Jessica Kerr in LDT

Overview of Scholarship

My research is focused on coding and robotics at the K-5 level. Throughout my graduate studies, I discovered a passion for providing spaces for younger students to learn what coding is, how to code, and why it is important. I have had a few opportunities to teach some coding lessons with K-5 students through classroom assignments, after school robotics clubs, and explicit computer science lessons. Through these limited experiences, I have been amazed at how quickly young learners have grasped coding concepts which seem complex. I am particularly drawn to coding and robotics because it provides a space for all students, regardless of their socio-economic background, academic ability, gender, race, etc, to gain important life skills. Coding and robotics helps students gain computational thinking, problem solving skills, creativity, and collaboration skills by productively struggling through coding tasks. The research I am proposing is focused on two ideas. The primary purpose of my proposed project is to study students' development of computational thinking through the use of unplugged and plugged activities. To conduct my study, I intend to provide a 10 week afterschool coding club at a local elementary school for 12-20 3rd-5th grade students. The study aims to begin with unplugged coding activities in order to build foundational coding skills, such as algorithms, loops, and debugging, as well as computational thinking (Hermans & Aivalogiou, 2017). The afterschool program will then explore learners' ability to transition the knowledge and skills they gained through the unplugged activities to a hybrid of unplugged and plugged activities (Microsoft Bits, educational robots, Makey-Makey, etc), and ultimately to plugged activities (Scratch).

The second purpose of the study is to determine how teaching elementary students to code and develop computational thinking skills might support the learning of mathematical

concepts. For the purpose of this study, I will be using Georgia's Mathematical Standards (Georgia Department of Education, 2023). In 2021, the Department of Education created new mathematical standards which "focus on strategic mathematical thinking and reasoning" and "align mathematics to industry and workforce needs and 21st century skills" (2021, pg. 3). Since there is a shift towards mathematical thinking and reasoning in the new standards, I aim to determine which specific standards can be supported through unplugged and plugged coding activities. The data gathered in this study will be used to inform future research and curriculum design.

Learning Theories

My proposed research is designed with a problem-based learning (PBL) structure, which is based in a constructivism learning theory. The primary focus of my research is to observe how students develop computational thinking through both unplugged and plugged activities. Computational thinking is the ability to analyze a problem, break it down into smaller parts, and formulate a solution. PBL provides an environment which is conducive to coding and the development of computational thinking because it allows students to design solutions within the context of meaningful problems (Schmidt, Loyens, et al., 2007, as cited in Norman & Schmit, 1992). Through PBL, students work collaboratively to figure out a code which can accomplish the presented task. Students construct their knowledge by building off of their prior knowledge and productively struggling. In this model, the teacher serves as more of a guide for student learning. By implementing a constructivist learning theory, I can focus more on how students problem solve and create their code, rather than whether or not they created the "correct" solution.

Research Design

For my research, I plan on implementing an action research design method. As mentioned previously, my proposed research is centered around conducting an afterschool coding club for 12-20 3rd-5th grade students at a local elementary school. The club will meet for an hour after school, once a week, for 10 weeks. The program will begin by introducing coding concepts through "unplugged" activities and transition to "quasi-plugged" activities , and "plugged" activities.

In my current design of the afterschool program, we will spend the initial three weeks learning the fundamentals of coding, such as algorithms and loops, through the implementation of unplugged activities. To plan my unplugged activities, I intend to use CS Unplugged and Scratch's curriculum as resources. The next three weeks will be focused on observing students' ability to transition computational thinking and coding skills to a hybrid of unplugged and plugged activities. For this stage of the program, we will use Microsoft Microbits. The final three weeks will focus on applying the skills developed to the most abstract stage of the program, plugged activities. For this stage, students will use Scratch to code. An additional tenth week has been built into the program to allow extra time for students to complete tasks.

To capture students' thinking, I intend to have video recording of students' conversations and interactions as they complete coding tasks and activities. The captured body movements will be analyzed to determine if movements are a part of students' thinking as they transition from unplugged to plugged activities.

Strengths, Limitations, & Implications

As I begin my research journey, I am excited to learn more about the LDT field and how coding and programming, specifically, play a role in young students' learning. My study will be strengthened by the passion I have for not just coding, but how it can enhance the learning of

elementary students. Since I am currently teaching at a local elementary school, I have easy access to an experiment site and participants. Another strength of my study is the nine years of teaching experience I have, specifically in the STEM content areas. As mentioned previously, I have some experience planning and teaching elementary students coding basics. My experience in this type of instruction will help me as I design my afterschool coding program. My knowledge of Georgia's Mathematical Standards will also be beneficial as I seek out opportunities to integrate coding and computational thinking into mathematical instruction and plan potential future research studies.

Strengths, Limitations, & Implications

As I design and prepare my research study, I have discovered a few possible limitations. One possible limitation is finding enough students to participate in the study. Since I plan to work with a vulnerable population, I not only need to have enough students sign up to join the coding club, but also receive permission from a legal guardian for students to participate in my study and be video recorded. Another possible limitation I foresee for my study is ensuring consistency of students' participation and attendance. Since I intend to conduct my study over the course of 10 weeks, I run the risk of having students potentially missing one or more sessions. These potential absences will need to be considered while analyzing the data. A final limitation I must consider for my research is the possibility of my own personal bias while analyzing the data. Since I work in the school I plan to conduct my research, there is a possibility that I will have former students participating in my study. This bias is one that I will need to disclose and keep in mind as I analyze the data.

In the readings I have completed so far, I have found that there is a lot more literature on the impact of coding and robotics at the middle and high school level, but less at the elementary

level. Through my research, I hope to bring more literature and data to those interested in the positive impact coding can have on elementary students. It is my intention to not only add to the learning, design, and technology field, but to find opportunities for my research to support fellow educators interested in integrating coding into their elementary curriculum and instruction.

References

CS Unplugged (n.d.). *Home*. https://www.csunplugged.org/en/

Georgia Department of Education. (2023). *Mathematics K-5*. https://www.georgiastandards.org/Georgia-Standards/Pages/Math-K-5.aspx

Georgia Department of Education. (2021, October). *Georgia's K-12 Mathematics Standards: Explanation of Changes and Improvements*. https://www.georgiastandards.org/Georgia-Standards/Pages/Math-K-5.aspx

Hermans, F., & Aivaloglou, E. (Eds.). (2017). *Proceedings of WiPSCE '17.* ACM Digital Library. https://doi.org/10.1145/3137065.3137072

Microsoft MakeCode. (n.d.). *Home*. https://makecode.microbit.org/

Norman, G. R., & Schmidt, H. G. (1992). The psychological basis of problem-based learning: A review of the evidence. *Academic Medicine*, *67*, 557-565.

Scratch Foundation. (n.d.). *About Scratch*. https://scratch.mit.edu/about

Schmidt, H.G., Loyens, S.M.M., van Gog, T., & Paas, F. (2007). Problem-based learning is compatible with human cognitive architecture: Commentary on Kirschner.