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Engaging Pre-service Teachers in an Online STEM Fair during COVID-19

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COVID-19 changed not only the way we live but also the way we teach and prepare pre-service teachers. The purpose of this paper is to describe the shift from a conventional STEM fair to an online teaching environment prepared by elementary pre-service teachers after the closure of the educational system in Cyprus as of March 2020. We describe a 3-steps process followed for the design, development, and delivery of the STEM fair concerning the technological equipment used, the activities' adaptations made by the pre-service teachers', and the level of readiness to teach online based on the initial outcomes of the STEM fair. The brief paper concludes with practical implications and suggestions for future attempts about online teacher education.

Keywords: Pre-service teachers; STEM fair; Online Education; Teacher Education; COVID-19.

Literature Review

STEM education is considered a transdisciplinary pedagogical approach as it brings together different disciplinary perspectives to solve real-world problems (Yakman, 2010; Guyotte et al, 2014). According to Menon and Sadler (2016) low self-efficacy is one of the main obstacles to effective primary STEM teaching, and this is especially true for pre-service teach-

ers (PSTs). Primary school teachers have low confidence in their ability to teach science STEM since they identify their limitations in STEM content (Norris et al., 2018). Therefore, to provide the necessary pedagogical skills to pre-service teachers, there is a need to move teacher preparation to one that enables them to go beyond covering the curriculum (Darling-Hammond & Bransford, 2005) to engage themselves in authentic STEM practices as learners and as teachers (Crawford, 2012). In our work we support that a STEM fair offers pre-service teachers: (a) the opportunity to explore in-depth a specific STEM topic as learners, (b) challenges their knowledge and skills as they interact with students, (c) provides experience working with students in smaller groups rather than in classroom settings, and (d) provides positive, authentic experiences to improve their low confidence (Avraamidou & Evagorou, 2007; Mbowane, de Villiers & Braun, 2017; NSTA report, 2012). The aim of this work is twofold: (a) to present how we moved from a school-based STEM fair to an online format due to school closures, and (b) to explore possible difficulties the PSTs might have because of the online mode of delivery.

Process

The participants of the study were 12 students studying to become K-6 teachers (PST) who attended two STEM education-related courses during Spring 2020 at the University of Nicosia, Cyprus. The course instructors (authors) planned to engage the PSTs in the preparation of a STEM fair as a way to provide an authentic learning experience (see Avraamidou & Evagorou, 2007 for details on STEM fairs for PSTs). The fair was planned to take place on March 22nd with the participation of K-6 students. The PSTs prepared their activities and received feedback from their instructors by the beginning of March 2020. When schools and universities in Cyprus closed because of COVID-19 we decided to move the STEM fair online. The development of the online fair involved four steps as outlined in Figure 1. The STEM fair was recorded (the language of interaction in Greek) and is available here: https://vimeo.com/420030615/fb8c626913

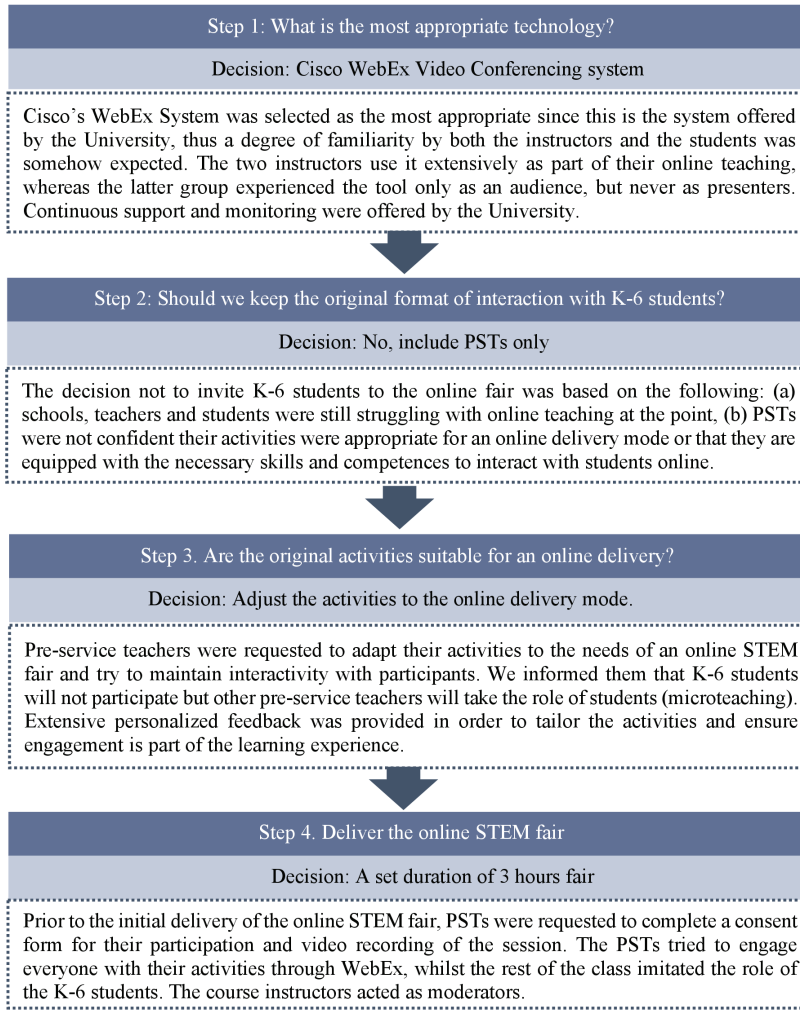

Figure 1. The flow-process for the development of the online STEM fair.

Results

This study was conducted within a theoretical framework that combines elements of case study design and grounded theory (Creswell, 1998). The cases of this study aim to use the replication logic according to which multiple cases within a study should predict similar or contradicting results (Yin,

2003). To explore possible difficulties that PSTs' might have because of the online mode of delivery, we focused on three of the PSTs as separate cases. The selection of the cases was based on two main criteria: (a) the different classroom behavior of the PSTs during the face to face instruction (see Table 2), and (b) the evaluation they received by their instructors during the online fair (see Table 2).

Table 1 presents a summary of how the three PSTs attempted to adapt their activity from a face to face to an online mode.

Table 1

Description of the activities designed before (campus-based) and during (online format) Covid-19

Case studies	Delivery method	Description of the activity
Case 1: Volcano eruptions	Face-to-face	A volcano model was built together with an investigation plan in which the pre-service teacher would use to ask the students during the implementation of the experiment including various substances and different quantities to make the volcano erupt.
	Online	The 3rd year PST started the presentation by asking questions to engage his classmates in the process of making predictions on what will happen when you mix soda and vinegar. Following the instructions from other PSTs, he conducted the experiment live engaging the audience in a collaborative manner via a set of critical questions which helped other PSTs explain the outcome of the experiment e.g. how can we make this volcano erupt? Why is this happening? In his reflection the PST referred to the disadvantage of not being able to engage K-6 students in the process, and also not being able to "play" with the activities prepared by other PSTs.
Case 2: How to blow a balloon on a bottle	Face-to-face	An investigation plan was prepared in which the pre-service teacher would use to ask the students to experiment with various substances and different quantities to blow the balloon on the bottle.
	Online	The 4th year student started presenting the process that led to the selection of the specific experiment. The student asked the audience to make predictions on what will happen if soda and vinegar were mixed in a bottle that is closed with a balloon. Then she presented a video of herself performing the experiment providing a detail description of the process followed without asking other PSTs to explain the outcome. In her reflection the student said that she chose the specific materials because are available in most homes but did not think of asking the PSTs to do the experiment at home.
Case 3: Exploring the planets using augmented reality (AR)	Face-to-face	An augmented reality (AR) environment was designed so students could learn about the planets through interaction. The activity was designed using an AR book and an application that could be downloaded on on a tablet. A set of questions were prepared to guide students in their exploration.
	Online	The PST presented the AR activity without involving the audience in any away despite suggestions by both instructors.

Table 2 presents a summary of data that were collected for the three cases. More specifically, during the semester we asked PSTs to reflect on different aspects of the courses, especially as we moved from a face to face into an online mode of teaching. The "Readiness to teach online" was identified through PSTs reflections and instructors' observations based on actions in technical, communicational and pedagogical dimensions. Instructors grouped PST's into high, medium and low-readiness level. A PST who was positioned in a high readiness level would be expected to demonstrate a good degree of performing technical tasks (such as design of learning activities that provide students opportunities for communication and interaction, complete basic computer operations [(i.e. sharing files and folders)], navigation through the Webex conferencing system, ease of use of digital tools, selections of the most appropriate tools to serve the needs of their activity and objectives). The Evaluation of Activity aspect that appears in Table 2 is the grade given to the PSTs for their STEM fair presentation with the following criteria (1) overall presentation (presentation skills e.g. voice, interaction with the audience), (2) organization of the selected Material (how well is the material presented?), Use of Multimedia (use of visual aids, clear slides etc), (3) Content understanding, (4) Presentation Preparedness (Ability to respond effectively to questions from the audience).

Table 2

Summary of the three cases

Aspects	Case 1	Case 2	Case 3
Teaching experience	No prior experience in schools, experience working in afterschool clubs	Moderate - attended school practicum on the current semester	No prior experience
Attitude towards online learning	Resistance towards online learning	Comfortable with online learning	Resistance towards online learning, less flexible
Face-to-face classroom behavior	Talkative in the classroom, reflective during classroom activities, contributed in group discussions and preferred hands-on activities and experiments	Talkative during classroom activities, not very reflective, contributed in group discussions	Less talkative, shy during classroom activities, not reflective, contributed to group discussions but not to whole class discussions
Technological readiness	Confident using digital technologies	Confident using digital technologies	Confident using digital technologies
Readiness to teach online	Ready	Could try	Not comfortable
Evaluation of activity	9.5/10	9/10	6/10

The information in the two tables outlines the following findings: (a) not all PSTs were able to engage the audience with their activities, mostly because they did not transform the activities in a way that would include online interaction, (b) all PSTs were comfortable with online technologies, and (c) not all PSTs presented a high level of readiness to teach online.

Implications for Practice

As evident in our findings, resistance to online teaching and technological readiness are not good predictors of teaching online. Furthermore, we hypothesize that the main difficulty PSTs faced was that they could not understand how to transform their activities in a way that would help them interact with the audience, probably because of their lack of experience with online teaching and learning. The below key implications can be highlighted from this brief:

Implication 1: The possibility of new school closures makes the need to prepare PSTs to deliver their classes online or in a blended mode imperative.

This is especially important for STEM courses that require different types of interaction, often including experimentation and participation in inquiry-based activities (Crawford, 2012). The process steps as outlined in Figure 1 can guide teacher educators to make adjustments and set up functional, online environments for PST preparation programs. Furthermore, teacher educators should also emphasize on the inclusion of pedagogical practices and tools related to online and distance learning and the use of virtual experimentation (de la Torre et al., 2013; Guimaraes, Cardozo, Moraes, & Coelho, 2010).

Implication 2: PSTs need time to appreciate the complexities on online teaching

PSTs need longer hours to become fully emerged in online teaching compared to a school-based setting (Moore-Adams et al., 2016) since remote teaching is a new experience. Sufficient exposure to various online teaching activities (as in the case of the online STEM fair) is a good foundation for pre-service teachers to engage in critical reflections of their activities and learn to meet the complexities and challenges of online or blended teaching.

Implication 3: Prepare teacher educators for online and blended learning

Teacher educators are not prepared to include practices related to online and blended learning in their teacher preparation programs (Bryans-Bongey & Graziano, 2019). In our study one of the authors is an expert in distance

learning and provided pedagogical support in the transition process. Our experience highlights the urgent need to prepare HE educators in two directions: (a) how to teach online, and (b) to explore the specific pedagogical practices that might be important in each field (i.e. use of virtual experimentation in science, group work) and include them in the teacher preparation courses.

Future Research

Our future research will focus on four different directions: (a) the analysis of PSTs' reflections, post-interviews, and the video of the online STEM fair to explore teachers' characteristics that make good predictors of online teaching readiness; (b) involving K-6 students as potential participants in the online STEM fair to simulate an authentic learning context, (c) exploring which online pedagogical practices and technologies might be best for the different aspects included in STEM teaching (i.e. virtual experimentation, group work, problem-solving), and (d) examine the current practices, necessary attributes, and level of e-readiness segments (i.e. technical administrative, pedagogical competencies) of PSTs› and instructors› to teach online.

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