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Digital Literacy, PBL pedagogies and drones for preservice teachers: Using reflexivity while designing an intervention

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Teaching coding is complex. Teaching coding to higher education students enrolled in teacher education courses who lack a background in technology education is even more so. This paper presents the first phase of an exploratory sequential designed study that investigates how digital literacy and problem-based learning pedagogies, meshed with drone activities can be used to help pre-service teachers develop an advanced level of program knowledge and skills. This paper will look at reflexivity in the research process of designing an intervention for pre-service teachers.

Keywords: STEM, drones, digital literacy, problem-based learning pedagogy, coding, reflexivity

Introduction

STEM instruction has been emphasized in education since the 1990s (Vela, 2021). Integrating digital pedagogies into the curriculum has become widespread in many national education systems, highlighting the need for digital technology teachers who can provide quality instruction to prepare secondary students for 21st Century careers (Chugh et al., 2023). Digital literacy has become a vital skill and it is essential for teachers to implement digital technologies into their classrooms to develop students' higher-order thinking and problem-solving skills (Quann, 2015). While there is existing literature on teachers' digital literacy competencies (Tomczyk, 2020), limited research focuses on enhancing the skill set of pre-service teachers to facilitate the improvement of digital literacy among their future students. This paper will present the first phase of an exploratory sequential designed study (Creswell, 2009) to upskill higher education students enrolled in teacher education courses on digital literacy and problem-based learning (PBL) pedagogies using the coding of drones. Specifically, the larger study examines how Michelle designs and leads the workshop to show pre-service teachers how to implement a drone coding project, integrating the teaching of digital literacy competencies and PBL pedagogies. The first phase of the project focuses on research reflexivity by analysing Michelle's reflective practices during the workshop design process. In this phase, Michelle will consider how to design a workshop so pre-service teachers learn coding concepts, develop technology skills, and gain the ability to impart these skills to their students.

Literature Review

Digital Literacy, Problem Based Learning and Drones in Education
Coined by Gilster (1997), the term 'digital literacy' focuses on the critical thinking skills users need to operate digital technologies and emphasises that it does not need to include programming or creating technology, it is focused on the operation of the technology. Others have continued the discussion on defining digital literacy in educational contexts by calling for a need to create a framework for teachers' digital literacy (Pacheco-Guffrey, 2021). This is supported by studies to gauge pre-service teachers' scientific beliefs and digital literacy (List et al., 2020). One approach to developing digital literacy is through PBL, a pedagogy designed to help students develop strategies to solve complex problems while learning discipline specific knowledge (Finkle & Torp, 1995). This pedagogy is beneficial because students are required to use a variety of resources, content-specific knowledge, and problem-solving strategies to present results to the problems which increase in complexity as new concepts are taught (Stanley & Waterman, 2000). The collaborative nature of PBL allows students to explore multiple solutions and expand their knowledge through peer interaction.Using drones through PBL has become a popular practice in education (Chou, 2018; Jayaratne & Smilnak, 2020), providing students with concrete experiences in which they interact with complex abstract and/or theoretical knowledge to develop answers to problems and test the results of those answers (Duraj et al., 2021). It has also been demonstrated that using drones and PBL pedagogies can help students develop a range of coding skills, from simple level coding to more advanced levels in higher education programming units (Bai et al., 2021). While there are studies to understand how teachers perceive the implementation of drone technology (Ahmed, 2021), there are limited investigations on building pre-service teachers' skills using drone technology in classrooms, apart from one case presenting the needs and readiness of pre-service teachers to implement drone technology in their classrooms

(Ng & Cheng, 2019).

Reflexivity in Research
As Michelle is engaged in the implementation of this technology with pre-service teachers, it is relevant to discuss the importance of reflexivity in this research, as this is a critical process that enables researchers to examine their own biases, assumptions, and positionality (Mortari, 2015). Similarly, reflexivity in social science research refers to an iterative and self-reflective process wherein researchers critically analyze their own subjectivity and its potential impact on the research process (Olaghere, 2022). Researchers adopt a reflexive approach to enhance transparency of the chosen research elements, or methods (Olaghere, 2022). However, there is limited discussion in the professional literature on reflexivity during intervention design. By embracing reflexivity during intervention design, researchers can enhance transparency and ensure that their intervention is appropriate to the research goals, as well as inclusive and ethical. Incorporating reflexivity into research design requires a systematic and intentioned approach. This begins by documenting personal reflections and engaging in regular self-assessments throughout the research process. There are various methodological approaches that can be employed to practice and document reflexivity (Finlay, 2002), such as journaling and diary techniques that involve recording personal reflections and insights into the research process. In conducting a thematic analysis and coding, researchers then systematically identify and analyze their own biases within the data analysis process.

Research Design

The research design for the larger study is based on using an exploratory sequential strategy (Creswell, 2009) under a Mixed-Methods methodology to study a program of inquiry using both qualitative and quantitative methods (Olaghere, 2022) (see Figure 1). Phase 1 used reflexivity practices to design the workshop as well as the research procedures (Mortari, 2015). Multiple researchers analyzed the reflections to ensure the application of triangulation (Denzin, 2012). Phase 2 will include implementation of the designed workshop for the pre-service teachers and will utilise a pre-test post-test research design to measure the pre-service teachers' perceptions before and after the workshop. The research question for the larger study is: What are the pre-service teachers' self-perceived levels of comprehension of programming skills and PBL pedagogies? A repeated measures ANOVA will be run to demonstrate a significant change in the surveys after the intervention. Phase 3 will include an interpretation of all data. This paper will focus on presenting the findings of Phase 1 of the larger project, which is taking a look at the reflexivity practices used to design the intervention, or workshop.

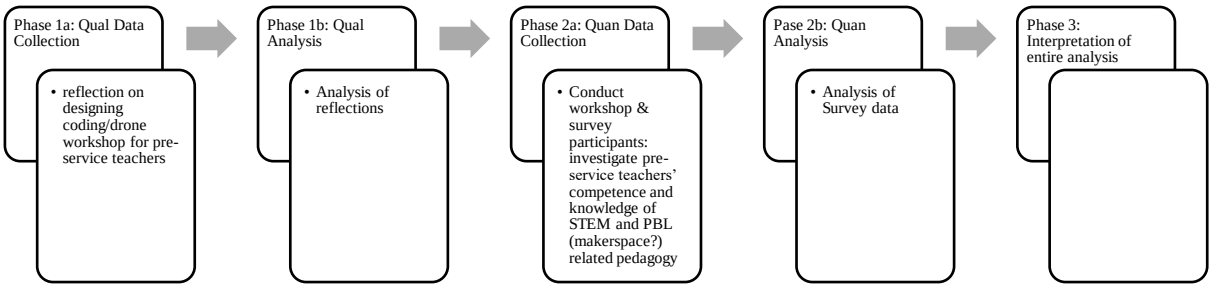

Figure 1: Exploratory sequential design (Creswell, 2009) of pre-service teacher drone workshop project

Position of Researcher (Michelle)
Michelle recognises the imperative of providing pre-service teachers with professional development (PD) opportunities focused on the use of technology. In a rapidly evolving digital era, this is just part of our daily lives, and its integration into educational settings needs to enhance teaching and learning experiences. This is crucial in preparing educators to meet the needs of students and create engaging learning spaces. By equipping them with the skills and pedagogical knowledge necessary for effective technology integration, teachers are empowered to foster active learning, critical thinking, and personalized instruction. Ongoing support and collaboration for teachers are key to ensuring successful implementation. As a researcher, Michelle is committed to promoting the benefits of technology in education and advancing best practices in pre-service teacher training.

Findings

An analysis of the reflections of Michelle during the intervention uncovered three major themes: consideration of 'Curriculum design,' consideration of 'pedagogical frameworks,' and consideration of 'technology challenges.' The following provides a discussion on the themes and how the intervention emerged.

Curriculum Design

When designing the intervention (PD activity for pre-service teachers), careful alignment was made with the existing curriculum to maximize its relevance. One of the first reflections stated, "teacher buy-in is important otherwise the teachers won't use it. Curriculum links are essential – link to specific content descriptions." By aligning the intervention with the curriculum, specific learning outcomes and standards could be addressed, ensuring that it directly contributes to students' academic growth. This coherence enhances the intervention's credibility and legitimacy among teachers, students, and other stakeholders. The reflections also considered the specific needs of pre-service teachers: "Most of my students want to learn something they will actually use in their future classrooms. Evaluations always note the importance of relevancy and practicality of course content." Before continuing with the other reflective themes, the intervention will be described.

Intervention

The intervention will focus on the Digital Technologies Curriculum (ACARA, 2014) with an emphasis on helping students "develop and use increasingly sophisticated computational thinking skills" (p. 3). Using this curriculum, the intervention was designed for pre-service teachers in a teacher education course. The project aims to show pre-service teachers how to implement a drone coding project that will incorporate the teaching of digital literacy and PBL pedagogies. Put in small groups, participants collaborate on activities that follow a sequence to embrace effective digital literacy and PBL teaching pedagogies.

This project sequence follows:

1. A review of common terminology used in coding drones (quadcopter, yaw, pitch, roll, etc) to help participants understand the drone and how it moves, which will be useful later during the coding of drones.
2. After completing a safety check, participants are able to fly the drones, following manoeuvring instructions.
3. Once the participants are familiar with the above, they will fly their drone through an obstacle course.
4. Next, participants are shown how to use the coding mode in the app and will be challenged to code their drone to survey a two-meter squared mat.
5. Participants will be expected to "walk the code," first to make sure their codes and measurements are accurate. Then, they can fly their drone to test their code and make revisions if necessary.
6. The final challenge will have participants coding their drone through the obstacle course.
7. Finally, participants will engage in reflective discussions about implementing similar projects in their future classrooms, including those on curriculum connections, drone safety, attaining equipment, considering location, essential technical drone skills, and potential technical challenges.

Pedagogical Frameworks

Using her prior experience teaching a 'Design and Digital Technologies' class for pre-service teachers, Michelle reflected, "When I taught DDT, we had students read about different pedagogies, different teaching frameworks. I remember PBL having an impact on students. They liked how this type of teaching had a student-centred approach and the critical thinking it inspired in students." Consideration of pedagogical frameworks before technology (Cowling & Vanderburg, 2020), such as PBL, was crucial in intervention design as they provide evidence-based strategies, support differentiated instruction, foster student engagement, and enable formative assessment, which will increase buy-in from the pre-service teachers, ensuring effective teaching practices and maximizing student outcomes.

Importantly, there are several chances for participants to learn digital literacy and PBL pedagogies through this process. For example, one of the first steps of this project is to teach common terminology for more effective communication and understanding of the technology. In literacy education, terminology has been categorised into three tiers (Beck et al., 2013): (a) Tier 1 - words used in everyday conversations; (b) Tier 2 - words used less commonly but can be found across disciplines and contexts; (c) Tier 3 - words that are subject-specific or technical terminology. To develop their understanding of the drone terminology, participants will have opportunities to learn and practice tier 3 words in an authentic context (Blachowicz & Fisher, 2000). In this project, participants will also be given opportunities to code, which is seen as a new literacy skill since coding uses a system of symbolic representation to communicate ideas (Weintrop & Wilensky, 2017). The intervention applies a PBL approach throughout the experiment since participants are asked to program the drones through different challenges (e.g. to survey an entire mat and manoeuvre through obstacle courses). After being provided with content knowledge, the participants must develop the answers through social interactions with their peers using problem-solving strategies (Hoople & Choi-Fitzpatrick, 2020). As participants successfully program their drones, new, more complex challenges will be provided to the participants.

Technology Challenges

Considering technology challenges is essential when designing a drone project of this nature for pre-service teachers. The integration of drones in schools offer exciting opportunities for hands-on learning and interdisciplinary exploration. However, it is crucial to address potential technology challenges to ensure a smooth implementation and maximize the learning outcomes of the project. The researcher included several reflections on her own experience with technology challenges that led to a step in the design that included discussion on potential challenges. The researcher reflected:

> drone connectivity issues with school firewalls! Don't forget to tell teachers that they will have to test the equipment and make sure the drones connect to the devices – devices may need to be disconnected from school's system….one big challenge is time! Time to charge all devices and drone batteries prior to lesson...Nothing worse than rocking up to a workshop with flat batteries!...other things to consider are finding the appropriate equipment, drone tips (good idea to password protect drones so they can only be connected to one specific device, holding the power button will reset the drone!), space to fly the drones (indoor best for Tello) and appropriate safety measures (long hair, safety glasses, etc).

Key considerations for drone project design include drone accessibility which may be limited due to budget and logistical issues, technical skills and knowledge, suitable flying locations, and technical support. Technical skills and knowledge can pose challenges for pre-service teachers as operating and programming drones require a certain level of expertise. Many educational institutions may have limited suitable areas free from obstacles required for flying drones. Lastly, ongoing technical support and troubleshooting mechanisms are vital. Drones can be complex devices, and technical issues may arise during the project. For example, some school network firewalls can restrict connectivity between the drones and the devices used to control the drones, while considering the time it takes to get the equipment ready (charging drone batteries, etc.) is also important. Considering these challenges when designing a drone project for pre-service teachers can ensure a smoother implementation, enhancing the learning experience and increasing the prospect they will consider implementing a similar project in their future classrooms. By addressing issues (Step 7 above) related to accessibility, technical skills, flying locations, and technical support, the project becomes more inclusive, empowering pre-service teachers to overcome technological barriers and fully engage with the educational potential of drones.

Conclusion

This paper shares the first phase of a larger study that uses an exploratory sequential strategy (Creswell, 2009) under a Mixed-Methods methodology. The researchers have sought to be transparent through reflexivity during the design of the intervention, which is a workshop to be used in higher education teacher preparation courses utilising drone technology and activities to upskill pre-service teachers. Although reflexivity is highlighted as an important part of the research process, there is limited research found that discusses reflexivity during intervention design. This paper presents a key consideration in designing a technology and PBL focused intervention that can be impactful while at the same time relevant to pre-service teachers to increase digital literacy in the classroom. By incorporating reflexivity into intervention design, researchers can enhance transparency by critically examining their own positions. Moving forward, there is still a need in the professional literature for further investigation of reflexivity in research in the context of intervention design to uncover potential impact and implications for designing effective interventions. By embracing reflexivity as a fundamental aspect of research practice, researchers can contribute to advancing the field of research and promoting transparency and rigor in intervention design.

References

ACARA (Australian Curriculum Assessment and Reporting Authority). (2014). *The Australian curriculum: Digital technologies (F–10): Structure*. https://www.australiancurriculum.edu.au/f-10-curriculum/technologies/digital-technologies/structure/

Ahmed. H. (2021). Towards application of drone- based GeoSTEM education: Teacher educators' readiness (attitudes, competencies, and obstacles). *Education and Information Technologies, 26*(4), 4379–4400. https://doi.org/10.1007/s10639-021-10475-6

Bai, O., Chu, H., Liu, H., & Hui, G. (2021). Drones in education: A critical review. *Turkish Journal of Computer and Mathematics Education, 12*(11), 1722–1727.

Beck, I. L., McKeown, M. G., & Kucan, L. (2013). *Bringing words to life: Robust vocabulary instruction* (2nd ed.). The Guilford Press.

Blachowicz, C. L. Z., & Fisher, P. (2000). Vocabulary instruction. In M. L. Kamil, P. B. Mosenthal, P. D. Pearson, & R. Barr (Eds.), *Handbook of reading research* (Vol. 3, pp.503–523). Erlbaum.

Chou, P. N. (2018). Smart technology for sustainable curriculum: Using drones to support young students' learning. *Sustainability*, *10*(10), 1–17. https://doi.org/10.3390/su10103819

Chugh, R., Turnbull, D., Cowling, M.A., Vanderburg, R., & Vanderburg, M.A. (2023). Implementing educational technology in higher education institutions: A review of technologies, stakeholder perceptions, frameworks and metrics. *Education and Information Technologies*, https://doi.org/10.1007/s10639-023-11846-x

Cowling, M. & Vanderburg, R. (2020). An interactive virtual reality physics instructional environment based on Vygotskian educational theory. In S. Gregory, S. Warburton, & M. Parkes (Eds.), *ASCILITE's First Virtual Conference.* Proceedings ASCILITE 2020 in Armidale (pp. 168–173). https://doi.org/10.14742/ascilite2020.0116

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Sage Publications.

Denzin, N. K. (2012). Triangulation 2.0. *Journal of Mixed Methods Research, 6*(2), 80–88. https://doi.org/10.1177/1558689812437186

Duraj, S., Pepkolaj, L., & Hoxha, G. (2021). Adopting drone technology in mathematical education. In 2021 3rd *International Congress on Human-Computer Interaction, Optimization and Robotic Applications* (HORA) (pp. 1-7). IEEE. https://doi.org/10.1109/HORA52670.2021.9461297

Finkle, S. L., & Torp, L. L. (1995). Introductory documents. Finkle, S. L., & Torp, L. L. (1995). Introductory documents. *Available from the Center for Problem-Based Learning, Illinois Math and Science Academy*, *1500*, 60506-1000.

Finlay, L. (2002). "Outing" the researcher: The provenance, process, and practice of reflexivity. *Qualitative Health Research, 12*(4), 531–545. https://doi.org/10.1177/104973202129120052

Gilster, P. (1997). *Digital literacy*. Wiley.

Hoople, G. D., & Choi-Fitzpatrick, A. (2020). *Drones for good: How to bring sociotechnical thinking into the classroom*. Morgan & Claypool Publishers LLC.

Jayaratne, K. S. U., & Smilnak, D. (2020). Use of drone technology in agriculture: Implications for agricultural education. *The Agricultural Education Magazine, 93*(1), 40-43.

List, A., Brante, E. W., & Klee, H. L. (2020). A framework of pre-service teachers' conceptions about digital literacy: Comparing the United States and Sweden. *Computers and Education, 148*, 103788-103795. https://doi.org/10.1016/j.compedu.2019.103788

Mortari, L. (2015). Reflectivity in research practice: An overview of different perspectives. *International Journal of Qualitative Methods*, *14*(5), 1609406915618045. https://doi.org/10.1177/1609406915618045

Ng, W. S., & Cheng, G. (2019). Integrating drone technology in STEM education: A case study to assess teachers' readiness and training needs. *Issues in Informing Science and Information Technology, 16*, 61–70. https://doi.org/10.28945/4288

Olaghere, A. (2022). Reflexive integration of research elements in mixed-method research. *International Journal of Qualitative Methods*, *21*, 16094069221093137. https://doi.org/10.1177/16094069221093137

Pacheco-Guffrey, H. (2021). Cultivating digital literacy. (GUEST Editorial). *Science and Children, 58*(5),10-13.

Quann, S. (2025). Integrating digital literacy and problem solving into instruction. Informational Material, World Education, Inc. Retrieved from: http://lincs.ed.gov/publications/pdf/digitalaccess-problemsolving.pdf

Stanley, E. D., & Waterman, M. A. (2000). Lifelines online—Curriculum and teaching strategies for adult learners: Integrating information technology with problem-solving pedagogies. *Journal of College Science Teaching*, *29*(5), 306-310.

Tomczyk, Ł. (2020). Skills in the area of digital safety as a key component of digital literacy among teachers. *Education and Information Technologies*, *25*(1), 471-486.

Weintrop, D., & Wilensky, U. (2017). How block-based languages support novices: A framework for categorizing block-based affordances. *Journal of Visual Languages and Sentient Systems*, *3*, 92-100. https://doi.org/10.18293/VLSS2017-011

Vanderburg, M., Vanderburg, R., Cowling, M., Chugh, R. & Sankey, M. (2023). Digital Literacy, PBL pedagogies and drones for preservice teachers: Using reflexivity while designing an intervention. In T. Cochrane, V. Narayan, C. Brown, K. MacCallum, E. Bone, C. Deneen, R. Vanderburg, & B. Hurren (Eds.), *People, partnerships and pedagogies*. Proceedings ASCILITE 2023. Christchurch (pp. 583-587). https://doi.org/10.14742/apubs.2023.585