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Teachers' perceptions of utilizing virtual field trips for teaching STEAM

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This study aims to reveal teachers' perceptions of using VFT environments in STEAM teaching. The study's sample consists of 11 mathematics teachers who are graduate students at a state university. In this study, designed as a case study, data is collected with semi-structured interview questions developed by the researchers, participants' reflections, and classroom observations. As a result of data analysis, teachers' perceptions are discussed under four categories: usability of VFT in teaching STEAM, influences on learning, instructional strategies, and factors affecting choosing VFT. Participants perceive the strengths of using VFT environments as being able to experience real-life situations in the classroom, facilitating the integration of STEAM disciplines, and flexibility/ease of access. On the contrary, they perceive their weaknesses as having a membership fee, language problems, and finding the appropriate VFT to integrate STEAM disciplines.

Keywords: Virtual field trip, teacher education, STEAM.

Introduction

In the 21st century, the idea that students should acquire the skills of creative thinking, problem-solving, critical thinking, inquiry, design thinking, and effective communication has become increasingly widespread. As a result, educators seek new approaches that can effectively inculcate these skills in students (Schleicher, 2012). When countries' education systems are examined, it is seen that practices that adopt an interdisciplinary approach, particularly to train individuals who possess 21st-century skills, are gaining more popularity each day (Çorlu et al., 2014). For this reason, STEM education, an interdisciplinary approach, helps students see the knowledge they learn in science, technology, engineering, and mathematics courses as parts of a whole and provides authentic and interactive learning experiences included in the curriculum of many countries. STEAM, recently renamed by integrating art into STEM branches, is an innovative approach that supports students' active and creative participation. STEAM can improve students' motivation and class participation (Henriksen, 2014), critical thinking (Tippett & Milford, 2017), develop students' higher-order cognitive skills, and increase student engagement through inquiry and authentic problem-solving through the integration of different disciplines (Jacques et al., 2020). However, some factors, such as the use of wrong or ineffective teaching methods and techniques, the constraints in education policies, and the fear of being unsuccessful, may cause students not to choose STEAM branches or not to choose a career in these fields (Kitchen et al., 2018). Studies show that interest and motivation are essential for students to continue their STEAM education and choose professions in these fields (López-Iñesta et al., 2020). The delivery of STEAM teaching in the context of real-life situations, with authentic examples and in a practical, associative, and hands-on way, will increase students' motivation and interest. Out-of-school STEAM experiences, one of which is field trips, can boost STEAM knowledge and skills, motivation, and interest and provide real-life STEAM scenarios (Zhao et al., 2020). However, there are various obstacles and difficulties in implementing field trips, such

as lack of budget, crowded classes, transportation, extra workload, and accessibility for disabled students (Behrendt & Franklin, 2014). With the advancement of technology, the use of digital devices and applications supporting experiential learning in education is increasing. One of these technologies is virtual reality (VR) technology (Radianti et al., 2020). This technology can be categorized as immersive VR (iVR) or non-immersive VR, depending on the level of immersion. In non-immersive systems, the user interacts with a 2D image on the screen with devices such as a computer, keyboard, and mouse, and non-immersive environments are more accessible in classrooms today and have lower maintenance and operating costs compared to immersive environments (Srivastava et al., 2019). Virtual field trips (VFTs) are a technology that can help students understand STEAM topics better and experience real-life situations in the classroom (Truchly et al., 2018). Integrating the arts into STEM education through VFTs can provide authentic and powerful learning opportunities. VFTs can break down the rigid boundaries between disciplines and encourage educators to engage learners in creative and artistic problem-solving (Henrkisen et al., 2015; Jolly, 2014). Using VFTs, students can engage in creative synthesis where senses, prior experience, and new understandings produce new knowledge. STEAM teaching with VFTs aligns with the nonlinear problem-solving and open-mindedness of creative thinking, providing a space for students to use their imagination and fuel problem-solving (Petersen et al., 2020). For instance, Clary (2016) explains how technology connects students to National Parks, letting them explore and learn in impossible ways through textbooks alone. VFT helps STEAM classrooms solve real-world problems and projects in real locations. These environments have many advantages, such as providing flexibility of access to places that students have never experienced before, applicability at any time, and bringing places where it is expensive, dangerous, or impossible to be to the classroom environment (Petersen et al., 2020). VFT is generally defined as learning experiences in the classroom, allowing students to see, hear, and interact with different sites through technology. Connected learning theory is valuable when designing STEAM instruction incorporating VFTs (Ito et al., 2013). This theory emphasizes the connection between learning and interest. It suggests that effective learning environments should draw on individual interests and be peer-supported in a manner that acknowledges each member's contributions. VFTs can be a powerful tool for enhancing STEAM instruction by allowing students to explore real-world scenarios in a virtual setting. By incorporating VFTs and connected learning principles, STEAM educators can enhance students' engagement, interest, and achievement in STEAM subjects. However, how teachers perceive VFTs directly affects whether these environments will be implemented in the classroom. When the literature is examined, studies state that teachers' perceptions of using technology in the teaching process substantially affect technology integration into the teaching environment. Given this, exploring teachers' perceptions of VFT-supported STEAM teaching in classrooms becomes essential. More research is needed on the factors influencing teachers' perceptions to fully harness the potential of VFTs as tools for delivering authentic learning experiences. This is particularly crucial as VFT-supported STEAM education authentically utilizes technological tools to engage students in real-world, multidisciplinary challenges. Such an approach promotes a balance of social and cognitive learning, mirroring the subtle interpersonal dynamics observed in professional communities of practice (Lombardi & Oblinger, 2007). While VFT may seem like an excellent way to provide students with an authentic learning experience, it should be used by teachers and integrated into the classroom. Because teachers are key decision-makers in the

classroom, it is essential to understand the factors teachers consider when making these decisions. The current study aims to reveal mathematics teachers' perceptions of using VFT environments in STEAM teaching. To this end, the study's research question can be stated: "What are mathematics teachers' perceptions of using VFT environments in STEAM teaching?"

Method

Research Design

This study is part of a more comprehensive dissertation examining how teachers design VFT-supported STEAM education. The goal is to determine how mathematics teachers perceive using VFTs as a tool in STEAM teaching. Within the study context, a case study approach is used to investigate teachers' perspectives in detail (Creswell & Poth, 2016). The case in this research is defined as the teachers who participated in the graduate course. This graduate course is designed to teach teachers how to use virtual learning environments to teach mathematics in the context of STEAM in face-to-face and online education. In the first four weeks of the study, training is provided for teachers on STEAM, 21st-century skills, VFT environments, virtual manipulatives, and tools, after which three lesson plans prepared by the researcher for using VFTs as a tool in STEAM teaching are presented. During the implementation of these lesson plans, attention is paid to using different VFT environments and including different technologies. For example, in one of the presented lesson plan samples, a virtual aquarium was organized with "Aquarium Architect." During this VFT, participants were asked: "Visitors to the National Aquarium seek more than just a visual experience; they desire knowledge and understanding about the marine life they observe. Recognizing this, the Aquarium is set to launch a new section dedicated to educating the public about the significance of our seas and oceans. The highlight of this new area will be a grand cylindrical fish tank. You have been selected for a crucial role: to design this centerpiece tank. It should captivate the eye and embody sustainability, innovation, and education principles. Each choice you make should resonate with the beauty and importance of our oceans."

Participants

The current study group comprises 11 mathematics teachers (three secondary school and eight primary school mathematics teachers) who enrolled in a graduate course during the spring semester at a state university in Ankara in the 2021-2022 academic year. In this study, the convenience sampling method is used (Merriam & Tisdell, 2015). Among the study's participants, three teachers (Emma, Sophie, and Luna) continue to teach actively at a school. The other participants started their graduate studies right after completing their undergraduate education. As part of their four-year undergraduate programs, all participants completed a year-long field placement in schools where they could conduct teaching practices. Except for Luna and Sophie, Ph.D. students and primary school teachers, all participants are master's students. Kate, who registered for the course through the Erasmus program, and Julia are from different countries. None of the participants had experience in designing a VFT-supported STEAM lesson. The training process provided in this study enabled teachers to enhance their proficiency in utilizing VFTs for STEAM education. All teachers in the sample had previously taken technology and science courses (essential physics 1 and 2) as part of their four-year undergraduate programs in mathematics education. During the training sessions,

participants were instructed on integrating VFTs into their STEAM lesson plans, focusing on the essential objectives of the other subject areas as outlined in the curriculum without delving into excessive details. The aim was to help teachers create more engaging and meaningful learning experiences for their students using VFTs.

Data Collection and Analysis

The current study's data is collected through semi-structured interviews, reflection forms, and classroom observations. Interviews were conducted after the practice (following the 4-week training and 3-week sample lesson plan presentations), and teachers were assigned to create lesson plans incorporating their chosen VFT environments. These lesson plans were later put into practice during micro-teaching sessions in the classroom) to understand how the teachers saw the role of VFT in STEAM lesson designs. The interview form consists of two main parts and includes 18 questions. The researcher prepared the interview questions, which were shown to 2 academicians for their opinions and academicians' views taken in determination. The interviews lasted approximately 30-35 minutes and were conducted on Zoom. The interviews were also recorded with a voice recorder to prevent data loss during the interview. The participants had no time limit, and a trustworthy environment was provided for them to express their thoughts freely. Before the interview, the participants were informed, and consent forms were obtained voluntarily. The obtained data were wholly transcribed, and each participant was assigned a pseudonym and coded by the MaxQda 2022 program. Categories and subcategories were created with the content analysis method from the data obtained.

Findings

Teachers' perceptions were discussed under four categories: usability of VFT in teaching STEAM, influences on learning, instructional strategies, and factors affecting choosing VFT.

Usability of VFT in Teaching STEAM

Teachers' perceptions of the usability of VFT in STEAM teaching are discussed in four sub-categories: accessibility/membership fee, flexibility and ease of access, language problem, and interface structure of VFT. In the first sub-category, some teachers mentioned that while integrating VFT environments into STEAM teaching, they had difficulty finding VFTs suitable for the course's learning outcomes. They also emphasized that VFT environments are limited and often paid. Ada explained her experience while researching a VFT suitable for the STEAM lesson plan she prepared as follows: "I think it's a bit challenging to find a VFT that allows students to explore a beehive, observe, and examine the life of bees. However, I found a 360 video that provided this experience". She also emphasized, "The VFTs I could find abroad regarding this topic were, unfortunately, all paid.". Thus, having difficulty accessing full content without payment was one of the problems. Teachers also mentioned flexibility/ease of access regarding using VFT in STEAM teaching. Luna emphasized the flexibility created by visiting the different places in the classroom environment at any time through VFT by stating, "I can go and see it for free, even if I do not live there, we can take the tours with my students whenever we want and take my students for free." Bella, on the other hand, emphasized the advantage of going to the museum without any transfer and stated that VFT environments are easily accessible and help in saving time by stating, "I may not have a chance to

take them to the museum. I mean because it takes a day to get there if we organized a real trip. But here they can get in and out in a minute.”. Another sub-category within the scope of usability is the limited language support that VFTs have. Sophie pointed out that these resources are generally in different languages, and this may cause problems for students whose native language is not English as follows; “Here again, the fact that the tools are not in Turkish, in our Turkish education context and this can be a problem for them (for her students).” Lastly, within the scope of usability, Kate mentioned the importance of the interface of the VFT used during teaching as “I planned a VFT, but it was like in Google Street view, and therefore VFT was not very effective. So, it was like taking a uni-dimensional trip.” Kate noted here that some VFTs do not support interaction, and therefore teaching remains superficial.

Influences on Learning

Teachers' perceptions of influences on learning are discussed in five sub-categories: connecting STEAM disciplines, understandability of STEAM disciplines, engagement and active participation, distraction, and, lastly, real-life experiences / authentic learning context. Under the first sub-category, some teachers emphasized that VFT environments are very useful in linking STEAM disciplines with each other and presenting them to students simultaneously.

Denis: In PISA tower, students encounter real-life problems and see the connection of mathematics and physics with real life rather than as independent lessons. They need to pay attention to the center of gravity when constructing a cylinder physically (by Tinkercad), recognizing its properties a cylinder mathematically. They also benefit from each other's thoughts through artistic production.

Denis emphasized that VFT enables easy and natural connections between different disciplines and provides students with valuable examples of real-life situations involving these disciplines. Another point teachers emphasize regarding the effect of VFT on learning is that it supports students in understanding STEAM disciplines in depth by allowing them to experience it.

Sophie: How do we usually make a rectangular prism in textbooks? often simplified, with measurements given and students simply drawing or calculating. However, giving students a VFT to a forest and asking them to build a birdhouse where birds can live is not a ready-made task. They must consider some things and design something themselves, so they must be active. That's when they understand why they must calculate a rectangular prism's surface area or volume. Because to design these houses, they need to examine birds and trees. They must consider the size of the bird when designing the house.

Sophie emphasizes that through VFT, students can make observations and recognize the need for different mathematical designs for different situations. Additionally, she highlights that students will better understand why specific calculations are necessary. Another highlighted sub-category is that VFT could increase students' engagement and participation in the lesson. Emma stated that these environments could increase the student's curiosity about a subject that he/she does not initially find interesting as follows; “I expect students to gain an understanding of how airplanes work, including the concept of weight capacity, the center of gravity. I hope this will spark their interest in pursuing a career in aviation engineering.” Ada pointed out that starting the lesson with VFT attracts students' attention in the first stage and facilitates the process: “It gets attention quicker. For example, they will take a journey to the beehive. They have never been to a beehive before (laughs), and they will

observe the geometric structure of the beehive themselves through the 360 videos”. Another concern of teachers is that VFT may distract students from the main subject. Bella highlights that student engagement in VFT can challenge classroom management; “They may easily get distracted VFTs. While exploring the Louvre, I expect them to examine quadratic functions, but they might be captivated by different paintings. This could pose a challenge for me as an educator.”. The sub-category that most of the teachers especially emphasized was real-life experiences and authentic learning context. As Maria stated, these environments help students visualize their real-life situations in their minds as follows; “I don’t think most students go to the recycling center. The cost of recycling is also something they may not be aware of. Instead of trying to imagine something they haven’t seen, they discover it. Unbelievably nice comfort.”. Here, she draws attention to the fact that students can easily imagine these areas thanks to VFT environments and experience these environments themselves rather than being transmitted by someone else.

Factors affecting choosing to use VFT

Teachers' perceptions of the factors affecting VFT selection in STEAM teaching were discussed in 3 sub-categories, including required preparation, not skilled enough, and time pressure. Almost all the teachers emphasized that lesson plans involving these environments require a lot of preparation and research. It was pointed out that when planning the lesson, it is essential to carefully consider where to visit these environments, how to associate them with disciplines, and which connections to make. Emma pointed out that the process requires good preparation at the planning stage: "Well, you must think very carefully about the connections. It is important to create opportunities in the VFT for students to notice the weight capacity and to plan these opportunities accordingly". All the participants had never experienced VFT environments before this study. In this context, one of the sub-categories that all of them brought to the fore was that they needed to be more experienced. For instance, Maria stated, "The reason was that I had not seen VFT before, I had a hard time integrating recycling center with mathematics and the other disciplines," and Sophie stated, "But with what objective could I relate it to? This was difficult for me.". Both teachers emphasized that they had difficulties due to their inexperience in course design supported by VFT environments. Another sub-category affecting the integration of VFT environments into the lesson was stated to be time pressure. Maria expressed her opinions on this subject as follows; “I can say that there is no way to implement such a thing; as a teacher, we cannot do it. Applying such a lesson plan in the classroom means not being able to keep up with the curriculum.” The teacher mentioned here that VFTs would be time-consuming and not applicable in the classroom setting.

Instructional Methods

Instructional methods teachers prefer when using VFT in STEAM teaching are discussed in 2 sub-categories: student-centered teaching and collaboration. All the teachers emphasized that they would use student-centered teaching in designing a lesson with VFT. Emma stated, "I didn't tell them how the plane stays in the air; instead, I asked them to discover when the plane stays in the air by playing with the simulation included in the VFT and noticing the forces involved.” As can be seen, she describes a VFT-supported course design as a student-centered environment that supports students' exploration. Collaboration was one of the sub-categories emphasized by teachers in the lesson design

with VFT. Tina explained how the use of these environments in such a way as to support cooperation among students would lead to the emergence of different ideas to be discussed in the classroom environment as follows; "And students will visit there. Furthermore, I think they will want to share. So, I thought of designing a collaborative environment where students can share what they see with each other". She stated the importance of students sharing information they did not know but realized and learned in real-life situations with their classmates.

Discussion and Conclusion

The current study aims to reveal mathematics teachers' perceptions of using VFT environments in STEAM teaching. When the results are examined, almost all the teachers perceive that using these environments in STEAM teaching will provide authentic learning environments for students. Another point emphasized by the teachers was that these environments were easily accessible from the classroom. In addition, teachers drew attention to some of the limitations and disadvantages of these environments. It is seen that the problems that teachers draw attention to are time pressure, preparation, distraction, language problems, and accessibility/membership fees. Participants Emma, Sophie, and Luna, active teachers, drew attention to the difficulties of implementing these environments in classroom settings along with STEAM teaching. Teachers may think this way because of the current education system in Turkey. Within the scope of this research, the supportive aspect of VFTs to STEAM education was emphasized, and at this point, teachers' perceptions were determined. Understanding teachers' perspectives is the first step towards assisting future VFT-STEAM designs, guiding effective teacher education programs, and ultimately helping practitioners implement successful VFT-STEAM.

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