Engineers in Action: Eswatini Suspended Footbridge
(Technical Paper)

The Failings of Online Learning for Elementary Education during the Covid-19 Pandemic
(STS Paper)

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Prospectus

Introduction

The “Wheels on the Bus” is a popular song sung among children in the United States as a way to stay entertained while riding the bus (The wheels on the bus, 2021). The United States is one of the countries in which this song is the most popular due to the many children who travel to school by bus. According to the Amalgamated Transit Union “more than 25 million children” ride a school bus (School Bus, n.d.). The sheer number of students that travel to school by bus demonstrates how easy it is for students to travel to their source of education in the United States. There are numerous forms of infrastructure in the United States that ensure that education is easily accessible. However, a guaranteed easy access to school is not something that holds true for many other places in the world. Julia de Kadt, a researcher for the Gautengy City Region Observatory, states that “there are still a number of primarily rural areas in South Africa where physical access to school remains extremely problematic” (Howard, 2018). For example, in Eswatini, a country located in Southern Africa, children have to travel over the Mtilane River every day to get to school. This section of the Mtilane River does not currently have a permanent bridge and will often experience flooding making it difficult and sometimes dangerous for students to travel to school. To solve this problem a suspended footbridge must be designed and constructed that will traverse the Mtilane River. The final technical deliverable will focus on the design process and the design of a suspended footbridge that will span across the Mtilane River.

Once a student is able to easily access their source of education, the success or failure of that education comes down to how well it is taught and received by students. Over the past two years, the United States educational system has experienced something never seen before, the Covid-19 global pandemic. The Covid-19 global pandemic caused around 124,000 schools to

shut down all over the United States in the Spring of 2020 (Map: Coronavirus and School Closures in 2019-2020, 2021). However, schools could not just stay closed for an indefinite amount of time. If schools did not open back up students would begin to fall behind which could have long-lasting effects. As a solution, schools were transferred to online and students began to rely on computers as their only means to access their education. However, the shift to online education was not a success story for the United States education system and more specifically for the United States elementary education. The STS research portion of this prospectus will explore further into why the United States reliance on computers in elementary education during the global pandemic was a failure rather than a success.

Technical Topic

In 2006, Engineers in Action (EIA), a non-profit organization, established their Bridge Program (What We Do, n.d.). The goal of the Bridge Program is to enable "today's students to become tomorrow's global leaders by building bridges with underserved communities" (What We Do, n.d.). Engineers in Action works with students from universities across the country to complete both the design and construction process involved with building bridges in communities that are currently isolated from required resources. Since 2006, EIA has worked with 32 different universities to construct 77 footbridges in 11 countries (What We Do, n.d.).

One of the countries that EIA's Bridge Program reaches is Eswatini, a country that is located in Southern Africa. The team will focus on the construction of a suspended footbridge that will cross the Mtilane River connecting the communities of Zombodze and Boyane. A footbridge is recommended for this community due the communities need to cross the river on a daily basis. Children are required to cross the river to go to school, while farmers and industrial workers are required to cross the river to access markets and work in the nearby city. The

Mtilane River also separates the communities from churches, bus stations and medical care. Currently, there is a temporary log bridge in place that allows the members of both communities to traverse the river. However, the Mtilane River experiences long periods of flooding that can occur all year round. The flooding makes it challenging and dangerous for both children and adults to cross the river. During the last three years, there has been six people injured trying to cross the river. To ensure both communities will have safe access to the necessary resources located on the opposite side of the river, the EIA has tasked the team with designing a suspended footbridge spanning across the Mtilane River.

In order to create a successful suspended bridge design, the team's first task is to analyze the information supplied by the EIA about the selected site. Analysis of the supplied information helps to determine the best approach to designing a bridge for this particular site. The information supplied includes details about the soil found on both banks of the river. A description of the soil types found at the site is used to determine if erosion will occur and if the site will properly support the bridge. Survey data, about the river and the river banks, is used to create a profile view of the location of the bridge. The survey data is then used with additional data about past storms to determine the highwater line for the river. The highwater line helps determine where the freeboard, the distance between the bridge and the highwater line, of the footbridge should be. Information about the surrounding area will also help determine the accessibility of materials required for construction. After the information supplied is analyzed, the next task is to design the suspended bridge. The information previously analyzed is used to compete calculations to determine requirements for the bridge. When designing the bridge, the team is responsible for following the design requirements set by the EIA. These design requirements consist of maximum and minimum measurements for aspects of the bridge like

span, freeboard, the height of the abutments, and the angle between the abutments and the bottom of the river. Using AutoCAD, a suspended bridge design will be created and drawn for the Mtilane River. After the suspended footbridge design is completed, the final task is to complete a construction and safety report for on site. This report will take into consideration the best way to safely construct the proposed footbridge design while on site in Eswatini. The final technical deliverable will consist of a completed design for a suspended footbridge that the EIA can safely and efficiently construct across the Mtilane River in Eswatini during the Summer of 2022.

STS Topic

During the Spring of 2020, the United States saw a drastic shift in their educational system. The Covid-19 global pandemic caused in-person schooling to be moved online. According to a survey completed by the United States Census Bureau during the pandemic at one point "93% of households with school-age children" reported that their children were using some type of distance learning (McElrath, 2020). Out of the 93% of households, 80% were using online resources as a substitute for in-person education (McElrath, 2020). Students from kindergarten to 12th grade began to attend classes using numerous video call platforms, like the now well-known Zoom. The United States educational system experienced an era that had never been seen before; a new reliance on computers to ensure that school-age children were continuing to receive their education. The computer presented itself as the United States saving grace in ensuring that students were still learning during the year and a half that the rest of society was in turmoil. Computers and education during the global pandemic appeared to have the means to be a success story for the educational system. Computers allowed learning to continue in a way that was safe for both students and teachers. However, this paper will look at

how the United States reliance on computers during the Covid-19 global pandemic was a failure for elementary education rather than a success story.

Elementary schools are considered “the most influential institution in children’s lives,” after family (Bennett, 1986, p. 1). The elementary school is where students develop “a strong foundation for further education” (Bennett, 1986, p. 2). For the past century the education system has relied on elementary education and educators to begin children in their learning experience. Since 1635, early education in the United States has consisted of children traveling to a school or classroom to receive their education (First Public School in America, 2013). Educators have been trained to teach their students in an in-person classroom. When the Covid-19 pandemic hit, 92.4% of teachers had never taught online school before (Marshall et al, 2020). However, due to the government’s goal of keeping students and educators safe, the educational system made an emergency transition to online learning. Educators were responsible for learning a new way of teaching online. The schools’ administrations were responsible for ensuring that all students had access to computers and the internet. Many elementary students had to develop a new understanding of how to use computers to access their school work as well as online classroom. While parents became responsible for ensuring their children were able to use the computer. The challenges that the educators, administrators, students, and parents faced when the transition to online elementary school occurred resulted in many problems developing throughout the school year. In looking at the failings in elementary education during the Covid-19 pandemic, that were a result of the United States reliance on computers to continue students’ learning experience, the United States education system can learn how to better transition to a new type of learning if another crisis would arise in the future.

To address the proposed research question, the STS theory that will be applied is the paradigm shift theory. Thomas Kuhn, a philosopher of science, was the first person to use the term paradigm shift (Thomas Kuhn, 2018). In 1962, Kuhn wrote a book titled *The Structure of Scientific Revolution* where he first introduced the world to the idea of a paradigm shift (DiBona et al., 2005, p. 253). Kuhn defines a paradigm shift as the evolution of a way of thinking (Kuhn, 2012). A paradigm shift occurs when there is a change, a shift, in the way society does something or how they think about or view something. Another way that the paradigm shift theory is viewed is through the Kuhn Cycle. The Kuhn Cycle is broken up into four different phases: pre-science, model drift, model crisis, and model revolution (McLeod, 2020). Breaking up the paradigm shift into four different phases allows the process revolving around the theory to be observed. Therefore, one can determine if a paradigm shift will actually occur or if the change has stopped during one of the phases and reverted back to the pre-science, the old way of thinking about something. In relation to the research question, society has seen many paradigm shifts occur as a result of the Covid-19 pandemic. The United States shifted from the in-person way that elementary education has been taught for centuries to a new online version. The paradigm shift theory will look closer at this change in education and the reason behind why it occurred, and then why the United States reverted back to in-person teaching rather than shift to online teaching. Applying the four phases of the Kuhn Cycle to the change in education can show why the cycle was not completed and a paradigm shift did not occur when it comes to the way that elementary education is taught in the United States.

Before applying the paradigm shift theory to the research question, it is important to take into consideration the varying critiques of this theory. One major critique of Kuhn's paradigm shift is how vague Kuhn is (Kordahl, 2018). Kuhn even admitted that his work created

"gratuitous difficulties and misunderstandings" (Kordahl, 2018). When looking at Kuhn's book, *The Structure of Scientific Revolution*, the reader can see how Kuhn often avoids directly defining all of the aspects of paradigm shifts, instead, he presents varying examples of scientific ideas that can be related to his view of what a paradigm shift is (Kuhn, 2012). Another critique surrounding Kuhn's paradigm shift is voiced by Steven Weinberg, a Nobel Prize-winning physicist. Kuhn believes that once a paradigm shift occurs then the old way of thinking is forgotten and no longer required, Weinberg disagrees (Kuhn, 2012). Weinberg discusses how even though a paradigm shift occurred related to Newtonian physics, Newtonian physics is still taught to new physicists (Weinberg, 1998). Contradicting Kuhn's belief that a paradigm shift results in the replacement of the original method, Weinberg discusses how paradigm shifts actually add on to the ideas that already exist rather than replace them (Weinberg, 1998). Many of the critiques related to Kuhn's paradigm shift is a result of his vagueness as well as his idea that paradigm shift results in complete replacement of an old theory.

Research Question and Methods

The methodology that will be used to answer the question, how was the United States reliance on computers during the Covid-19 global pandemic a failure for elementary education rather than a success story, is a discourse analysis. A discourse analysis will take into consideration different written sources related to the research question (Adolphus, n.d.). Analyzing these different resources allow conclusions to be drawn about the quality of elementary education received online during the Covid-19 pandemic. Sources that will be analyzed will include news articles that discuss how students, teachers, parents, and administrators handle the change to online school. Other sources that will be analyzed will be posts on varying social media platforms by students, teachers, parents, and administrators that

expresses their opinion about the new form of education that occurred. Another type of source that will be helpful in answering the research question is statistical data related to test scores that elementary students received before the pandemic and during the pandemic. One more written source that will be analyzed to answer the research question is the different curriculums that were used before the pandemic and during the pandemic. By looking at the differences in the curriculums a comparison of the quality of education received from each form of education can be completed.

Conclusion

This prospectus looks at the process that will be required to design and construct a suspended footbridge and the failings that were a result of the United States reliance on computers to continue elementary education during the Covid-19 pandemic. The final technical deliverable will focus on the pre-design, design, and post-design tasks that the team will complete in order to execute the design process required for building a bridge over the Mtilane River in Eswatini. Allowing the EIA to complete safe and effective construction of the designed suspended footbridge during the Summer of 2022. While the STS research paper will explore the impact of the reliance on computers in elementary education during the pandemic and shed a light on the failings that this solution had. This research will then help the United States education system determine a better way to handle a future crisis that will ensure the integrity of a student's learning experience does not suffer.

Works Cited

Adolphus, M. (n.d.). Use discourse analysis. *Emerald Publishing.* Retrieved from https://www.emeraldgrouppublishing.com/how-to/research/data-analysis/use-discourse-analysis

Bennett, J.W. (1986). The Year of the Elementary School. *First Lesson: A Report on Elementary Education in America.* (pp. 1-2) U.S. Department of Education.

DiBona, C., Stone, M., & Cooper, D. (2005). *Open Sources 2.0: The Continuing Evolution*. O'Reilly Media, Inc.

First Public School in America. (2013). National Geographic Society. Retrieved from https://www.nationalgeographic.org/thisday/apr23/first-public-school-america/#:~:text=Although%20it%20has%20changed%20locations,school%20is%20still%20operating%20today.&text=Background%20Info%20Vocabulary-,On%20April%2023%2C%201635%2C%20the%20first%20public%20school%20in%20what,was%20established%20in%20Boston%2C%20Massachusetts.

Howard, J. (2018). Boats, donkeys and their own two feet: How kids around the world get to school. *CNN*. Retrieved from https://www.cnn.com/2018/08/07/health/school-transportation-parenting-without-borders-intl/index.html

Kordahl, D. (2018). Did Thomas Kuhn Kill Truth?. *The New Atlantis*. Retrieved from https://www.thenewatlantis.com/publications/did-thomas-kuhn-kill-truth

Kuhn, T. (2012). The Priority of Paradigms. *The Structure of Scientific Revolutions*. Fourth Edition. (pp. 43-52). The University of Chicago Press.

Map: Coronavirus and School Closures in 2019-2020. (n.d). Education Week. Retrieved from https://www.edweek.org/leadership/map-coronavirus-and-school-closures-in-2019-2020/2020/03

Marshall, D.T., Shannon, D.M., & Love, S.M. (2020). How teachers experience the COVID-19 transition to remote instruction. *Phi Delta Kappan*. Retrieved from https://kappanonline.org/how-teachers-experienced-covid-19-transition-remote-instruction-marshall-shannon-love/

McElrath, K. (2020). Nearly 93% of Households With School-Age Children Report Some Form of Distance Learning During Covid-19. *United States Census Bureau.* Retrieved from https://www.census.gov/library/stories/2020/08/schooling-during-the-covid-19-pandemic.html

McLeod, S. (2020). Thomas Kuhn- Science as a Paradigm. *SimplyPsychology*. Retrieved from https://www.simplypsychology.org/Kuhn-Paradigm.html

School Bus. (n.d.). Amalgamated Transit Union. Retrieved from https://www.atu.org/work/school#:~:text=55%20percent%20of%20K%2D12,10%20billion%20annual%20student%20rides.

The wheels on the bus. (2021). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/The_Wheels_on_the_Bus

Thomas Kuhn. (2018). Stanford Encyclopedia of Philosophy. Retrieved from https://plato.stanford.edu/entries/thomas-kuhn/

Weinberg, S. (1998). *The Revolution That Didn't Happen.* The New York Review of Books.

What We Do. (n.d). Engineers in Action Bridge Program. Retrieved from https://www.eiabridges.org/what-we-do

*Information related to the Eswatini site was given to the team by the Engineers in Action Bridge Program