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The Realities of Elementary Design-Based Learning in the Virtual Shift
SESSION VI: Virtual, Hybrid and Online: Lessons Learned
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Abstract

This presentation will provide an overview of research conducted during the pandemic and published in the Fall edition of the Journal of STEM Education: Innovations and Research. The timely study examined the effect of the COVID-19 pandemic on elementary teacher self-efficacy with design-based learning in either blended or online settings. In addition to looking at the status of design-based learning in elementary settings, this study also identified what resources and support elementary teachers need to administer design-based learning in an environment other than the traditional in-person setting. This qualitative study included semi-structured interviews with a sample of four elementary STEM teachers in rural and suburban school settings with a large range of experience in STEM education. The findings of the research revealed a dip or temporary decrease in all four teachers' self-efficacy in design-based learning at the beginning of the virtual shift elicited by the COVID-19 pandemic. A culmination of a lack of access to resources for both students and teachers, the teachers' lack of control and support for students in a virtual environment, and a lack of prioritizing STEM education amid the shift all contributed to this dip in the elementary teachers' self-efficacy. Along with these barriers, the research also revealed the teachers' solutions to these barriers including condensing or chunking design-based activities and the Engineering Design Process. In conclusion, the elementary teachers stated that support from colleagues, past higher education courses, additional time, and access to physical or monetary resources were needed to overcome the barriers that a virtual and blended learning setting created for design-based learning.

Introduction

In students' elementary years, entering the STEM pipeline through exposure to STEM has a significant influence on students' subsequent STEM experiences (Ball et al., 2017). Students are in their formative years early on in their K-12 journey as they undergo career development and exposure to career choice (Foltz et al., 2014). Design-based learning, one of the approaches to integrating STEM content, provides students with the opportunity to practice the critical thinking skills needed for the STEM pipeline (Change the Equation, 2012; Doppelt, 2009). Design-based learning, a traditionally hands-on approach, allows students to go through a full design cycle from planning to analysis, integrating a multitude of topics to help develop a prototype and solve a problem (Fortus et al., 2004). This instructional strategy for STEM education is used across K-12 grade levels, allowing students to build upon their design thinking across their academic careers.

The education system underwent an unexpected and startling transformation in the Spring of 2020 due to the COVID-19 pandemic as schools around the world shifted to virtual formats (Dibner et al., 2020; Ferdig et al., 2020). Many K-12 schools continued to deliver instruction in a

virtual format through the end of the 2020 school year, despite the many obstacles it presented to teachers across content areas and grade levels. As all teachers and school systems reevaluated their approaches, methods for STEM education were questioned given its traditionally hands-on nature.

To analyze elementary approaches for STEM education, this study, recently published in the Journal of STEM Education: Innovations and Research was developed to shed light on the changes in teacher self-efficacy with delivering STEM content using design-based learning in virtual and blended learning settings elicited by the COVID-19 pandemic (Sain & Bowen, 2022). Interviews were conducted to assess the evolving realities of using design-based learning in new formats with elementary students, looking at both teacher self-efficacy throughout this period of transformation and what they did to overcome the obstacles they faced. This study also sought to identify what elementary teachers needed in terms of support or resources to be able to implement design-based learning with their students in virtual and blended learning classrooms.

Methodology

This research by Sain & Bowen (2022) addressed two questions: 1) What is the effect of the COVID-19 pandemic on teacher self-efficacy in delivering design-based learning to elementary students? 2) What resources and support are teachers seeking to administer online or blended learning delivery of design-based learning with elementary students in the current environment?

Using a qualitative approach, the researchers analyzed elementary teachers' shifting self-efficacy by using design-based learning with their students in virtual and blended learning classrooms through virtual semi-structured interviews. The population for this study was elementary teachers using STEM pedagogical approaches, with a purposeful sample of four elementary STEM teachers. The teachers in this study volunteered to participate and ranged in geographical location and years of experience teaching. Before their interviews, the teachers completed the Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey (Friday Institute for Educational Innovation, 2012). The results of this survey were not used for the findings of this research, but rather provided the researchers with descriptive statistics on the teachers' experience with STEM education to ensure they were appropriate participants for this study. All four participants reported high self-efficacy and attitudes toward STEM content.

All participants were led through a semi-structured interview protocol with eight interview questions addressing both research questions. Six of the questions were dedicated to assessing the teachers' evolving self-efficacy with delivering design-based learning in virtual and blended learning settings. The remaining two questions asked the participants about the resources and support needed to be able to continue using design-based learning beyond the traditional in-person format. After the interviews concluded, the researchers used a transcription service and proceeded to create a qualitative codebook based on the participants' responses, allowing the researchers to stay rooted in the data and become familiar with the emerging themes. After the codebook was developed, the researchers analyzed the transcriptions using methods set forth by Creswell (2014). Due to their careers in STEM education, the researchers practiced reflexivity with the participants as they corresponded before, during, and after the interviews, as well as during the analysis of the results.

Results

Research Question 1

The first research question analyzed the effect of the COVID-19 pandemic on elementary teacher self-efficacy in delivering design-based learning. The findings across all interviews are outlined below.

Evolving Self-Efficacy

Throughout the interviews, all participants immediately dove into the first research question, discussing their self-efficacy and confidence in broader STEM education. Each of the participants reported that their initial self-efficacy with Integrative STEM education and design-based learning activities was high before the pandemic. Following this report, each of the participants also explained their subsequent decrease in self-efficacy due to the barriers elicited by the pandemic. One of the participants stated, "... it's just I'm still stuck on how do you do it virtually basically. I have no problem and doubt that I can do it. It's just taking the time to figure it out and making it work." It was evident across interviews that the participants' self-efficacy with design-based learning evolved throughout the pandemic.

Barriers to Self-Efficacy

After discussing their dip in self-efficacy due to the pandemic, the participants proceeded to discuss the barriers that caused this decrease. The teachers reported the shift to virtual learning as a significant barrier, with most stating that they struggled to support their elementary students synchronously without being in person. Another substantial barrier was the sudden shift in priorities within their schools. With all the participants teaching STEM exclusively, some reported having to switch their focus to support core subject areas. One participant stated, "...there wasn't an expectation for the kids to complete any specials." They continued to reiterate the shift in priorities by comparing their current situation to pre-pandemic priorities, "I can say for certain last year before March, STEM was pretty high up on the list."

Remedies

Several barriers were referenced that influenced the teachers' self-efficacy with design-based learning in virtual and blended settings, including being able to complete a full design-based learning unit with students in synchronous or asynchronous settings. As one participant said, "It's so hands-on based that it really handcuffs us in what we are trying to teach in that immersive collaborative purposely layout for how a STEM lesson or a design lesson should be." As the participants shared their experiences, they also brought attention to the remedies they developed to attempt to keep design-based learning as an instructional strategy for STEM. All participants referenced condensing or segmenting full-length activities, parsing out the Engineering Design Process into smaller segments, and developing activities that used only common household items. To allow students to continue doing design-based learning at home, one participant stated, "We found at home, design build-it projects. Things you can do with toilet paper rolls and toothpicks."

Research Question 2

The second research question asked participants about the resources and support they would need to be able to continue design-based learning with their elementary students in either a virtual or blended learning setting.

Teacher Support

One of the significant themes that emerged regarding support for teachers was support from their colleagues across different forums. Whether the support and guidance came from the teachers within their building, teachers across social media, or teachers from networking opportunities, the participants found significant value in their colleagues. Support from fellow teachers took the form of words of encouragement and brainstorming opportunities. One participant said:

> The more that you can collaborate with others and bounce ideas back and forth, the more heads are better than one type deal, that has definitely helped boost our confidence that we can get through this even in challenging times.

Academia

Another theme that resonated across interviews was the value of the participants' academic experiences on their ability to adjust their instructional strategies. Participants were not asked about their academic background, but it organically came to light as the participants shared that they pulled on knowledge gathered during their coursework in STEM education. One participant was pulling on pedagogy from their graduate degree courses, stating, "I had a class that focused on design-thinking and project-based learning and all that. I really try to, and I'm still trying to work through how that's going to look this year."

Time

At no surprise to the researchers, the participants discussed needing time to adjust to the changes brought forth by the COVID-19 pandemic in their interviews. Needing time to assess the changes and brainstorm ways to reconstruct design-based learning for the virtual and blended learning environment was an ongoing concern for the teachers at the time of their interviews which occurred at the end of 2020. This support went beyond just time in the classroom, to time in general as the world shifted beyond the education system, with one participant speaking for their colleagues, sharing:

> Any of them are teaching full-time, so for them to take the time beyond teaching full-time, some are going home to their kids who they're catching up with their work than at night. And then on top of that, trying to figure out what the heck am I going to teach next week? That's very overwhelming for people.

Needing Access to Resources

The last theme that all the participants referenced in their interviews was the urgent need for access to resources. These resources included instructional strategies and programs, finances for programs and technology, support and training with technology, physical access to the school to get teaching materials, and additional professional development. Two participants referenced that these resources were essential for elementary students who are in their formative years and need additional support and guidance. This lack of access to finances and resources molded into the earlier theme of STEM education as a plummeting priority as one participant shared,

"Whereas now I kind of feel bad for asking for anything because I know it's not their top priority."

Discussion

The results of this study provided timely information to the elementary STEM community, shedding light on teachers' self-efficacy with design-based learning in the virtual and blended learning environments mandated by the COVID-19 pandemic. There was evidence across each of the participant interviews of a temporary dip in the participants' self-efficacy in using design-based learning with their elementary students. Participants reported the barriers that contributed to this dip, including a lack of student resources, teachers' inability to support or control students as they traditionally do in the virtual environment, and the shift of priorities in schools. To address this dip, participants developed remedies that included condensing their activities, segmenting the Engineering Design Process, and implementing activities that only required common household items for students to complete at home.

In analyzing the results of the second research question addressing the resources and support elementary teachers needed to use design-based learning in virtual and blended learning settings, the participants presented several factors that the education field can continue to implement or start providing for help. The participants stated that support from their colleagues across platforms, their academic courses, time to digest and brainstorm, financial support, and professional development would help in making design-based learning equally as impactful for students in virtual and blended learning environments. The recommendation for more professional development supports research by Havice et al. (2018) on the value of professional development specifically for teacher self-efficacy with design-based learning.

Conclusion

This study identified the status of elementary STEM teachers' self-efficacy with design-based learning in light of the COVID-19 pandemic, the barriers that caused a dip in the teachers' self-efficacy, how they remediated the barriers, and what they would like to see to continue to explore using design-based learning in virtual and blended learning environments. Education stakeholders must use this information to further build on the resources available to all teachers that are navigating these new digital spaces, and the research community must continue to seek out information on ways to support teachers beyond those sampled in this study. Virtual and blended learning environments will continue beyond the pandemic, as will design-based learning. Elementary educators will be more likely to use this instructional strategy for Integrative STEM education if it is adaptable.

While this study contributed the knowledge of what teachers need, it also unintentionally identified what teachers have already done to mitigate some of the barriers faced by the COVID-19 pandemic. The participants in this research adjusted their design-based learning instruction accordingly to ensure their elementary students were still maintaining access to STEM education. It is worth noting these mitigations, including leaning on fellow teachers for support, adapting or segmenting the Engineering Design Process, and identifying free resources students can access from home, could help further the use of design-based learning with elementary students in virtual and blended education settings in the future.

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