "challenging activities," "stealing ideas," and "limited time to get ready." The field notes corroborated the code of "time-consuming:"

After activity four, I can clearly state that the greatest challenge is limited time. Drama has its own application stage, and so does STEM. It takes too much time to execute a STEM-drama application stage. I never fell behind schedule, but it was hard. (Field notes: 07.12.2021)

Participants' Recommendations for STEM+drama Activities

The second subquestion asked participants for their recommendations about STEM+drama activities. Table 5 presents the results.

Table 5. Participants' Recommendations for STEM+drama Activities

Categories	Code	Participants	Quotes
Recommendations for Schools	More common	1, 2, 5, 7, 8	**P2:***"… Ma'am, I think those activities should be held in every classroom so that all students can participate in them."*
	Executing during mid-term breaks	7	**P7:***"…We'd better hold those activities during mid-term breaks so that we can go over the topics and achieve learning retention.*
	Performing once a week	3	**P3:***"…Ma'am, we should perform those activities once a week.*
Practical recommendations	Executing in out-of-school settings	3, 5, 6, 7	**P6:***"… We could have performed the activity of "land" outside the school on a plot of land. We could have made our enactments on a theatre stage.*
	Equal participation	1, 2, 3, 5	**P1:***"… Well, for example, only some of us were able to join the role-playing. We need scripts which that allow every student to participate. In that way, all students can have a part to play.*
	Different games	1, 3, 4	**P4:***"…We could have played "hot or cold." We could have played a different game with balls. We could write down numbers underneath the balls, put the balls in a bag, then choose balls one by one, and write down*

		those numbers on the board and add them up.
More material	4	**P4:***"…There should have been more material.*
Different topics	5	**P5:***"…I think we should do similar activities for different topics.*

Participants' recommendations regarding STEM+drama activities were grouped under the categories of "recommendations for schools" and "practical recommendations." The category of "recommendations for schools" consisted of the codes of "more common," "executing during mid-term breaks," and "performing once a week." The category of "practical recommendations" consisted of the codes of "executing in out-of-school settings," "equal participation," "different games," "more material," and "different topics" (Table 5).

Discussion

This study focused on middle school students' views of STEM+drama activities and reached important results.

Participants stated that the STEM+drama activities made them more interested in theoretical and applied math and helped them enjoy learning and learn faster. We can state that STEM+drama activities allow students to enjoy learning and make them more motivated. Participants also stated that the visual materials encouraged them to achieve learning attention. Research shows that STEM activities make students more engaged and motivated, resulting in learning retention (Altan et al., 2016, Baran et al., 2015; Bircan, 2019; Hangün, 2019; Şahin et al., 2014; Quang et al., 2015, Yıldırım & Selvi, 2017). Research also shows that STEM activities help students develop more positive attitudes towards math, have higher academic performance, and enjoy math more (Ceylan, 2019; Daymaz, 2019; Öner & Capraro, 2016; Şahin et al., 2014; Şireci, 2021). On the other hand, Erçetin (2021) reported that STEM activities did not affect students' academic performance and attitudes towards math. However, he found that STEM activities made students more interested in STEM-related professions.

Participants noted that they liked the STEM+drama activities because they were fun activities that allowed them to perform enactments and use materials to turn abstract concepts into concrete representations. They added that the STEM+drama activities diversified the learning process, encouraging them to work together to design products. Gümüş (2017) found that drama activities facilitated academic performance, positive attitudes, and learning retention. Borlat (2018) reported that drama activities promoted students' internal and external motivation. Özsoy (2017) also investigated the effect of STEM+drama activities and reported two results. First, STEM and drama methods have similar planning and implementation processes, and therefore, STEM+drama activities provide fun and lasting learning. Second, STEM+drama activities help students develop 21st-century skills. Our results are consistent with the literature.

Participants believed that they spent too much time on the preparation and application stages of the STEM+drama activities. The researcher observed that participants were concerned that they would not be able to cover the other math topics. The researcher thought that she gave participants enough time to prepare their enactments. However, participants' statements showed that the time given to them was not enough. Research shows that the limitations of STEM+drama activities are the lack of material and time (Ünal, 2019; Wang et al., 2011). Our results are consistent with the literature.

Some participants did not like the enactments because they had small roles. The number of participants was too high (n=22) for that kind of activity. Moreover, the plans were too intense. Therefore, not every participant had the opportunity to participate in the enactments. Participants also made a note of that and stated that every student should have a chance to have a role in enactments.

Participants had never had STEM+drama activities before. Therefore, they had a hard time with the activities due to their lack of experience. They were afraid of making mistakes, resulting in low self-confidence. Some participants noted that there should have been more materials in the activities. Wang et al. (2011) also found that the greatest challenges of STEM activities for teachers were the lack of time, material, and technology.

Participants recommended that STEM+drama activities be held in every classroom. They stated that STEM+drama activities should involve more children's games and materials. They also suggested that STEM+drama activities be tailored to other subjects and topics. They also noted that holding STEM+drama activities outside the classroom would have positive effects on their learning. Siew (2018) reported that science teachers recommended that STEM activities be held as extracurricular activities in appropriate settings. They added that this could let them overcome the problem of time constraints.

Overall, participants believed that STEM+drama activities could be used for math and other subjects. Research also shows that STEM education helps students develop math and problem-solving skills (Baran et al., 2016; Kopcha et al., 2017; Siew, 2018; Wang, 2013). If we can eliminate the problems regarding the application stage, we can ensure that STEM+drama activities make students more interested and motivated and help them have higher academic performance and develop more positive attitudes towards STEM fields.

Conclusion

STEM+drama activities tailored to math teaching are fun, active, effective, and visual activities that help students enjoy learning and achieve easy and fast learning. Students who participate in STEM+drama activities enjoy using materials and working in groups and become more motivated about math. However, STEM+drama activities have some challenges. Not every student is able to take part in them. Some students find some activities difficult to perform. They do not have enough time, material, experience, and self-confidence.

Students recommend that STEM+drama activities be more common and integrated with different games. They suggest that those activities be held for different subjects and topics in different settings. Moreover, they think that STEM+drama activities should offer more children's games and materials.

Limitations and Recommendations for Future Research

This study had five limitations. First, the sample was recruited only from the 7/B classroom of Fatih Sultan Mehmet Imam Hatip Secondary School in Muş/Hasköy, Turkey. Second, the sample size was small (n=22). Future studies should focus on different educational levels and recruit more students. Researchers should conduct similar studies and compare their results to ours. Third, this study adopted phenomenology, which is a qualitative research design. Future studies should employ mixed research designs to better understand data and results and deepen our understanding. In addition, researchers should look into the effect of STEM+drama activities on students' academic performance in math. There should be more projects, seminars, workshops, and conferences on STEM+drama activities to help educators recognize the shortcomings of the planning, implementation, and evaluation processes. Fourth, the sample had a skewed gender ratio (17 boys and five girls). Future studies should recruit an equal number of male and female participants. Fifth, the program was short in duration and narrow in scope. The program lasted four weeks and focused only on rational numbers. Therefore, the program may have been insufficient to produce the desired effect. Researchers should come up with more longitudinal plans and compare their results. The researcher observed that participants knew little to nothing about STEM and drama. Teachers should integrate the learning outcomes of STEM education into the math, science, and technology design courses. They should also integrate the learning outcomes of drama into the Turkish course. Schools should set up STEM-drama workshops. Authorities should integrate STEM+drama activities into curricula and

lesson plans in order to overcome the problem of time limitations. Math textbooks should include STEM+drama activities to make sure that students have enough materials to conduct STEM+drama activities with.

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