STUDENTS' PERSPECTIVES ON USING AN ACTIVATED CLASSROOM TEACHING APPROACH WITH COMPUTATIONAL THINKING TO INTRODUCE CODING: A CASE STUDY AT A SOUTH AFRICAN UNIVERSITY

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ABSTRACT

Coding, often referred to as programming, involves the development of computer programs or instructions for execution by a computer. Effective teaching of coding requires mastery of three key competencies: (1) understanding coding concepts and constructs, (2) the ability to combine these constructs to create functional computer programs, and (3) the use of appropriate pedagogical strategies to facilitate learning. While the first two skills suffice for most students learning to code, all three are essential for prospective teachers who aspire to become effective coding instructors.

This study proposes the Activated Classroom Teaching (ACT) Methodology as a novel pedagogical approach to teaching coding, integrating computational thinking principles through game development. This research aimed to evaluate the extent to which prospective teachers accept the ACT Methodology as a teaching approach and their intention to adopt it in their future classrooms.

To address these objectives, a mixed-methods research design was employed. Quantitative data were collected from 256 prospective teachers through questionnaires, while qualitative insights were gathered via focus group discussions, involving eight groups of six participants each. This dual-method approach enabled a comprehensive analysis of participants' perceptions and intentions regarding the ACT Methodology.

Findings reveal that prospective teachers exhibit overwhelmingly positive attitudes toward the ACT Methodology, perceiving it as an effective and engaging way to learn and teach coding. Furthermore, the results indicate a strong intention among participants to implement this approach in their future teaching practices, recognizing its potential to enhance both their professional growth and their students' learning experiences.

This research contributes to the growing discourse on coding education by providing empirical evidence on the acceptance and applicability of innovative teaching methodologies. It offers valuable insights for educators and policymakers seeking to improve the integration of coding and computational thinking in teacher training programs. By advocating for the ACT Methodology, the study underscores its

potential to empower future teachers and transform coding education in diverse educational contexts.

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STATEMENT OF ORIGINAL AUTHORSHIP

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: 

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To Nelisiwe, thank you for your love, patience, and unwavering support.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter provides an overview of the study, beginning with the background and context in Section 1.2. Section 1.3 outlines the study's focus and purpose. An overview of relevant literature is presented in Section 1.4, followed by a discussion of the conceptual framework in Section 1.5. The research objectives and questions are addressed in Sections 1.6 and 1.7, respectively. The research design and methodology are detailed in Section 1.8. Section 1.9 covers the validity of the study's results, followed by a discussion of the study's limitations and delimitations in Sections 1.10 and 1.11. Section 1.12 gives the thesis outline and Section 1.13 concludes the chapter.

1.2 Background and context of the study

Coding, sometimes referred to as programming, is the skill of developing computer programs or instructions to be followed by a computer (Holvikivi, 2010; Larsson, 2018). Teaching coding entails the following skills and knowledge: 1) knowledge and understanding of coding concepts and constructs, 2) having the knowledge and understanding to put these concepts and constructs together to create computer programs, and 3) being able to, via an appropriate pedagogy, disseminate this knowledge and understanding to students (Xie et al., 2019). In general, for many students studying coding the first two requirements are enough for success, and the third is a bonus. However, for prospective teachers it is imperative that they attain all three skills and knowledge in coding to guarantee any success as coding teachers. The importance of this is further highlighted by the Department of Basic Education having introduced a new subject to its curriculum called Digital Technology (Department of Basic Education, 2012). This subject is to be taught in the Foundation, Intermediate, Senior and Further Education and Training (FET) phases, and covers topics of: 1) system technologies, 2) using keyboards and developing typing skills, 3) learning about Word processing, 4) creating spreadsheets, 5) digital citizenship, and 6) Computational Thinking and coding (Department of Basic Education, 2012). The University responded to this addition by introducing a Digital Technology module for third-year Foundation and Intermediate Phase teaching students. When these students graduate from the University they will have a teaching degree that will make them eligible for employment to teach the very same content mainly to learners in the Intermediate and Foundation Phase (grade 4 to 6) as well as those in the Senior Further

Education and Training Phase (grade 7 to 9). This makes the choice for game development (which is more interesting and fun for young school learners to learn in Scratch) better suited than more mature app and program development associated with more complex Integrated Development Environments, and that are less suitable for young learners (Nikiforos et al., 2013; Kalelioğlu & Gülbahar, 2014; Marimuthu & Govender, 2018). This research study looks into proposing a strategy that can be used to introduce third-year students (prospective teachers) to block-based coding through game development infused with Computational Thinking. Ultimately, it is hoped that these students' acceptance of the strategy, as well as their intention to use the strategy, will encourage them to use this strategy in the same, or similar ways, once they become teachers.

Briefly, the strategy being proposed is based on three scaffolding and inter-supporting ideas, namely: 1) the Activated Classroom Teaching (ACT) pedagogies (Blewett, 2017), 2) Computational Thinking Framework (Let's Talk Science, 2018), and 3) the Predict, Run, Investigate, Modify and Make framework, also known as the PRIMM framework (Sentance & Waite, 2017).

The ACT pedagogies are novel digital-age teaching pedagogies that transform the technology practices when teaching in the classroom (Blewett, 2017). These pedagogies place the students at the centre of learning and the lecturer as facilitating this learning. These pedagogies consist of five teaching strategies, namely: 1) curation, 2) conversation, 3) correction, 4) creation, and 5) chaos pedagogies (Blewett, 2017).

The Computational Thinking Framework (Let's Talk Science, 2018) is based on research conducted by organizations based both in the United Kingdom and the United States of America which attempted to answer the longstanding questions: 1) What is Computational Thinking? and 2) How can Computational Thinking be taught? These researchers found that in many cases, instead of explicitly defining Computational Thinking, references describe Computational Thinking in terms of what students must know and do to develop Computational Thinking (Let's Talk Science, 2018). Sometimes the learning outcomes are conceptual (e.g., the concept of algorithms) and sometimes the learning outcomes are skills-based (e.g., algorithmic thinking) (Let's Talk Science, 2018). Concerning how Computational Thinking can be taught, the

researchers then proposed a framework to teach Computational Thinking and named it the Let's Talk Science Computational Thinking Framework. This framework proposed the following strategies for introducing students to Computational Thinking: 1) unplugged, 2) tinkering, 3) remix & re-use, and 4) make. While this framework was developed by researchers from the USA and UK, the researcher intends to bring together the ACT pedagogies and Computational Thinking when trying to find the most effective way of introducing learners to coding. The opportunities made possible by this linkage could be very inspiring.

Thirdly, the PRIMM framework consists of a set of steps that can be implemented to introduce learners to computer programming or coding (Sentance et al., 2019a), while this strategy can be used and applied to text-based programming languages (Sentance & Waite, 2017), it can also be successfully implemented when teaching block-based coding via game development (Law, 2020). Briefly, the steps in the PRIMM framework are: 1) predict, 2) run, 3) investigate, 4) modify, and 5) make. Taking learners through these steps can be very beneficial for them in their programming and coding development (Sentance et al., 2019b; Law, 2020). The ACT pedagogies, The Let's Talk Science Computational Thinking approaches, and the PRIMM framework are all based on recent research that align well for scaffolding knowledge and skills, especially those of Computational Thinking and coding, which helps to justify this research. All of these three approaches/frameworks are explained in the literature.

1.3 Focus and purpose of the study

In many cases introduction to coding using game development overlooks Computational Thinking and focuses on game aesthetics of graphic design and sounds (Law, 2020), thus neglecting the development of critical thinking and problem-solving skills which are imperative for the development of coding skills (Law, 2020). Various researchers have called for the development of critical thinking and problem-solving skills in game development when teaching block-based coding (Gresse von Wangenheim et al., 2019; Tan et al., 2021). The strategy proposed in this study intends to incorporate these skills into the researcher's own practice when introducing game development through block-based coding. This strategy can also be used with text-based coding.

Some of the reasons for neglecting critical thinking and problem-solving skills when teaching gaming through block-based coding are: 1) some instructors are not willing to undertake the amount of planning and effort required, 2) the successful teaching of high-order thinking skills through the use of a simple tool, such as Scratch, might be less challenging to an experienced individual, who thus might see it as a trivial and time-wasting endeavour, 3) in some cases some instructors lack the experiential and technical knowledge to innovatively teach coding content successfully by using technology in an educationally effective way (Blewett, 2017), and 4) large class numbers make it difficult to teach, especially when introducing new and unfamiliar content to students, such as coding. In addition, contexts can differ. However, these concerns are often high when teaching critical thinking and problem-solving skills through gaming for block-based coding.

This study focuses on a strategy to introduce coding infused with Computational Thinking via game development. This strategy combined the ACT pedagogies used to teach block-based coding together with Computer Science discipline-specific strategies (Computational Thinking and the PRIMM Frameworks) through game design and development. While various research around the teaching and learning of Computational Thinking and game design and development exist, to the researcher's knowledge, none have included the ACT pedagogies. Through this study the researcher also attempted to determine the extent to which students accept being taught coding using the strategy as well as their intention to use this strategy when they finally become coding teachers. The hope is that the students will eventually teach coding content using similar or self-improved strategies.

1.4 Review of literature

In this literature review the researcher asked two questions: 1) What strategies have been used to introduce students to coding? and 2) What theories inform the strategy proposed?

A longstanding debate in the field of Computer Science, specifically that of Education has focused on what programming paradigm is best to use for introducing novices to coding (Krishnamurthi & Fisler, 2019). In computer programming, the different paradigms that exist describe the various ways in which programming tasks are solved

(Kumari et al., 2015). There are many programming paradigms, and the paradigm chosen usually determines the approach used in solving the problems (Vujoševič-Janičić & Tošić, 2008). There are five main programming paradigms, namely 1) imperative, 2) functional, 3) logical, 4) object-orientated programming and 5) event-driven programming (Vujoševič-Janičić & Tošić, 2008; Kumari et al., 2015).

Briefly, the imperative paradigm is described as a set of explicitly listed step-by-step instructions that are given to a computer to accomplish a certain task (Avacheva & Prutzkow, 2020). The functional paradigm is composed of a neat set of functions in which each function is designed to accomplish one task and these functions can follow each other in any order depending on which function is called next (Janeček & Pergl, 2017). The logical paradigm consists of a set of predefined rules and facts that logically test incoming information against these rules and facts before producing results. While the object-oriented paradigm divides programs into classes and objects (Yilmaz et al., 2019). Simply described, classes are blueprints (designs) for objects and objects are actual instances of classes (Yilmaz et al., 2019; Nwokoro et al., 2021). This paradigm encourages students to solve problems from the perspective of their reality through envisaging how objects in their social contexts function (Yilmaz et al., 2019; Nwokoro et al., 2021). The students then program these objects based on their visualisation of the way the objects function (Yilmaz et al., 2019; Nwokoro et al., 2021). Lastly, in event-driven programming, the flow of a program is determined by events such as user actions, sensor outputs and parameters from other programs or functions (Lalejini & Ofria, 2018). For this research, the researcher used the Scratch Integrated Development Environment (IDE) which considers, to different extents, all of these paradigms as each paradigm is important in the teaching and learning of coding. The premise is that this will help make it easier for the students to migrate from Scratch to any other coding language. One such coding language is Delphi, which is a more sophisticated programming language that is referred to as a programming language belonging to the event-driven programming paradigm that is studied later on in high school from grades 10 to 12 in South Africa.

The different programming languages that fall within the different paradigms can also be used with popular strategies, such as pair programming, to introduce coding to novices. In pair programming, two programmers work side by side to solve a

programming task (Faja, 2014). These programmers can be experts or novices and can be paired in three possible combinations, namely: 1) expert and expert, 2) expert and novice, and 3) novice and novice (Wray, 2010). The most desirable combination for any novice is to work and learn from an expert (Lui & Chan, 2006), however it is not always possible to pair a novice with an expert in all situations. Thus, it is very common to find novices paired with other novices when pair programming (Wray, 2010). Moreover, various setups can further be utilized in pair programming depending on the role of each student in the pair. These setups can be: 1) unstructured pairing, 2) driver-navigator, 3) backseat-navigator, 4) tour guide, and 5) ping-pong pairing (Wray, 2010). The most common setup of pair programming is unstructured pairing in which the programmers work side-by-side on solving a programming task as their roles intertwine between typer, reader or guide, and problem-solver (Wray, 2010; Faja, 2014). Since pair programming is socially driven by encouraging peer discussion and sharing of ideas, its success relies on the two students being able to work well together (Faja, 2014). In this context we can use pair programming along with the conversation pedagogy where a pair of students is conversing using technology. We can also set the students up to use Zoom with one student sharing their screen and both making corrections to a code. This is called correction pedagogy. Another approach that can be used would be to encourage the students to make games in pairs using Scratch, which align closely with the creation and chaos pedagogies of the ACT model. The strategy that the researcher used was not restricted to pair programming but used both single- and pair-programming setups, and even larger groups were encouraged.

Visualization, simulation, and animation of content have also been other strategies used to introduce novices to programming using visually appealing content (Price & Price-Mohr, 2018). In this case, visuals can be simulated to depict the main behaviours of algorithms. The understanding is that visual simulations will make it easier for students to assimilate algorithms and ease their transition to code (Gillern & Robert, 2017). In most cases, these simulations use visually appealing graphics (Gillern & Robert, 2017; Price & Price-Mohr, 2018). The thinking is that appealing graphics will maintain the focus and interest of students. In other cases, students are required to depict their visualization of algorithms as they learn how to program (Gillern & Robert, 2017). While visualization and simulation of algorithms are commendable, the

researcher did not rely on the use of aesthetically appealing visuals to teach coding, since the aesthetics do little for the actual teaching of coding and Computational Thinking (Law, 2020). Even though the games used to teach the students block-based coding were aesthetically appealing, the researcher did not consider aesthetics a key component of game design as Computational Thinking was considered to be paramount. The researcher anticipates that once the teaching students experience using aesthetically appealing graphics in game design, they will use appealing graphics to gain and maintain the attention of their young learners (Gillern & Robert, 2017).

In other cases, storytelling and roleplay have also been used to introduce students to coding (Burke & Kafai, 2010). In the case of storytelling, students convert a story, whether in a book or a movie in its coded form (Lui et al., 2021). When roleplaying, students act out different roles so they can immerse themselves and envisage the interaction between the different pieces of code in the program (Burke & Kafai, 2010). Thereafter, the understanding is that they can easily assimilate their roleplay and stories into their code (Price & Price-Mohr, 2018). This strategy works best for younger students and not mature students since the interest in roleplay and storytelling decreases with age when teaching coding (Tengler et. Al, 2022). Another shortfall in using storytelling and roleplay to introduce coding that is closely associated with the aesthetics of game design and development is that storytelling and roleplay encourage the students to focus more on telling the story using graphics, text and sounds as opposed to applying Computational Thinking skills through using programming concepts and constructs to code programs. In the strategy that is proposed by the researcher, while storytelling and roleplay are not recommended for mature students, if and when necessary, the researcher will use both to further clarify coding concepts and constructs to the students. The reason for doing this is that these students will experience this and introduce their learners to coding the same way or in self-improved ways when they are coding teachers themselves.

Gaming and block-based coding is another popular strategy covered in the literature that is used to introduce novices to programming (Rose et al., 2018; Xu et al., 2019; Vahldick et al., 2020). In many cases, students have been observed creating and defining the rules of games through spoken language. In this study, the researcher taught the students to define the rules of the game in game design and development by

using block-based coding. This is based on the premise that students learn coding much better if they design and create games, which is something that they like to play – as seen in real life where youths enjoy playing games physically or on their technological devices. Moreover, the immediacy with which Scratch programs can run encourages the students to work towards a complete and working solution so they can test and improve their programs. It is easy to give students the impression that coding involves making objects on the screen move and produce different sounds – as is the norm in real life situations, and more so in games not guided by strict and specific rules. It is also possible to give the students the impression that coding is all about gaming and playing. Therefore, the researcher's focus in teaching coding through game design and development needs to be on creating games that will promote Computational Thinking and problem-solving skills. In this study the primary focus will be on cultivating these skills when using gaming to introduce the students to coding, hopefully, these students will use a similar method if not better to also cultivate the skills of Computational Thinking and problem solving within their learners once they become teachers themselves. In the same way, graphical aesthetics, sounds and game playing are secondary by-products of game design and development.

While various strategies to introduce coding to novices have been researched, the researcher proposes that the teaching of block-based coding through game design and development be done using strategies informed by theory, namely: 1) the ACT methodology (Blewett, 2017), 2) the Let's Talk Science Computational Thinking Framework (Let's Talk Science, 2018), and 3) the PRIMM Framework (Sentance & Waite, 2017). Firstly, the ACT methodology describes a set of 21st century digital-age teaching pedagogies that encourage teachers to effectively use technology for effective teaching (Blewett, 2017). These pedagogies include: 1) curation, 2) conversation, 3) correction, 4) creating, and 5) chaos (Blewett, 2017). The ACT pedagogies encourage the teacher to seek affordances possible with technology in the classroom for effective teaching using this technology. The assumption is that technology excites students and will encourage them to learn (Blewett, 2017), moreover since the greater majority of students nowadays are digital natives, the understanding is that they will learn better under familiar contexts, therefore giving technology to students during their learning can yield positive results (Blewett, 2017).

For instance, in the curation pedagogy, students can use their technologies to search for and sift through the information they deem important and necessary for a certain topic (Blewett, 2017). This repetitive searching for and sifting through information using technology, a tool that excites students, gets them actively involved in their learning as they curate and share information with others (Blewett, 2017). The conversation and correction pedagogies rely heavily on communication between students as they discuss learnt content, this can be based on teacher-directed prompts or incorrect statements that need correction (Blewett, 2017). While the creation and chaos pedagogies encourage learners to produce artefacts in response to insufficient information (creation pedagogy) or too much information (chaos pedagogy) (Blewett, 2017).

The ACT methodology helps promote several skills depending on the pedagogy chosen (Blewett, 2017). The curation pedagogy helps to promote the students' research skills, while the conversation and correction pedagogies enhance social and communication skills as students collaborate (Blewett, 2017). The creation and chaos pedagogies train digital literacy skills necessary for success in the 21st century (Blewett, 2017). These skills change the role of students from simply being consumers of technology to knowing how to be producers of technology as they learn both how to use and create technology, which are important skills for prosperity, especially in the 4th industrial revolution where they will be faced with problems that will require the creation and use of technology to solve them (Blewett, 2017).

The tools that can be used to support effective teaching and learning when using the ACT pedagogies are various, the Internet can be used for curation, discussion forums and wiki-boards can be used for conversation and correction, while creation of games via Scratch in the context of block-based coding can be used for the creation and chaos pedagogies. It should be noted that having the knowledge to use technology is insufficient for effective teaching and learning. Rather, the ability to use that technology in pedagogical ways is also necessary (Blewett, 2017). Therefore, simply being able to use a state-of-the-art technological tool does not result in good teaching, something is missing. In other words, merely giving our lecturers and students cutting-edge technology does not necessarily guarantee desirable results. In many cases, the results are worse than without this technology, which has paradoxically hindered

learning (Blewett, 2017). Therefore, where we have technology, technical knowledge and a good lecturer, the only missing piece for effective learning is an appropriate pedagogy – and that is where the ACT methodology comes in.

The Let's Talk Science Computational Thinking Framework consists of a set of approaches for teaching Computational Thinking, namely: 1) unplugged, 2) tinkering, 3) remix & re-use, and 4) make (Let's Talk Science, 2018). Briefly, the unplugged approach encourages students to design and plan their solutions, this can be in the form of IPO and flowcharts, pseudocode and algorithms as well as trace tables. Unplugged in this instance refers to designing on paper before coding. However, with increased technological development precoding design can now be carried out using computers. Tinkering refers to slightly changing a small piece of code and observing how the code behaves as a result of that change (Let's Talk Science, 2018). Remix & re-use refers to learning from a piece of existing code in real time. A small piece of code is changed, and then incorporated into a different program from the original and its performance observed (Let's Talk Science, 2018). The make approach refers to encouraging students to make programs on their own from Scratch (Let's Talk Science, 2018). In this study, the researcher incorporated these approaches when they introduced students to coding to help train students' Computational Thinking skills.

The PRIMM framework on the other hand is a set of steps that can be implemented to introduce learners to computer programming or coding (Sentance & Waite, 2017). While the PRIMM framework strategy has been used and applied to text-based programming languages (Sentance & Waite, 2017), it can also be successfully implemented when teaching block-based coding via game development (Law, 2020). The PRIMM framework consists of the following steps: 1) predict, 2) run, 3) investigate, 4) modify, and 5) make (Sentance & Waite, 2017). The predict and run steps, which can be used in conjunction with the unplugged approach of Computational Thinking, can be used to encourage students to dry-run on paper or mentally trace through the steps of a program and then predict the results (Sentance et al., 2019b). This can be in the form of an imaginary number that is said to be input allowing the student to mentally trace through a program, via the use of a designing tool, until they arrive at the predicted result. The investigate step, which can be used in conjunction with the tinkering approach of Computational Thinking, encourages

students to examine existing programs and how they function (Sentance et al., 2019). In this step emphasis and focus should be placed on understanding different pieces of code and how they work together (Sentance et al., 2019b). The modify step, which can be used in conjunction with the remix & re-use approach of Computational Thinking refers to students modifying a piece of code and seeing how it reacts to that modification (Sentance et al., 2019a). While the make step, which is also found in the Let's Talk Science Computational Thinking Framework refers to students creating their programs from Scratch to demonstrate their knowledge and understanding (Sentance et al., 2019a). In this study, the researcher learns from these three theories and fuses them into one and proposes a strategy based on these for introducing coding through game design and development. Ultimately, the hopes and intentions of this research are to propose a strategy that incorporates the ACT pedagogies, Computational Thinking approaches, and the PRIMM framework to introduce students to block-based coding through game development and then test their acceptance of the strategy as well as their intention to use the strategy in the future. To the researcher's knowledge the use of a combination of these approaches has not been seriously investigated in the Computer Science Education field until now.

1.5 Conceptual framework

In this study the researcher used a conceptual framework drawn from theory. A conceptual framework is a textual or visual depiction of how variables to be studied in a research study are expected to interact with each other (Van der Waldt, 2020), whereas a theoretical framework is a structure that can be used to support a research study's theory (Adom et al., 2018). The main difference between the two is that a conceptual framework is composed of variables that the researcher wants to study, whereas a theoretical framework is based on many years of research that a researcher uses to discuss their findings (Adom et al., 2018). The conceptual framework used in this study is primarily based on the Theoretical Framework of Acceptability (Sekhon et al., 2017). This theoretical framework is used to study healthcare workers' as well as patients' acceptance of healthcare interventions (Shayo et al., 2022.; Crocker & Stout, 2023). The conceptual framework (Appendix G) referred to in this study is designed to understand the factors that affect 1) the students' acceptance of the intervention proposed in the study and 2) to test these students' intention to use the proposed strategy and 3) to ultimately predict usage behaviour in the future when these

students become teachers. In this conceptual framework, acceptance is defined as the extent to which a student accepts an intervention, predicated on three factors: 1) experienced factors, 2) people factors, and 3) trust factors. Intention on the other hand is defined as the extent to which a student intends to be a user of the intervention in the future, predicated on three factors: 1) anticipated factors, 2) people factors, and 3) trust factors. The combination of acceptance and intention can be used to predict the likelihood of usage behaviour, where usage behaviour is described as the role or behaviour a student would likely play in society once they become teachers as a result of the proposed intervention. Usage behaviour is separated into four possibilities: 1) use as a deliverer, 2) use as a receiver, 3) use as both a deliverer and receiver, or 4) no use. This is explained in more detail in following sections in paragraphs lower down.

To begin with, the experienced or anticipated factors mentioned above are described as experiences (experienced or anticipated) that students deem positive or negative when participating in an intervention. These experiences are predicated on three factors: 1) effectiveness, 2) burden, and 3) affection. Experienced factors can be described from the perspective of the student's experience and anticipated factors would be the student's anticipated experiences as teachers in the future. Effectiveness describes the extent to which the intervention is perceived as having achieved its purpose. Burden is the perceived amount of effort that was required to participate in the intervention. While affection is how the participant felt (in terms of enjoyment) about the intervention. People factors on the other hand is the extent to which people influence a student's view of an intervention. These can be experienced or anticipated views. In this study the researcher described the students' anticipated factors as future teachers. In this conceptual framework, people factors consist of two-component factors, namely 1) social influence and 2) facilitator influence. Social influence is the extent to which the views of any layperson, such as a fellow student, an acquaintance or any other person that may have knowledge of the intervention, affected a student's views of an intervention. While facilitator influence is the extent to which the participant's perception was influenced by the knowledgeable experts involved in the intervention, such as their lecturer or tutor.

Trust factors are the degree to which students deem an intervention as consistent and trustworthy, predicated on two factors: 1) intervention coherence, and 2) reliability.

Trust factors were studied from both the perspective of being a student (experienced) and that of being a teacher (anticipated). Coherence refers to the extent to which the participant perceives that the content of the intervention as achieving the purpose of the activity. While reliability describes the extent to which a participant deems an intervention as reliable and trustworthy.

The factors that affect intention, which is described as the extent to which a student intends to use the strategy proposed, are similar to those of acceptance. However, as noted above, the experienced factors of 1) effectiveness, 2) burden and 3) enjoyment are no longer experienced but are anticipated factors, to which self-efficacy is added, and are studied from the perspective of the student becoming a teacher. Self-efficacy in this regard is seen as the extent to which a student sees him- or herself as performing at the required levels when using the intervention proposed in the future as a teacher. The schematic in Appendix G clarifies how the different main and component factors are expected to interact with each other.

As previously stated in this conceptual framework the researcher is of the view that both acceptance and intention can be used to predict usage behaviour. In this case usage behaviour is the anticipated manner in which the intervention will be used by the participant when they become a teacher. In this case, there are four possible results from usage behaviour: 1) use as a deliverer, 2) use as a receiver, 3) use as both a deliverer and receiver or 4) no use. Use as a deliverer would be when a student, who is now a teacher, uses an intervention simply for teaching purposes. Use as a receiver would be when a student, who is now a teacher, uses an intervention simply for learning purposes, for instance when attending workshops or studying, etc. Use behaviour as both a deliverer and receiver would be when a student uses an intervention in the future as both a teacher and a student. No use is simply no use of the strategy at all. A high acceptance coupled with a high intention is expected to result in usage behaviour as a deliverer as well as a receiver. A high acceptance and a low intention is expected to result in use as a receiver. A low acceptance and a high intention is expected to result in use as a deliverer. A low acceptance and a low intention is expected to result in no use. Appendix H provides a simplified illustration of how acceptability and intention is expected to affect the different usage behaviours.

The Theoretical Framework of Acceptability, on which the conceptual framework of this study is based is a theory that has been used to understand healthcare workers' and patients' acceptance of an intervention before, during and/or after an intervention is administered to patients. It can be used at three different stages to test acceptability: 1) retrospective acceptability, 2) current acceptability and 3) prospective acceptability (Sekhon et al., 2017). In the researcher's conceptual framework, retrospective and prospective acceptability relate to acceptance (experienced acceptability) and intention (anticipated acceptability). Therefore, retrospective acceptability, as noted in the Theoretical Framework of Acceptability, relates to the combination of experiences a student underwent during an intervention, which consist of experienced factors, people factors and trust factors according to the conceptual framework. Whereas prospective acceptability, as noted in the Theoretical Framework of Acceptability, relates to a student's anticipated experiences as a future teacher. These consist of anticipated factors, people factors and trust factors according to the researcher's conceptual framework. The affective attitude in the Theoretical Framework of Acceptability relates to the affection experienced or anticipated. The coherence in the Theoretical Framework of Acceptability relates to intervention coherence experienced or anticipated by the student. Burden in the Theoretical Framework of Acceptability, relates to the burden experienced or anticipated by the student. Intervention reliability in the trust factors is the only component factor not accounted for by the Theoretical Framework of Acceptability, but one that the researcher deemed necessary to include in the conceptual framework to further test the reliability of an intervention.

1.6 Research objectives of the study

The objectives of this study are to determine:

1. students' perspectives towards the ACT methodology pedagogies when used to teach programming
2. the best component predictors of acceptance and intention on future usage of the ACT methodology's pedagogies
3. how the component factors of acceptance and intention affect future usage of the ACT methodology's pedagogies.
4. why Acceptance and Intention affect Usage Behaviour the way they do

1.7 Critical research questions of the study

The questions this study intends to answer are:

1. what are the students' perspectives towards the ACT methodology pedagogies when used to teach programming?
2. what are the best predicting component factors of acceptance and intention on future usage of the ACT methodology's pedagogies?
3. how do the component factors of acceptance and intention affect future usage of the ACT methodology's pedagogies?
4. why does Acceptance and Intention affect Usage Behaviour the way they do?

1.8 Research design and methodology

1.8.1 Research design

This study is based on the Design Science Research methodology where this methodology is used mainly as a problem-solving blueprint to produce solutions to problems and not necessarily as a structure to describe or understand why and how phenomena occur (Vom Brocke et al., 2020). The main outcomes of a Design Science Research study can be one of two possible solutions. These are solutions that 1) either utilize acquired knowledge to solve problems, create change or improve existing solutions or 2) those that generate new knowledge, insights and theoretical explanations (Vom Brocke et al., 2020). In this study, the researcher iteratively designs a solution that is based on prior research that has produced theories, models and frameworks to create a solution for ultimately the use of the Activated Classroom Teaching pedagogies in the teaching and learning of block-based coding infused with Computational Thinking and the PRIMM framework in game design and development. Hence, the researcher utilizes gained knowledge to solve problems, create change and improve existing solutions. The reasoning behind this is that the researcher observes that in many cases when teaching block-based coding alone or via game design and development, instructors often place little emphasis on Computational Thinking, which is a very important aspect of coding. Moreover, the researcher also notes that instructors also lack a strategy or pedagogy when teaching using technology which is a tool that appeals to today's students and when used effectively can enhance teaching and learning (Blewett, 2017). The researcher thus

bases the proposed strategy on the Activated Classroom Teaching pedagogies (Blewett, 2017), which are 21st century digital-age teaching strategies, the Let's Talk Science Computational Thinking (Let's Talk Science, 2018), and PRIMM frameworks (Sentance & Waite, 2017) in game design and development. In this study, the researcher learns these different approaches, thus utilising the knowledge gained from these different approaches to solve problems, create change and improve existing solutions.

The researcher further divided the steps in the Design Science Research methodology into five steps, these normally range from four to six steps depending on the design model chosen (Anggraini & Putra, 2020). In this study, the researcher used the ADDIE Design Science Research process to plan and structure both the games and strategy used in teaching the students. The stages in the ADDIE are 1) analysis, 2) design, 3) development, 4) implementation and 5) evaluation.

The analysis stage in the ADDIE requires the researcher to analyse a problem for which they intend to create or design a solution (Vom Brocke et al., 2020). The main goal of a researcher at this stage is to understand the problem as well as the participants, at this stage the researcher can also lay out what should be taught and how (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). This stage is followed by the design stage where the researcher drafts an overview of an intervention or solution. This overview is in many cases based on the literature reviewed, hence extensive reading and planning occurs at this stage (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). The main aim of the design stage is to provide a prototype that can be communicated easily with relevant stakeholders to show the importance of the research to be undertaken. Hence, at this stage the researcher lays out the strategy, delivery methods, structure, duration, assessment and feedback that will be integral to the research (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). Thereafter, the researcher proceeds to the development stage where the researcher creates the content of the course based on the previous two stages (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). At this stage it is important to check for consistency and any possible issues that could arise during the intervention (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). If the research passes this stage, the research moves to the implementation stage. In the implementation stage, the researcher carries out their

intervention (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020) and much attention is placed on checking if any issues arise and if there is any need for redevelopment, redesign or even reanalysis (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). The last stage in the ADDIE is evaluation where the researcher assesses the intervention against the intended goals and standards (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). The main aim of the evaluation stage is to test the intervention's reception and to test the extent to which it was successful. Further improvements to an intervention can be proposed at this stage. Table 1.1 shows which Activated Classroom Teaching pedagogy will be used with which PRIMM step. Linked to the curation pedagogy is the information step, where students will curate, collect and share information with each other using technology. This step is not included in other PRIMM studies but it forms an important part of students' learning about coding concepts and constructs. Thus, in actuality this strategy should be viewed as being partly based on the I-PRIMM.

Table 1.1: Activated Classroom Teaching pedagogy used with each PRIMM step

ACT - PEDAGOGIES	PRIMM – STEPS	LTS COMPUTATIONAL THINKING
Curation	*Information*	*Information*
Conversation	Predict, Run and Investigate	Unplugged and Tinkering
Correction		
Creation	Modify	Remix and Reuse
Chaos	Make	Make

1.8.2 Research methods

In this study the researcher used a mixed methods research approach (Apuke, 2017) as opposed to a purely qualitative (Mohajan, 2018; Cropley, 2002) or quantitative research approach (Apuke, 2017). In a mixed methods research study, the researcher deals with both types of data, namely descriptive (qualitative) and numerical (quantitative) (Apuke, 2017). The reason many researchers use a mixed methods approach over another approach is due to the power of triangulation which can be used

to strengthen research results. With triangulation, one way to strengthen the results is by the researcher firstly collecting quantitative data and then following this with the collection of qualitative data that are based on questions that seek to further understand the quantitative results. As mentioned, in a quantitative research approach the researcher deals with numerical data or quantitative data (Apuke, 2017), while in a qualitative research approach the researcher works with descriptive data or qualitative data (Mohajan, 2018; Cropley, 2002). The large number of anticipated participants in this study make it ideal for the study to be a mixed methods research study that has a strong leaning towards quantitative research methods so that the researcher is able to collect both quantitative data (or widespread views of data) (Apuke, 2017), as well as qualitative (or in-depth) data. Therefore, the choice of study to be undertaken by a researcher impacts both the breadth and depth of data to be collected. In this study the researcher collected both types of data (quantitative and qualitative), with a strong focus on the quantitative data collected from a large group of participating students.

1.8.3 Sampling

While the research can be conducted in person or using online environments, the research participants selected were the University's students that met the stipulated requirements. These participants will be the entire population of third-year Intermediate and Foundation Phase students that were registered for EDCM111. The sampling chosen was purposive since all of these students (300+) were registered for this module. Moreover, the questionnaire (Appendix E) was sent out to all students via Google Forms where the students had to indicate at the end of the questionnaire their willingness to participate in focus-group interviews. Thereafter, the researcher randomly selected no more than 50 students to participate in focus-group interviews of no more than 6 students per group resulting in a total of 8 groups. This ensured that 1) we gathered data that was highly reflective of the entire population and 2) the high number of research participants (both from participating in the questionnaires and focus-group interviews) enabled the researcher to be able to project the study's findings even to future students, assuming all influential conditions and variables remain constant. The recruitment conditions that must be met by the students to be considered as participants in this research were 1) university affiliation must be that of University of KwaZulu Natal in the Edgewood Campus, 2) the year of study must be third year or higher, 3) the phase registered for must be the Intermediate and

Foundation Phase and lastly 4) each student must also be registered for the module, Introduction to Computer Systems, Data Representation and Coding (EDCM111). At the beginning of the semester, an email to all potential participants was sent out. The email outlined the module and included details about the study and content to be covered during the period of the study. This email also included the ethical clearance certificate as well as the permission to conduct the study from the University's Registrar. Before the module to be used for the research study started, students were emailed an informed consent to sign and return. While all students were taught the content, only those agreeing to participate in the study were considered for questionnaires and focus-group interviews.

1.8.4 Type of study

The research undertaken used a case study model. A case study purposefully selects research participants that will answer the research questions directly (Patnaik & Pandey, 2019). The researcher chose to conduct a case study because the research environment was a single University and the participants its students.

1.8.5 Data collection methods

Data can be collected in various ways, namely through 1) observation, 2) asking questions and 3) artefact analysis (Plowright, 2011). In this study, the researcher used questions as the only method of data collection. The research tools used for asking questions are 1) questionnaires and 2) interviews. Since this study is a mixed methods research study, the researcher used both a questionnaire and an interview schedule to collect data from the research participants. A link to a Google Forms questionnaire was emailed to students to fill in and submit once completed, while the interviews were conducted in focus groups using randomly selected students depending on their willingness to participate in group interviews. The questionnaires were used for the collection of quantitative data and the focus-group interviews for the collection of qualitative data. The data collection process began by administering questionnaires, followed by holding focus-group interviews. It was anticipated that filling in the questionnaires as well as the focus-group interviews would not take students longer than 20 minutes to complete. The questionnaires would be captured, and analysed using SPSS. It was anticipated that this process would not take longer than one week to complete. Immediately thereafter, focus-group interviews would be conducted, after

which the transcribing and analysing of the interviews would also take a week. No observation or artefact analysis were conducted in this study.

1.8.6 Data collection tools

The questionnaire used a five-point Likert scale, divided into the following options: 1. strongly disagree, 2. disagree, 3. neutral, 4. agree and 5. strongly agree for students to respond to a set of statements. The responses were restricted to these five and students were not given the option to provide their own narrative. The researcher collected the responses from the questionnaires and collated the data. The researcher then analysed the results using both descriptive and inferential statistics. The descriptive statistics were used to enable the researcher to obtain a better understanding of the respondents, while the inferential statistics enabled the researcher to test the extent to which the results are representative of the student population. Therefore, the responses to the questionnaire provided the researcher with quantitative data only. However, since it is possible to convert numerical data into narrative data, ultimately this is what the researcher does as the researcher narratively expound on their findings. The interviews on the other hand were partly based on the results from the quantitative results and on understanding the students' views of the ACT pedagogies. The students' responses during the interviews were coded and placed into reflective themes.

1.8.7 Data analysis

Table 1.2 outlines how the research questions were addressed.

Table 1.2: How the research questions were addressed

Research Question	Data Collection Instrument and statement/ question number	Method of analysis
1	Questionnaire: 1-32 on 72-74 and 33-71 on 72-74	Regression analysis
2	Questionnaire: 1-32 on 72-74 and 33-71 on 72-74	Regression analysis
3	Interview Schedule: All questions	Coding and themes
4	All questions	Synthesis of research question 1 to 3.

1.8.8 Research paradigm

The research paradigm this study is based on is the interpretivist paradigm. This paradigm's ontology disputes the idea of a single reality or truth and views reality as experiential and dependent on each individual's experiences (Pervin & Mokhtar, 2022). Hence, in this research, the researcher interviewed (via a questionnaire and an interview schedule) the research participants to get their views and opinions of the strategy proposed. Interpretivism's epistemology is predicated on the premise that people come to know what they know through personal experiences, and hence knowledge is subjective to an individual through that individual's lenses (Pervin & Mokhtar, 2022). Thus, in this research, the researcher also aimed to understand each respondent's views from their perspective and from what they shared with the researcher.

1.9 Validity and reliability

Validity or credibility implies accuracy and appropriateness of data collection and data analysis. Further, it implies trustworthiness, thoroughness and quality (Golafshani, 2003). On the other hand, reliability or dependability implies that the procedures used to collect data give almost similar findings under constant conditions (Magwa & Magwa, 2015). While objectivity refers to whether findings are unbiased and how neutral and objective the researcher is (Magwa & Magwa, 2015). Therefore, validity, reliability, and objectivity connote the extent to which the research results can be accurately interpreted and results generalized to populations and conditions (Tichapondwa, 2013). In this study, the researcher made use of a purposively selected sample of participants which represented all the members of the population under the study which are bound by university and campus, year of study, phase registered for, and enrolment into the module, thus increasing the validity, reliability and objectivity of this study.

Furthermore, for the questionnaire, in order to explore the structure of the items in the sub-constructs within each construct and validate the proposed scales of items in the model, factor analysis with promax rotation is applied to the items in each construct.

During the process, some items may be dropped either because they do not load strongly enough onto any factor or because they cross-load onto multiple factors.

The factor extraction is deemed to be successful if the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) exceeds 0.6 and Bartlett's test of sphericity is significant.

The factor structure that results from EFA is then used as a starting point for confirmatory factor analysis (CFA) in which the construct validity (both discriminant validity and convergent validity) and reliability are tested. Items that negatively affect either reliability or validity may be dropped in order to attain these important statistics. An additional statistic to measure reliability – Cronbach's alpha - will also be calculated. An alpha value of at least 0.7 is considered adequate.

1.10 Limitations of the study

A major concern was that the researcher could not ensure student attendance at large lectures, despite encouraging the students to attend all lectures. To overcome this the researcher promoted whole-class engagement, learned student names and requested them to introduce themselves by name when answering or asking a question. It has been found that questionnaire response rates decrease with an increasing number of questions (Sandelin, 2022). Therefore, the researcher personally requested the students to answer as many questions as possible. To encourage independent responses, students were also requested to answer the questionnaire without collaborating with each other or discussing responses.

During group interviews, it is possible for participants to be influenced by the responses of their peers and therefore falsify the results to some extent. To overcome this, the researcher encouraged the students to be as open as possible while remaining true to themselves.

Due to the large number of students expected to register for the module, it was difficult to interview all of them and analyse all of their qualitative data, hence a random sample of these students was selected based on availability.

1.11 Delimitations of the study

The research is a small-scale study carried out in one university, having to conduct the research across many universities would have been the ideal situation so we can see

how different students from different universities respond to the strategy proposed. This would also allow for the generalisation of the findings to other students in other universities, however, this was not explicitly possible since the research was conducted on students at only one university in KwaZulu-Natal.

The strategy proposed is not an absolute, however a work in progress, therefore, the results obtained from the study cannot be guaranteed that they will be positive, or at their ultimate best. This is a result of the study being a Design Science Research, which in this case is not an action research study, however, the aim is to improve the strategy even after this Ph.D. study.

1.12 Thesis outline

The remainder of the thesis is structured as follows: Chapter 2 presents the literature review, followed by a discussion of the conceptual framework in Chapter 3. Chapter 4 covers the research methodology, while Chapter 5 focuses on the data analysis. Chapter 6 provides a discussion of the findings and Chapter 7 concludes the thesis.

1.13 Conclusion

In conclusion, this chapter has outlined the key elements of the study, beginning with the background and context in Section 1.2. The focus and purpose of the research were presented in Section 1.3, followed by an overview of relevant literature and a discussion of the conceptual framework in Sections 1.4 and 1.5, respectively. The research objectives and questions were addressed in Sections 1.6 and 1.7, while Section 1.8 covered the research design and methodology. Section 1.9 discussed the validity of the study's results, and Sections 1.10 and 1.11 covered the limitations and delimitations. Finally, Section 1.12 outlined the thesis, and Section 1.13 concluded the chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

According to Bhattacherjee (2012), conducting a review of related literature has three main purposes. Firstly, it helps the researcher to become acquainted with the existing literature in their field of study. Secondly, it allows the researcher to establish a connection with the essential authors, theories, and findings in the field. Lastly, it helps the researcher to identify the gap that needs to be filled in the specific area of study (Bhattacherjee, 2012). While there is a significant body of literature on the use of technology in teaching, there is a dearth of research on the use of technology and pedagogy in institutions of higher education that specifically prepare future teachers, particularly in the teaching and learning of coding in the South African context.

The primary objective of this chapter is to conduct a literature review that closely relates to the current study. Sections 2.2 and 2.3 delve into the significance of technology and pedagogy in teaching prospective coding teachers. In Section 2.4, the attitudes and beliefs of prospective teachers concerning the use of technology in teaching and learning are discussed. Sections 2.5 and 2.6, concentrate on the discussions surrounding Computational Thinking and Scratch programming, respectively. Section 2.7 provides a review of the literature on the Activated Classroom Methodology. Lastly, Section 2.8 serves as the concluding Section of the chapter.

2.2 Technology in the teaching and learning of prospective coding teachers

Technology is the development and application of tools, machines, materials and processes that assist in solving human problems (Wahab et al., 2012). Although digital technology has been present for a long time, its implementation and use in education, particularly in the training of future teachers in the South African context, has lagged behind. This lack of integration has resulted in the underutilization of the benefits that come with the use of technology in education. These benefits include but are not limited to increased student engagement, personalized learning, access to a wide range of resources, and improved communication between lecturers and prospective teachers. Prospective teachers can learn how to use a variety of technological tools and platforms to improve their teaching methods by integrating technology into teacher training programs, which will make education more engaging, effective and efficient.

To improve teaching and learning outcomes and prepare aspiring teachers for the challenges of 21st century teaching and learning, technology integration in education, often referred to as educational technology, is crucial.

There are numerous technologies and applications that may be used to train aspiring teachers and that provide a variety of material and functions in educational environments. Adeoye and Ojo (2014) show the many technology instruments utilized in teaching and learning in Figure 2.1.

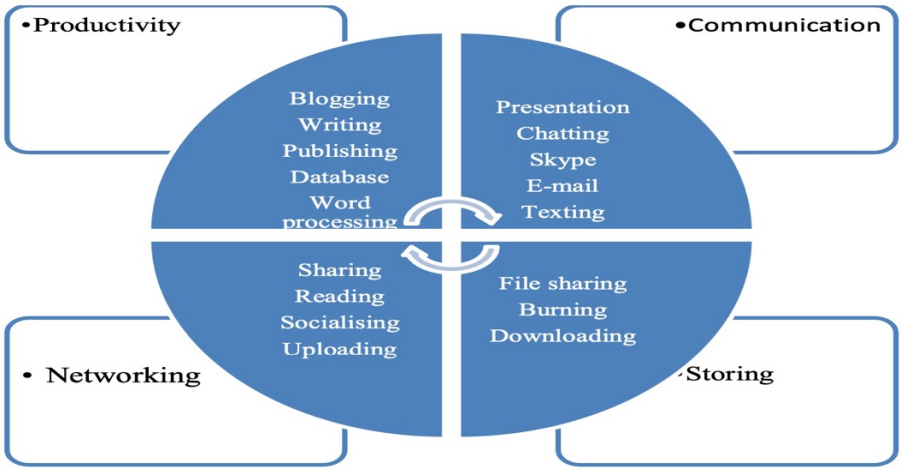


Figure 2.1: Technological tools used for teaching and learning (Adeoye & Ojo, 2014)

The use of productivity tools like word processing, desktop publishing and blogging helps users work more effectively (Adeoye & Ojo, 2014). On the other hand, networking tools enable information flow across local and international networks, enabling students and instructors from various locations to work together and learn from one another (Adeoye & Ojo, 2014). Furthermore, storage applications like Dropbox and Google Drive offer a safe way to store and share important data (Adeoye & Ojo, 2014). For virtual classrooms and teleconferences, communication technologies like Skype, presentations and chat are crucial (Adeoye & Ojo, 2014). To improve student learning outcomes, these technological tools can be used in a variety of teaching and learning settings. It is crucial for lecturers and prospective teachers to be knowledgeable about and adequately skilled in the usage of these technologies

because they are becoming more and more relevant to teaching and learning (Akinnagbe & Baiyeri, 2011).

2.2.1 Teaching prospective teachers using technology

In recent years, teacher training institutions have increasingly adopted technology, not only as a symbol of progress but also in their day-to-day teaching and learning operations to train future teachers (Klenin et al., 2020). While technology was not widely accepted for teaching in such institutions in the past, there is now a growing willingness to utilize it for educational purposes (Klenin et al., 2020). Although South African teacher training institutions still have a long way to go in fully embracing technology for teaching, lecturers have made considerable progress in training prospective teachers using technology. One argument in this literature review is that lecturers should not simply instruct future teachers to use technology without using it themselves for teaching and learning. To fully appreciate and understand the benefits of technology in their classes, lecturers of prospective teachers should explore the different technologies available and incorporate them into their teaching. This will hopefully provide prospective teachers with examples that they can incorporate into their future teaching.

Given the above-mentioned points, technology can play an essential role in the development of prospective teachers' teaching and learning processes. Incorporating technology into teaching can enhance engagement by providing interactive and multimedia learning experiences. Lecturers can use existing videos, simulations and games to increase engagement with teaching and learning materials, or they can create new content for students to interact with using their devices. By using multimedia and interactive technologies, lecturers should aim to encourage prospective teachers to incorporate such methods into their own teaching practices in the future.

The use of technology in teacher training institutions can also foster collaboration and enhance the learning experiences of prospective teachers (Koehler & Mishra, 2009). Lecturers can encourage prospective teachers to use online platforms for group work and resource sharing, which promotes collaboration among peers (Laurillard, 2012). Although many online platforms used for collaboration and resource sharing are not education-focused, research suggests that they can be effectively utilized for

educational purposes (Basar et al., 2021). By exposing prospective teachers to these technologies, lecturers can demonstrate the potential benefits of using technology in education, thus encouraging prospective teachers to also incorporate technology into their own teaching practices in the future (Harris & Hofer, 2009).

2.2.2 Teaching prospective coding teachers using technology

Despite the abundance of literature on technology's role in preparing prospective teachers, in the South African context there is little study on how it can specifically be used to teach coding to them. Few prospective teachers of coding are aware of the benefits of technology for teaching and learning, even though many of them are tech-savvy and have grown up in the digital era (Lei, 2009). As many prospective teachers still rely on conventional media and teaching methods. During teaching practice evaluation, lecturers frequently witness lesson plans and lesson presentations that do not make use of technology (Fitriati et. Al, 2023). This can be linked to the fact that despite technology being available, the prospective teachers' lecturers and previous teachers used traditional teaching methods. As a result, current and new prospective coding teachers frequently adopt the same methodologies, which limits the advantages that technology could provide.

2.2.3 Paradigm shift

There is thus a need for a paradigm shift in how South African prospective coding teachers are taught and trained to teach, especially when using technology for teaching and learning purposes. Prospective coding teachers should receive more training on how to teach in learner-centred classroom environments and less on how to teach in teacher-centred environments. In teacher-centred classroom environments, the teacher is viewed as the sole source of knowledge, mainly using traditional teaching methods and resources (Wright, 2011). On the other hand, learner-centred classrooms view teachers as guides to knowledge, with a focus on the student and their learning, which can be facilitated by technology (Tzenios, 2022). In such environments, knowledge exists outside of humans and is instead made possible using technology, where a pertinent requirement is for students to know how to use technology to find information. Table 2.1 provides a comparison of teacher-centred vs. learner-centred teaching environments.

Table 2.1: Comparison of learning environments (UNESCO, 2003)

	Teacher centred learning environments	Learner centred learning environments
Classroom activity	Teacher centred, didactic	Learner centred, interactive
Teacher role	Fact teller, the expert, rigid	Collaborator, facilitator, sometimes learner
Instructional emphasis	Rote	Inquiry and invention
Concepts of knowledge	Accumulation of facts, quantity	Transformation of facts
Technology use	Drill and practice	Communication, collaboration

Source: UNESCO (2003)

Adopting learner-centred teaching approaches that incorporate technology can offer numerous benefits for prospective coding teachers (Ohei et al., 2023). Firstly, technology provides coding tools, development platforms, debugging tools and libraries that give prospective teachers valuable hands-on coding experience during their training. Secondly, technology allows for personalized instruction and support for differentiated learning by providing tools that cater to each prospective teacher's unique needs and preferences. For example, adaptive learning software can offer personalized feedback and learning activities to prospective teachers. Thirdly, technology can connect coding content to real-life applications, such as solving real-world problems through coding challenges and hackathons. These are just a few benefits of using technology in teaching prospective coding teachers, and many others exist.

2.3 Technological pedagogy in the training of prospective coding teachers

While technology is often thought to be a tool that improves work processes, many researchers suggest that simply using technology for teaching purposes does not always result in positive outcomes (Carstens et al., 2021). In fact, sometimes using technology can lead to worse results than when it is not used, which is perplexing. To mitigate negative outcomes when using technology to teach, evidence suggests that a

teaching pedagogy is needed (Blewett, 2017). In computer science education, there has been a long-standing debate about the most effective pedagogy for teaching programming (Belmar, 2022). Research suggests that the use of technology can enhance the effectiveness of teaching, especially when coupled with a pedagogy of teaching that utilizes technology (La Fleur & Dlamini, 2022). This introduces us to the concept of technological pedagogy.

To understand and describe the concept of technological pedagogy we ought to first describe pedagogy and technology separately. It is known that pedagogy refers to the strategies that educators use to teach students (Shah, 2021), while technology was defined as the development and application of tools, machines, materials and processes that assist in solving human problems (Wahab et al., 2012). Therefore, technological pedagogy can be defined as the integration of technology into teaching practices to enhance student learning outcomes and teacher effectiveness (Mishra & Koehler, 2006). It is imperative for each and every prospective coding teacher to have technological pedagogy, so they know not only how to use technology, but also know how to use it effectively for teaching and learning purposes, which is partly what is argued for in this study.

Recently, there has also been growing interest in the development and use of 21st century teaching pedagogies that promote participation, productivity and personalized activities to train prospective teachers (AbdulRab, 2023). These pedagogies prioritize prospective teachers' abilities and achievements over what and how much content their lecturers can cover. As a result, 21st century teaching pedagogies facilitate relevant teaching that aligns with prospective teachers' social contexts, often through meaningful projects that require problem-solving and supported by powerful teaching strategies while promoting the use of technology in educationally relevant ways (Gyawali & Mehndroo, 2023). Some examples of 21st century teaching pedagogies that relate closely to this study by utilizing technology include gaming, collaborative learning, flipped classroom, and visual, audio and kinaesthetic (VAK) learning. Below, is an exploration of these pedagogies in more detail.

2.3.1 Gaming

Gaming is a popular strategy in literature that has been used to introduce novices to coding through games (Rose et al., 2018; Xu et al., 2019; Vahldick et al., 2020). In many cases, students have created and defined game rules through spoken language. In this study, the researcher aims to teach prospective teachers game design and development through block-based coding, believing that they will learn coding more effectively by designing, creating and playing their own games, which they enjoy doing. To create these games, the prospective teachers will use the Scratch program. The immediacy with which Scratch programs run is expected to encourage the prospective teachers to work towards complete and functional solutions, as they test and improve their programs. The hope is that this approach will motivate the prospective teachers to continue learning coding and not give up easily.

However, gaming, especially on the Scratch platform can create the misconception that coding is solely about moving objects on a screen and producing sounds, which can easily be adopted by novice programmers (Brennan & Resnick, 2012). This is also seen when the youth is playing games that are not guided by strict rules. This may lead to the false belief that coding is solely about gaming and playing. To counter this, the researcher aims to teach coding through game design and development that promotes Computational Thinking and problem-solving skills. The study focuses on cultivating these skills through gaming, with the hope that prospective teachers will apply similar methods when they become teachers and pass these skills on to their learners. While playing games and manipulating objects on the screen can be a by-product of game design, the primary focus would be on developing problem-solving and Computational Thinking skills.

2.3.2 Pair programming

Another popular strategy among coding lecturers is pair programming, which falls within the category of collaborative learning (Laal & Laal, 2011). Pair programming involves two programmers working together to solve a programming task (Lui et al., 2010; Faja, 2014). These programmers can be experts or novices, and there are three possible combinations for pairing them: 1) expert and expert, 2) expert and novice, and 3) novice and novice (Wray, 2010). For novices, the most desirable combination is to work and learn from an expert. When paired with an expert, the novice

programmer's learning outcomes and thus grades can improve. However, it may not always be possible to pair a novice with an expert. Therefore, it is common to find novices paired with other novices during pair programming (Wray, 2010). For this study, it is expected that none of the prospective teachers have any programming experience in university, and very few, if any, had programming experience in high school.

The research participants of this study are thus programming novices, as they have little to no programming experience. For such individuals, research has shown that pair programming can help improve their problem-solving skills since it requires students to collaborate and communicate effectively when solving programs (Mikum et al., 2014). In fact, students who work in pairs on programming tasks demonstrate better problem-solving skills than those who work alone (Mikum et al., 2014). Moreover, programming novices can easily get frustrated with the learning curve and problem-solving aspect of programming, especially when working alone. However, students working in pairs tend to report increased problem-solving confidence and less frustration with programming tasks and related materials. This is attributed to the support that pair programming provides, compared to students working individually without a supportive partner.

Pair programming can be enhanced through the use of different setups that cater to the students' needs and levels of expertise. These setups can include unstructured pairing, driver-navigator, backseat-navigator, tour guide, and ping-pong pairing (Wray, 2010). In unstructured pairing, students randomly switch roles between typer and problem solver in a pair, whereas in a driver-navigator setup, each student is either the typer or the problem solver, and their roles do not change (Wray, 2010). Backseat-navigator pairing is a setup in which one student provides directions and suggestions to the other student, who does most of the coding. In the tour guide setup, both students switch roles frequently, with one prospective teacher explaining the code and problem-solving strategies as they go along (Wray, 2010). Finally, ping-pong pairing involves both prospective teachers taking turns writing code and testing it, with each person taking over from the other as needed (Wray, 2010).

The most common setup for pair programming is unstructured pairing, where the programmers work side-by-side on solving a programming task, and their roles intertwine between typer, reader or guide, and problem-solver (Wray, 2010; Faja, 2014). However, it is essential for each partner to experience both sides of the pair, regardless of the chosen setup, to improve their programming and problem-solving skills. While pair programming can be used with or without technology, lecturers are called upon to encourage prospective teachers to use technology when using pair programming as a pedagogy of teaching.

Furthermore, since pair programming relies on social interaction and peer discussion to encourage sharing of ideas, its success depends on the ability of the two prospective teachers to work together effectively (Faja, 2014). In this study, the researcher proposes to use the Activated Classroom Teaching (ACT) methodology pedagogies to introduce prospective teachers to coding. The ACT methodology consists of five pedagogies, namely: curation, conversation, correction, creation and chaos (Blewett, 2017). The researcher can incorporate pair programming into the conversation pedagogy, where two students converse about coding topics using technology. In addition, the researcher can use the correction pedagogy by setting up Zoom sessions where one student shares their screen and the other makes corrections to a program. Another approach is to encourage pairs of students to make games using Scratch, aligning with the creation and chaos pedagogies of the ACT methodology. Although the proposed strategy is not limited to pair programming, the strategy proposed can be used effectively in both single and pair programming setups. The researcher also encourages interaction among prospective teachers to be as individuals, pairs or larger groups when implementing this strategy underpinned by the use of technology.

2.3.3 Flipped classroom

The flipped classroom (Schmidt & Ralph, 2016) has gained popularity as a teaching pedagogy in recent years. In this approach, students do at school what they would normally do at home, and vice versa. Thus, students watch recorded lectures and study materials at home, while in class they work on activities that would traditionally be assigned as homework, but now under the guidance and supervision of the teacher. The benefits of this approach are numerous, including: 1) deeper understanding of knowledge, 2) development of independent learning skills, 3) reduced time for

introducing new topics and 4) the ability of teachers to create more engaging lessons that promote student interest and interaction with the content.

Recently, researchers have explored an extension of the flipped classroom known as "flipping the flipped classroom" (Zainuddin & Halili, 2016). In this approach, the traditional flipped classroom practices remain in place, but with the added expectation that students will share what they have learned with their peers by teaching them, while the teacher takes on the role of a student (Zainuddin & Halili, 2016). This method encourages the students to think more critically about the material, as research indicates that when students know that they must present content to their peers, they tend to do more research and expand their knowledge. This method is very beneficial for prospective coding teachers as it helps train them early in their teaching development to teach, as well as to equip them with content and a technologically relevant teaching pedagogy.

This study will examine various elements of the flipped classroom, such as assigning prospective teachers with activities they would have done at home to be completed in class, these activities would be pedagogically underpinned by technology. The technology used would be technology that encourages student engagement and collaboration through the pedagogies of the ACT methodology (Blewett, 2017). Moreover, the ACT methodology pedagogies are quite flexible, allowing students to work on activities at home or in the classroom, and to interact with teaching and learning materials at home or by attending lectures on campus. While it is noted that both methods have proven effective for teaching, the use of the ACT methodology in this study does not limit the setting for activities and lectures as is the case with the flipped classroom.

2.3.4 VAK learning

VAK (visual, audio and kinaesthetic) learning encourages teachers to understand students' needs and identify the conditions under which they excel when learning (Sreenindhi & Tay, 2017). Teachers using VAK learning will typically group students into three categories: visual, audio and kinaesthetic students (Sreenindhi & Tay, 2017). Visualization, such as simulation or animation of content, is often employed to introduce novices to programming and to make the material more engaging (Price &

Price-Mohr, 2018). Using simulations, lecturers can demonstrate the main behaviours of algorithms and clarify concepts to avoid misconceptions among students. The idea is that visualizing algorithms can facilitate prospective teachers' understanding and help them convert concepts into code (Gillern & Robert, 2017). To this end, visually appealing graphics are commonly used in these visualizations (Gillern & Robert, 2017; Price & Price-Mohr, 2018). The thinking is that since attractive graphics can sustain students' focus and interest and improve their comprehension of programming content, the same can be said for the prospective teachers. In this study, while visually appealing graphics are not a core component of Computational Thinking and problem solving, they will be a secondary by-product of game development and coding. The vast majority of studies using VAK focused on students in primary and high school and not prospective teachers at the university level. There is therefore a gap in the literature, which this research will contribute to filling.

In other cases, students are required to create their own visualizations of algorithms and code as they learn programming (Gillern & Robert, 2017). They can use drawings or digital art to make these depictions. The idea is that, instead of relying on the lecturer to provide visuals, it is better for prospective teachers to produce their own, as it can enhance their understanding of programming. While visualization and simulation of algorithms are useful teaching tools, the researcher does not plan to rely on aesthetically appealing visuals to teach coding, since aesthetics do not play a significant role in teaching coding and Computational Thinking (Law, 2020). Even with the games the researcher intends to use to teach block-based coding, aesthetics will not be a primary consideration in game design; they will only be a by-product of game development, with Computational Thinking being the primary focus. The researcher hopes that by incorporating aesthetically appealing graphics into their games, the prospective teachers will see the value in using such graphics when teaching young learners in the future as visually appealing graphics are enticing to young learners (Gillern & Robert, 2017).

Storytelling and role-play are effective methods of teaching coding to students who learn best through audio and kinesthetic means (Burke & Kafai, 2010). In storytelling, students listen to a story and then convert it into code (Resnick & Silverman, 2005). In role-playing, students act out different roles to immerse themselves in the

interaction between the different pieces of code in the program (Burke & Kafai, 2010). Role-play can be based on a story that students listened to. The idea is that students can easily assimilate their role-playing and storytelling to their code (Price & Price-Mohr, 2018). However, this strategy is encouraged more with younger students and less with more mature students because interest in role-playing and storytelling decreases with age when teaching coding (O'Byrne et. Al, 2018.; Gillespie, 2022).

One drawback of using storytelling and role-play to introduce coding is that these methods can encourage students to focus more on the graphics, text and sounds used to tell the story, than applying Computational Thinking skills to code programs using programming concepts and constructs. While these strategies may not be recommended for mature students, the researcher will use them when necessary to clarify coding concepts and constructs to the prospective coding teachers. The hope is that these prospective teachers will in turn use similar or improved strategies when they become coding teachers themselves.

2.3.5 PRIMM framework

An additional pedagogical approach closely linked to ACT pedagogies and proving effective is the PRIMM framework (Sentance & Waite, 2017). Developed by Sentance and Waite (2017), the PRIMM framework offers a set of strategies that educators can employ to guide their students through coding instruction. These strategies encompass five key steps: 1) prediction, 2) running the code, 3) investigation, 4) modification and 5) make (Sentance & Waite, 2017). Originally designed for text-based programming languages, the PRIMM framework's use extends beyond this and can be easily adapted to teaching block-based coding through game development (Law, 2020). The surging popularity of the PRIMM framework stems from its robust emphasis on nurturing Computational Thinking processes. A brief discussion of the PRIMM framework is presented below.

The first step in the PRIMM framework is the 'Predict' strategy, which prompts students to forecast the outcomes of a given program. This program might be presented as an algorithm, a flowchart or even a game scripted in Scratch. Engaging in predictive exercises compels students to undertake cognitive processes that bolster their abilities

through visualization - an essential skill for budding programmers as they navigate coding.

The next step in the PRIMM framework is ‘Run’, when students execute or run their programmed code. This action serves a threefold purpose: 1) validating their earlier prognostications about the program's behaviour, 2) comprehending its operational mechanisms and 3) assessing the outcomes generated post-execution (Sentance & Waite, 2017). Consequently, students engage in a comparative analysis between their initial predictions and the program's actual output and behaviour. This collaborative process among peers cultivates a sense of cooperation and communication, aligning well with the conversation pedagogy that is being employed.

The synergy between the predict and run steps, seamlessly aligns with ACT pedagogies to foster Computational Thinking, thus serving as a catalyst for students to engage in paper-based or mental program tracing. This process entails envisaging the program's step-by-step progression and anticipating the corresponding outcomes, as expounded by Sentance et al. (2019a). This could manifest as a hypothetical input, which the student navigates mentally through the program's logical flow using a design-oriented approach, culminating in the projected outcome. In effect, this exercise acts as a cognitive workout, honing the students' thinking faculties (Sentance & Waite, 2017; Sentance et al., 2019a).

The third step in the PRIMM Framework is ‘Investigate’, where students rigorously assess the program's functionality through diverse inputs. By subjecting the program to varying inputs and executing them, students can ascertain the program’s alignment with its anticipated outcomes (Sentance & Waite, 2017). Equally vital to this investigative process is the inclusion of extreme and out-of-range data, encompassing inputs the program is not inherently designed to handle. This practice serves as a litmus test, encouraging students to scrutinize the program's behaviour. The ensuing results trigger collaborative discussions among students. In instances where the program yields unexpected results, these discussions are centred around dissecting the underlying reasons for such outcomes and brainstorming potential resolutions. This conversational exchange facilitates a collective effort to rectify issues and ensure the program operates as intended, effectively applying corrective measures.

The ‘Investigate’ step, which synergizes with the conversation and correction pedagogies of the ACT methodology, serves to bolster Computational Thinking by prompting students to dissect pre-existing programs and dissect their functioning (Sentance et al., 2019b). Within this strategy, paramount importance lies in comprehending the distinct code components and elucidating their interplay (Sentance et al., 2019b).

The fourth step in the PRIMM framework is ‘Modify’, directing students to refine given programs to achieve specific operational outcomes (Sentance & Waite, 2017). These adjusted code blocks can be subsequently extrapolated for use in distinct yet analogous programs (Sentance & Waite, 2017). This iterative process of refining and then transferring modifications cultivates the students' proficiency in applying the acquired knowledge and skills. The ‘Modify’ step prompts students to fine-tune a code segment and observe the ensuing impact on the program's behaviour (Sentance et al., 2019a). Ultimately, this equips them for the most intellectually challenging phase, ‘Make’.

The Make strategy within the PRIMM framework centres on students crafting entirely novel programs that integrate diverse knowledge gleaned from various learning sources into a cohesive whole (Sentance & Waite, 2017). This approach can be likened to the chaos pedagogy in the ACT methodology, wherein students develop games by synthesizing vast amounts of information. This process demands them to sift through and amalgamate knowledge from disparate resources, resulting in a functional program (Sentance & Waite, 2017).

While the ‘Make’ strategy, akin to the chaos pedagogy of the ACT methodology, entails students crafting programs from the ground up to demonstrate their knowledge and comprehension (Sentance et al., 2019a). In this study, the researcher synthesizes insights from these diverse teaching pedagogies, culminating in a proposed intervention that introduces coding through game design and development, with a keen emphasis on nurturing Computational Thinking. Ultimately, the aim of this research is to showcase how the ACT methodology can effectively introduce students to block-based coding through game development, gauging both their retrospective acceptance of the strategy and their prospective acceptance of the intervention. To the best of the

researcher's knowledge, this contribution remains relatively unexplored in the realm of computer science education.

2.4 Prospective coding teachers' attitudes and beliefs

2.4.1 Prospective teachers' attitudes and beliefs towards technology in education

Recent research has shed light on prospective teachers' attitudes towards the use of technology in education (Nikou, 2024). While some studies have suggested that prospective teachers may have negative attitudes towards technology for teaching purposes (Akturk et al., 2015), an overwhelming majority of the literature suggests that prospective teachers have positive attitudes and beliefs towards the use of technology for learning (Ray et al., 2023). The difference lies in how prospective teachers will use technology for learning versus how they will use it for their teaching (Nikou, 2024). In fact, many prospective teachers view technology as an essential tool for enhancing student learning and engagement (Ray et al., 2023). This positive attitude towards technology is important because research has shown that when teachers have and demonstrate positive attitudes towards technology in education, it can have a positive impact on their students' academic achievement and engagement (Ray et al., 2023). The hope is that prospective teachers build and maintain positive attitudes towards the use of technology in education right into their professional careers.

In line with the above, it is thus crucial for lecturers to encourage positive attitudes towards technology among prospective teachers and to provide them with the necessary training to effectively integrate technology into their teaching practices. By doing so, they can empower future teachers to use technology to create engaging and effective learning experiences for their students. It is also important for lecturers to model the use of technology in their own teaching, as this can help to further reinforce the benefits and importance of technology in education to prospective teachers (Machaba & Bedada, 2022). Therefore, cultivating positive attitudes towards technology in education amongst prospective teachers is essential for promoting the effective use of technology in classrooms thus ensuring that these prospective teachers are equipped with the necessary skills that they need to thrive in the 21st century classroom (Machaba & Bedada, 2022).

2.4.2 Coding prospective teachers' attitudes and beliefs towards technology in education

While much of the literature on the attitudes prospective teachers have towards technology use in education focuses on a generic mix of prospective teachers' attitudes, it is important to consider the unique perspective of coding prospective teachers as well. Coding teachers may use technology to teach programming languages and Computational Thinking and may also leverage technology to facilitate project-based learning and collaboration among students. Two pertinent questions in this regard arise. Firstly, what are the attitudes of coding prospective teachers towards the use of technology in teaching and learning? And secondly, what are the best predictors of the use of technology for prospective teachers when teaching coding? This study seeks to sheds some light on these issues.

It is essential to consider the attitudes of prospective coding teachers towards the use of technology in teaching and learning, as these attitudes can vary depending on their majors and seniority (Serin & Bozdağ, 2020). Currently, not all prospective coding teachers are computer science education majors and research has shown that prospective teachers with positive attitudes towards technology in education are more likely to use technology in their teaching (Davidovitch & Yavich, 2021). The consensus is that the use of technology will make the teaching and learning process more manageable for these prospective teachers. It is thus important for teacher training education programmes to provide subject-specific technology training that is tailored to the unique needs and goals of each major. By doing so, teacher education programmes can help foster positive attitudes towards technology among prospective teachers and equip them with the skills they need to effectively integrate technology into their teaching practices.

2.4.3 Predictors of technology use by prospective teachers

Some research has shown that attitudes towards technology in education differ based on gender and age (Colley & Comber, 2003). Male prospective teachers tend to rate technology more positively than their female counterparts, and younger users are more likely to use technology than older ones (Colley & Comber, 2003). In this study, all participants are in the same age group, therefore age is not a contributing factor. Other research is inconclusive as to whether gender differences do really play a role in

prospective teachers' attitudes towards the use of technology in education (Cai et al., 2016). However, we cannot completely ignore these factors and others as contributing towards the use and non-use of technology by prospective teachers for teaching and learning purposes.

It is thus worth noting that during teaching practicals, prospective teachers underuse technology for educationally effective teaching, compared to their use of technology for their own learning and generic administration purposes. This can be attributed to their attitudes and beliefs about technology. Specifically, prospective teachers' beliefs about technology use in education, such as their perceived ease of use and usefulness, can affect their willingness to incorporate technology into their teaching (Luik & Taimalu, 2021). For example, if a prospective teacher finds coding in a particular language or using a specific environment difficult, they may avoid using that technology altogether. Similarly, if a prospective teacher does not see the value of a particular planning tool in a technological device, they may not use it. Therefore, perceived ease of use and usefulness can be used to help predict the future use of technology by prospective teachers (Luik & Taimalu, 2021). Various other factors play a crucial role in predicting future technology use. By understanding the factors that affect prospective teachers' attitudes toward technology, policymakers and curriculum designers can better design curricula that encourage and enhance the use of technology in educationally effective ways. In Sections 2.4.3.1 to 2.4.3.5 the researcher discusses specific theories of technology adoption and how each theory predicts technology use and or non-use.

2.4.3.1 Technology Acceptance Model

The Technology Acceptance Model (TAM), developed by Davis (1989), is one of the most influential models in information systems (IS) research. This model seeks to explain user acceptance of technology by focusing on two main determinants: perceived usefulness (PU) and perceived ease of use (PEOU). PU is defined as "the degree to which a person believes that using a particular system would enhance their job performance," while PEOU refers to "the degree to which a person believes that using a system would be free of effort" (Davis, 1989: 320). These two factors directly influence an individual's attitude toward using the technology, which in turn affects their behavioural intention (BI) to use the system, ultimately predicting actual usage.

Several empirical studies have validated TAM across different technologies and settings, cementing its reputation as a robust model for predicting technology adoption (Venkatesh & Davis, 2000; King & He, 2006). TAM has been extended multiple times to include additional constructs such as social influence, experience and output quality. For instance, Venkatesh and Davis (2000) proposed TAM2, which introduced subjective norms and image as important variables in mandatory usage settings. Later, Venkatesh and Bala (2008) introduced TAM3, incorporating both cognitive instrumental processes and social influences to offer a more comprehensive framework for understanding technology acceptance.

2.4.3.2 Theory of Planed behaviour

The Theory of Planned Behaviour (TPB), introduced by Ajzen (1991), is an extension of the Theory of Reasoned Action (TRA). TPB adds a third factor: perceived behavioural control (PBC), to TRA's original components, which are attitudes, behaviour and subjective norms. The model posits that behavioural intentions (BI) are a function of these three factors: (1) an individual's attitude towards the behaviour (favourable or unfavourable evaluation), (2) subjective norms (perceived social pressure to perform or not perform the behaviour) and (3) perceived behavioural control (the perceived ease or difficulty with which one performs the behaviour, reflects on past experience and anticipates obstacles) (Ajzen, 1991).

TPB has been widely applied to predict human behaviour in a variety of domains, including technology adoption. For instance, Mathieson (1991) compared TAM and TPB in the context of technology acceptance and found that TPB provides a more comprehensive view of technology adoption because it incorporates perceived behavioural control. In addition, empirical studies suggest that TPB is effective in explaining behaviour that requires conscious control, such as online purchasing and system adoption (Pavlou & Fygenson, 2006; Taylor & Todd, 1995).

2.4.3.3 Decomposed TPB

The Decomposed Theory of Planned behaviour (DTPB) was developed by Taylor and Todd (1995) to address some of the limitations of TPB by decomposing its core constructs: attitude, subjective norms and perceived behavioural control, into more specific belief structures. For example, attitude is decomposed into three belief

components: perceived usefulness, perceived ease of use and compatibility. Similarly, subjective norms are decomposed into peer influence and superior influence, while perceived behavioural control is divided into self-efficacy and facilitating conditions (Taylor & Todd, 1995).

DTPB has been widely used in IS research to explain technology adoption behaviour. By breaking down the constructs into more manageable elements, researchers gain a more detailed understanding of what influences users' technology adoption decisions (Shih & Fang, 2004). This allows for the identification of specific interventions to increase adoption rates by addressing the individual belief components that contribute to behavioural intentions.

Empirical evidence suggests that DTPB provides better explanatory power than TPB or TAM alone, especially when the behaviour in question involves complex decision-making processes (Shih & Fang, 2004; Wu & Chen, 2005). However, the increased complexity of the model can also be a limitation, as it requires more comprehensive data collection and analysis.

2.4.3.4 Unified Theory of Acceptance and Use of technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed by Venkatesh et al. (2003) to consolidate previous models of technology acceptance, including TAM, TPB and others. UTAUT identifies four key determinants of technology use: (1) performance expectancy (the degree to which an individual believes that using the system will help them achieve gains in job performance), (2) effort expectancy (the ease associated with using the system), (3) social influence (the degree to which individuals perceive that important others believe they should use the new system) and (4) facilitating conditions (the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system) (Venkatesh et al., 2003).

UTAUT also includes four moderating variables: gender, age, experience and voluntariness of use. These moderators help explain differences in technology adoption across different groups and contexts. UTAUT has been widely adopted in IS research due to its capacity to explain up to 70%, significantly higher than earlier

models, of the variance in behavioural intention to use technology (Venkatesh et al., 2003).

2.4.3.5 Extended UTAUT

In 2012, Venkatesh et al. extended the UTAUT model to UTAUT2, adapting the model to consumer technology use contexts. The extended model added three new constructs to the original UTAUT framework: (1) hedonic motivation (the enjoyment or pleasure derived from using the technology), (2) price value (the trade-off between the benefits of using the technology and the monetary cost) and (3) habit (the extent to which people tend to perform behaviours automatically due to learning) (Venkatesh et al., 2012).

UTAUT2 has been found to enable better analysis in voluntary and consumer contexts, where factors like enjoyment, habit and cost are important considerations (Venkatesh et al., 2012). Empirical studies have validated the model in various settings, including mobile technology, online learning platforms and e-commerce (Escobar-Rodríguez & Carvajal-Trujillo, 2014; Baptista & Oliveira, 2015).

2.5 Computational Thinking

The Computational Thinking Framework (Let's Talk Science, 2018) is an attempt to provide a wholistic description of Computational Thinking. It is based on research conducted by organizations based both in the United Kingdom and the United States of America which attempted to answer the longstanding questions: 1) What is Computational Thinking? and 2) How can Computational Thinking be taught? These researchers found that in many cases, instead of explicitly defining Computational Thinking, references describe Computational Thinking in terms of what students must know and do to develop Computational Thinking (Let's Talk Science, 2018). Sometimes the learning outcomes are conceptual (e.g., the concept of algorithms) and sometimes the learning outcomes are skills-based (e.g., algorithmic thinking), however they could not reach an encompassing definition (Let's Talk Science, 2018).

In relation to how Computational Thinking can be taught, the researchers then proposed a framework to teach Computational Thinking and named it the Let's Talk Science Computational Thinking Framework. This framework proposed the following

strategies for introducing students to Computational Thinking; 1) unplugged, 2) tinkering, 3) remix & re-use and 4) make. When instructors introduce their students to Computational Thinking the framework suggests that they guide their students through each of these strategies.

Briefly, the unplugged approach encourages students to design and plan their solutions, this can be in the form of IPO and flowcharts, pseudocode and algorithms as well as trace tables. Unplugged refers to laying the design out on paper before commencing coding, however, with recent improvements in technology, this preparation can be carried out using a computer. Tinkering refers to slightly changing a small piece of code and observing how the code behaves as a result of that change (Let's Talk Science, 2018). Remix & re-use refers to learning from a piece of existing code as it is used in a certain program and then taking that small piece of code, changing it, and then incorporating it into a different program (Let's Talk Science, 2018). The make approach relates to encouraging students to make programs on their own from scratch (Let's Talk Science, 2018). In this study, the researcher incorporates these approaches when introducing students to coding in order to help train students' Computational Thinking skills.

While the Computational Thinking Framework (Let's Talk Science, 2018) was developed by researchers from the USA and UK, for this study, the researcher combined the ACT pedagogies, which were developed by a South African professor, with the Computational Thinking Framework to try to find the most effective way of introducing learners to coding. The opportunities possible by this linkage can be very inspiring. Below the researcher discusses the different views of Computational Thinking that every coding student ought to learn, namely: 1) problem decomposition, 2) pattern recognition and abstraction, 3) algorithmic design, 4) automation and parallelisation and 5) debugging and problem simulation.

2.5.1 Types of Computational Thinking

2.5.1.1 Problem decomposition

The breaking down of problems into smaller, more manageable parts or tasks is referred to as problem decomposition (Kwon & Cheon, 2019). This is a very important skill to learn for every programmer, especially prospective teachers since they need to

know how to decompose problems on their own and devise solutions to those problems. However, they also need to be able to know how to decompose, evaluate and understand students' solutions so they know with which concepts their students are struggling and how to clarify those concepts to their students. Problem decomposition is of utmost importance to prospective teachers as it gives them the ability to discuss solutions with their peers, which ultimately trains them for their future careers when they are decomposing, solving and discussing problems with their students.

Research has shown that, often in the early stages of programming, students are able to correctly decompose and solve problems. However, once problems start to become more complex, students tend to struggle to decompose problems so they are able to design and code correctly working programs (Kwon & Cheon, 2019). To assist students to decompose problems, they should repeatedly read problem statements until they understand them correctly. Students can also use algorithms, pseudocodes, a decomposition or input-output chart, or a flowchart that uses visual representation of processes for a program (Kwon & Cheon, 2019).

However, just as being able to decompose problems into smaller parts and then creating solutions to those problems is an important aspect to teaching, how prospective teachers are trained to evaluate decomposition of programs by their students is also a very important aspect. When evaluating decomposition of programs, teachers can use Dr. Scratch which is a program that evaluates the complexity of code formulation in a program. Alternatively, they can set rubrics that specify exactly which aspects they intend to evaluate and how much they rate each aspect. While, in this study the researcher did not necessarily teach prospective teachers how to evaluate programs for decomposition, it was a by-product of the study as the prospective teachers had to discuss, correct, modify and create games as they collaborated with their peers.

2.5.1.2 Pattern recognition and abstraction

Pattern recognition and abstraction entails being able to identify and analyse patterns, trends or regularities within data or information and creating generalized models or representations (Acosta et al., 2023). Abstraction focuses on the prospective teacher's

ability to visualize and depict the essential details of a problem and its solution, while at the same time disregarding irrelevant information, to develop generalized models or representations of a problem (Waite et al., 2018). Once prospective teachers can properly abstract problems and their solutions, they should be able to visualise that problems that may seem different can be solved in the same way, thus abstraction can support pattern recognition within similar and different contexts. This then enables prospective teachers to be able to apply their knowledge and skills of programming in different contexts, irrespective of the problem at hand.

There is a consensus that abstraction goes together with visualization, where visualization is the ability of a programmer to visualize through mental conceptions Computational Thinking abstractions (Wing, 2006). When students have proper and clear visualisations they can better program and understand complex coding better. In cases where students have weak mental/ cognitive abstractions, instructors can support them by using video representations of algorithms (that are moving) or through more concrete representations that are static.

2.5.1.3 Algorithmic design and thinking

The development of step-by-step instructions to solve problems in a systematic and efficient manner is referred to as algorithm design (Kahneman, 2011). This entails approaching problems with a computational mindset, emphasizing logical reasoning and procedural problem-solving techniques (Kahneman, 2011). At its simplest form algorithm design can be in the form of pseudocode, input-output charts as well as flowcharts. In the early phases of students learning to program, it is imperative that they are taught algorithmic design and thinking, so that not only are they able to design algorithms but they are able to interpret them. For prospective teachers, this forms a strong basis for them since they should know how to design algorithms on their own, as well as to be able to interpret algorithms designed by fellow students and their own students in the future so they are able to correct them, if necessary.

Research has shown that students who show a strong algorithm design base are able to code better-structured programs (Dagdilelis et al., 2004). Research has also shown that while students are able to design algorithms and code programs for simple and isolated topics, they tend to struggle when programs require them to use different

concepts in a complex program (Islam et al., 2019). Therefore, while it is important for students to know and understand how concepts function, it is more important for them to be taught how concepts can be combined to solve problems. This results in far richer learning as opposed to isolated knowledge of programming concepts and constructs. In this study, while the researcher taught the prospective teachers the use of individual concepts in programming, the researcher also taught how to combine these concepts to create working and efficient programs.

2.5.1.4 Automation and parallelization

The automation and parallelization of programming tasks are crucial considerations in modern educational environments, especially when employing tools like Scratch, which are designed for novice programmers. The Scratch Integrated Development Environment (IDE) is primarily block-based and was developed by the Lifelong Kindergarten Group at MIT Media Lab to introduce coding in a simplified, user-friendly manner (Resnick et al., 2009). While Scratch is commonly used in early education to teach programming concepts, researchers have begun exploring ways to optimize its use, particularly through the automation and parallelization of tasks, to enhance learners' experiences and expand capabilities for advanced users.

Parallelization refers to giving instructions to a computer that are executed in a synchronous manner (Akl, 1997). In the context of Scratch, where tasks and sprites (characters) can operate concurrently through event-driven programming, parallelization is already built into the environment to some extent. Scratch allows for parallelism via "when green flag clicked" blocks or "when I receive" event messages, which can run code in different sprites simultaneously (Maloney et al., 2010).

Recent research has explored extending this parallelism by making it more accessible to users (Van Esch & De Jong, 2020). For example, studies have investigated creating more advanced parallelization techniques within Scratch by automating sprite behaviours to act independently yet synchronously, allowing students to grasp more complex programming concepts like threading and multitasking without leaving the user-friendly interface of Scratch (Meerbaum-Salant et al., 2013).

In addition, one of the challenges with parallelism in Scratch is that it doesn't support true multi-threading, which can limit its capacity for teaching more advanced parallel computing concepts (Grover et al., 2015). Researchers suggest the potential for integrating Scratch with more advanced IDEs or adding features that facilitate real multi-threaded parallelism, allowing users to learn more sophisticated parallel computing strategies (Maloney et al., 2010).

Automation in programming refers to the ability to execute tasks automatically without continuous human intervention (Jennings et al., 1999). Scratch already provides a degree of automation through its built-in blocks and predefined logic structures that simplify programming for novices (Brennan & Resnick, 2012). However, more advanced forms of automation, such as intelligent tutoring systems (ITS) or automated assessment tools, have only recently started to emerge for Scratch.

Automating repetitive tasks is beneficial in large educational contexts, where instructors might need to assess hundreds of student projects. Work by Harms et al. (2016) on creating automated systems for feedback in Scratch IDE has shown the potential for scaling feedback delivery without the need for direct human intervention. In addition, efforts to develop automated testing systems for Scratch projects can enable students to receive immediate feedback on the correctness of their code, fostering a more productive and iterative learning process (Srikant & Aggarwal, 2017).

Automation can also be useful in personalizing learning experiences in Scratch. Intelligent systems capable of dynamically adjusting learning materials based on a student's progress or coding errors can create a more adaptive and personalized environment (Sengupta et al., 2013). This would allow students to work independently while ensuring they are continually challenged and supported.

The combination of parallelization and automation offers exciting possibilities for Scratch as both a learning tool and a developmental platform. Automation can assist with managing parallelized tasks, such as providing real-time analytics on student progress as they engage with multiple tasks or threads in a program. Moreover, automated guidance systems could help students understand how to structure their

programs to take advantage of parallelism, using event-driven programming principles already embedded in Scratch.

Recent research has begun exploring the benefits of combining these elements to improve coding education. For instance, Chin et al. (2021) examined how automated tools could support the learning of parallel programming in novice-friendly environments like Scratch. They proposed that, through intelligent automation and parallelism, learners could transition smoothly to more complex programming environments in later stages of their education.

2.5.1.5 Debugging and simulation

The identification and fixing of errors or bugs in a program or algorithm and evaluating solutions based on predefined criteria is referred to as the process of debugging (McCauley et al., 2008). While various IDE platforms offer debugging tools, anecdotally we see that in many cases students tend to use these less than manual debugging techniques. Manual debugging techniques will include the scrutinising of code, mostly on printed paper, finding errors in the scrutinized code and fixing those errors. For novice programmers, this can be a daunting task, especially for long and exhaustive programs. To be able to do this, students must be able to mentally simulate how their programs are currently functioning, how they are supposed to function and what results they should be getting at each point of code execution. For many novices this is difficult and often leads them to not spending enough time debugging their own code, a very important skill every programmer should have.

Considering the interest that this research has in relation to the use of technology in the teaching and learning of coding, particularly in the Scratch IDE, how can technology driven IDEs be designed and used by novice programmers to encourage them to use technology to their benefit without affording them a steep learning curve? While in this study the researcher does not use any IDE platform specifically designed for debugging code, prospective teachers will be taught how to debug their own code in the Scratch IDE.

2.5.2 Scratch coding

Scratch is a visual programming environment developed by the Lifelong Kindergarten group at the Massachusetts Institute of Technology (MIT) Media Lab, introduced in 2007 (Resnick et al., 2009). Scratch is designed primarily for young learners (ages 8 and up) to introduce them to programming concepts through a block-based interface. It allows users to create interactive stories, games and animations by snapping together code blocks that represent different programming constructs such as loops, conditionals, variables and event handlers (Maloney et al., 2010).

The Scratch Integrated Development Environment (IDE) differs significantly from traditional text-based programming languages (e.g., Python and Java) because it abstracts complex syntax and focuses on fostering creativity and logic. This ease of use makes it particularly suitable for beginners, helping them build Computational Thinking (CT) skills without being bogged down in syntactical rules (Brennan & Resnick, 2012).

Scratch is used globally in educational settings to teach core computational concepts such as sequences, loops, variables, conditionals and events, while also encouraging problem-solving, design and creativity (Meerbaum-Salant et al., 2013). The IDE's drag-and-drop interface simplifies the process of building algorithms by using visual blocks, making it approachable for learners with no prior programming experience (Franklin et al., 2017).

In classrooms, Scratch is often used to introduce computational concepts to younger students, providing an engaging environment for learning the basics of computer science. It is also used to foster creativity and teamwork as students can create projects individually or collaboratively, often sharing their work on the Scratch online platform (Aivaloglou & Hermans, 2016). Outside formal settings, Scratch is used in extracurricular activities, such as coding clubs, summer camps and maker spaces, to enhance students' coding abilities (Kafai & Burke, 2015).

Research has demonstrated that Scratch is effective for introducing students to control structures such as loops and conditionals. Loops are represented visually by blocks that contain other blocks, providing an intuitive way for learners to understand

repetition (Meerbaum-Salant et al., 2013). Similarly, conditionals are introduced as "if-then" blocks, allowing students to easily grasp how to make decisions in their programs. Studies have found that the use of these visual metaphors significantly reduces cognitive load compared to text-based programming, facilitating easier comprehension of complex concepts (Schneiderman, 1983).

Scratch's block-based programming also makes event-driven programming intuitive. Students can assign actions to different events, such as clicking a sprite or pressing a key. Parallelism, or the execution of multiple scripts simultaneously, is another key feature. Students can understand parallel processes through the use of multiple sprite actions happening concurrently, which is harder to visualize in traditional text-based programming environments (Brennan & Resnick, 2012).

Variables in Scratch are represented by blocks that students can drag and use to store data. However, research shows that while Scratch is good for introducing students to basic data representation, the understanding of abstract concepts like variables and data types can still be challenging for beginners (Grover & Basu, 2017). Scratch allows for the creation and use of variables, but research has found that younger students often struggle with abstract concepts like the persistence of data and its role in computations (Meerbaum-Salant et al., 2013).

2.6 Activated Classroom Teaching methodology

While several approaches have been attempted to teach coding to prospective teachers, the researcher proposes a strategy that involves teaching block-based coding through game design and development. Specifically, the researcher suggests using the ACT methodology to introduce coding to prospective teachers. The ACT methodology comprises a set of 21st century digital-age teaching pedagogies that encourage lecturers to use technology effectively for teaching purposes (Blewett, 2017). These pedagogies include 1) curation, 2) conversation, 3) correction, 4) creation and 5) chaos. The ACT pedagogies aim to help lecturers apply the affordances that technology can offer in the classroom, which can lead to effective teaching and learning practices when technology is placed in the hands of prospective teachers. The assumption is that prospective teachers are excited by technology and that incorporating technology into their learning can foster positive results, especially since many are digital natives and,

generally, people learn best in familiar contexts (Blewett, 2017). The hope is that the prospective teachers will use similar or even better techniques when they become teachers. Sections 2.7.1 to 2.7.5 cover each of the pedagogies of the ACT methodology in detail.

2.6.1 Curation pedagogy

Curation pedagogy is a powerful tool for encouraging prospective teachers to use technology to search, sift and curate information that is important and necessary for a particular topic (Ungerer 2016). This approach involves a repetitive cycle where the prospective teachers develop key skills and knowledge, such as the ability to 1) identify what they do and do not know, 2) how to effectively sift through information using technology and 3) identifying where to find this information and 4) how to create a chronological filing system for saving their findings. Using this approach, aspiring teachers can deepen their understanding of the content they are studying as well as acquire essential digital literacy skills that are essential for the current profession. These skills and knowledge are essential for the effective use of technology in the classroom and can boost motivation and engagement among students (Ungerer, 2016).

The curation pedagogy also stresses the value of preserving and sharing knowledge with others. This can be accomplished by keeping research results on personal devices or sharing them with others via technology. Students can participate in a collaborative learning environment by interacting with one another, exchanging ideas and building on one another's expertise. As a result, students can improve their communication and teamwork skills while also understanding the material more thoroughly. Therefore, curation pedagogy can be seen as a unique and effective way to teach and learn, especially when it comes to the use of technology in the classroom. By emphasizing the value of seeking, classifying and curating information, the curation pedagogy promotes a collaborative learning environment that is beneficial to other aspiring instructors. It also provides future educators with the resources they need to succeed as both digital students and educators. In the future, when they are teachers, it is hoped that these teachers would also teach their students these skills.

2.6.2 Conversation pedagogy

A key element of the Activated Classroom Teaching methodology is the discussion pedagogy. This pedagogy places a strong emphasis on the value of cooperative learning, where prospective teachers are encouraged to cooperate and exchange knowledge and concepts (Blewett, 2017). Prospective teachers can participate in conversations and debates with their colleagues, wherever they may be, by using technologies such as online forums and video conferencing. As a result, the conversation pedagogy puts an emphasis on creating critical abilities including communication, social cohesiveness, technology and technological pedagogical skills. For aspiring teachers who plan to use technology in their classrooms, these abilities are crucial. Students can learn how to express their ideas and views clearly through discussion, as well as learn how to actively listen to and intelligently respond to their peers.

The conversation pedagogy also places an emphasis on critical thinking development in addition to the previously described abilities (Blewett, 2017). Students are challenged to think thoroughly about the subjects they are studying while also learning how to assess and evaluate various points of view and arguments through the use of open-ended questions and Socratic questioning. The conversation pedagogy in the Activated Classroom methodology offers a strong foundation for group learning activities that improve their capacity for communication, critical thinking and technical literacy. Future educators can have a deeper understanding of the subject matter and the abilities necessary to be successful instructors in the contemporary classroom by cooperating and exchanging thoughts and expertise.

2.6.3 Correction pedagogy

Compared to conventional teaching methods, the correction pedagogy constitutes a substantial change. The acquisition of proper knowledge and skills is frequently prioritized in traditional teaching strategies, whereas correction pedagogy places a greater emphasis on the need for error correction and the ongoing growth of knowledge (Blewett, 2017; Virlan, 2022). In order to stimulate critical thinking and reflection on their knowledge of a topic, prospective teachers are urged to spot and correct inaccurate content (Blewett, 2017; Virlan, 2022). This method acknowledges that

knowledge is an ongoing process that needs constant updating and improvement rather than being static and unchangeable.

Mistakes are not seen as failures in correction pedagogy, but rather as worthwhile learning experiences (Blewett, 2017). In order to encourage future teachers to make mistakes and ask questions, lecturers are expected to establish a safe and encouraging learning atmosphere. The corrective pedagogy encourages active engagement and participation, which can result in deeper comprehension and more fulfilling learning experiences, through establishing a culture of cooperation and openness. Correction pedagogy also emphasizes metacognition, i.e., the capacity to reflect on one's own thought processes. Therefore, instructors should encourage their students to acquire metacognitive abilities like self-reflection and self-evaluation, which can improve their capacity to keep track of their own learning and development. Greater autonomy, independence and a sense of ownership over one's own learning may result from this.

Ultimately, the Activated Classroom methodology's correction pedagogy offers a dynamic and avant-garde method of teaching and learning. This strategy can assist aspiring teachers in developing the critical thinking abilities and intellectual flexibility necessary to succeed in today's quickly changing environment by highlighting the value of error correction, teamwork and metacognition (Blewett, 2017). Students can learn more about the subject matter and hone their problem-solving abilities by being encouraged to recognize and solve flaws in their own thinking and knowledge. The corrective pedagogy works well for preparing pupils for the difficulties of the future while also creating a welcoming and encouraging learning atmosphere.

2.6.4 Creation pedagogy

Creation pedagogy encourages prospective teachers to create artefacts that demonstrate their learning. This approach is founded on the idea that learning subject matter is only one aspect of obtaining knowledge; it also comprises creating new knowledge via participation and critical thinking (Blewett, 2017). Aspiring teachers are encouraged to create a range of learning-related artefacts, including quick films, textual assignments and simple Scratch programs. By participating in this creative process, individuals can demonstrate a more thorough and nuanced understanding of the subject they have learned. This approach helps aspiring teachers get a deeper

comprehension of the material while also allowing them to develop their own creative potential.

The creation pedagogy also fosters an environment of experimentation and innovation where students are motivated to take calculated risks and investigate small innovative ideas (Blewett, 2017). By creating artefacts that reflect their own unique perspectives and ideas, future teachers can contribute to the body of knowledge in the classroom and learn from one another. Ultimately, the creation pedagogy offered by the Activated Classroom methodology provides a powerful approach to teaching and learning that places a significant emphasis on the importance of collaboration, critical thinking and creativity. By encouraging students to create artefacts that demonstrate their learning, teachers may help them develop a deeper understanding of the subject matter and a sense of ownership of their own learning.

2.6.5 Chaos pedagogy

The Activated Classroom methodology's chaos and creation pedagogies are similar in that they both motivate students to produce learning artefacts (Blewett, 2017). The degree of structure and control given to students during the artefact creation process is the primary distinction (Blewett, 2017). Chaos pedagogy gives prospective teachers the most options, the least structure, the most knowledge and the least control over what to make as an artefact, in contrast to creation pedagogy where students are given a few, clear instructions (Blewett, 2017). Since it needs students to use a variety of sources of knowledge and material to produce the required item, chaotic pedagogy is the most cognitively taxing. In chaotic pedagogy, students are pushed to accept ambiguity, uncertainty and complexity. They must navigate a purposefully chaotic learning environment while being active participants in their own learning. Students are under pressure to develop their flexibility, creativity and problem-solving skills as they work to produce an artefact that complies with the task's requirements while also incorporating their own unique point of view and ideas.

This pedagogy encourages students to use a variety of information sources, such as their own experiences and observations, as well as academic material, to produce a complex and nuanced artefact that reflects their learning journey. This approach not only helps students develop a deeper understanding of the subject matter, but also

promotes the development of critical thinking, collaboration and metacognitive skills. Overall, the chaos pedagogy of the Activated Classroom methodology offers a unique and innovative approach to teaching and learning. By encouraging students to embrace complexity and uncertainty, this pedagogy challenges them to develop the cognitive and emotional skills they need to thrive in today's rapidly changing world.

Ultimately, the abovementioned pedagogies of the ACT methodology are known to help promote several skills depending on the pedagogy chosen (Blewett, 2017). The curation pedagogy helps to promote the prospective teachers' research skills, while the conversation and correction pedagogies enhance social and communication skills as the prospective teachers work collaboratively (Blewett, 2017). While the creation and chaos pedagogies train digital literacy skills necessary for success in the 21st century (Blewett, 2017). These skills change the role of the prospective teachers from simply being consumers of technology to knowing how to be producers of technology as they learn both how to use and create technology, which are important skills for prosperity, especially in the 4th industrial revolution where they will be faced with problems that will require them to solve problems both using and creating technology (Blewett, 2017).

2.7 Conclusion

In conclusion, this literature review has demonstrated the importance of conducting a review of related literature in research, as outlined by Bhattacherjee (2012). The chapter has focused on the use of technology in institutions of higher education that specifically prepare future teachers, with a particular emphasis on coding.

This chapter has provided a comprehensive review of the literature relevant to the current study. Sections 2.2 and 2.3 explored the critical role of technology and pedagogy in the training of prospective coding teachers. Section 2.4 examined the attitudes and beliefs of these teachers regarding the use of technology in teaching and learning. The focus then shifted to Computational Thinking in Section 2.5 and Scratch programming in Section 2.6. In addition, Section 2.7 reviewed the literature on the Activated Classroom.

CHAPTER 3: CONCEPTUAL FRAMEWORK

3.1 Introduction

This study, unlike studies based on theoretical frameworks, takes on the form of a conceptual framework where the interactions between the variables that will be studied are represented visually and textually in a diagram (Van der Waldt, 2020). In contrast, a theoretical framework lays the groundwork for the theory of a research endeavour (Adom et al., 2018). While a conceptual framework is created by the researcher and includes variables intended for study prior to conducting research, a theoretical framework is based on extensive prior research and is used by the researcher to provide context to their findings (Adom et al., 2018). This is the main difference between the two.

This chapter begins with a discussion of the Theoretical Framework of Acceptability in Section 3.2, focusing on its constituent constructs. Following this, the conceptual framework adopted for the study is presented in Section 3.3. The chapter concludes in Section 3.4.

3.2 Theoretical Framework of Acceptability

The conceptual framework adapted for this study is informed by the Theoretical Framework of Acceptability proposed by Sekhon et al. (2017). This framework was initially used to explore the acceptability of interventions among healthcare workers and patients. According to this theoretical framework, acceptability is a multifaceted concept that encompasses the extent to which individuals involved in delivering or receiving a healthcare intervention perceive it as appropriate, based on their cognitive and emotional responses to both anticipated and experienced aspects of the intervention (Sekhon et al., 2017).

The Theoretical Framework of Acceptability is comprised of seven key constructs. These include: 1) affective attitude, 2) burden, 3) ethicality, 4) intervention coherence, 5) opportunity costs, 6) perceived usefulness, and 7) self-efficacy. Figure 3.1 provides a visual representation of these seven constructs within the theoretical framework (Sekhon et al., 2017). Understanding how these constructs may cluster and influence acceptability is an empirical question that requires observation and experience, rather

than relying solely on theory or pure logic (Sekhon et al., 2017). In the following Sections, each of these constructs will be elaborated upon.

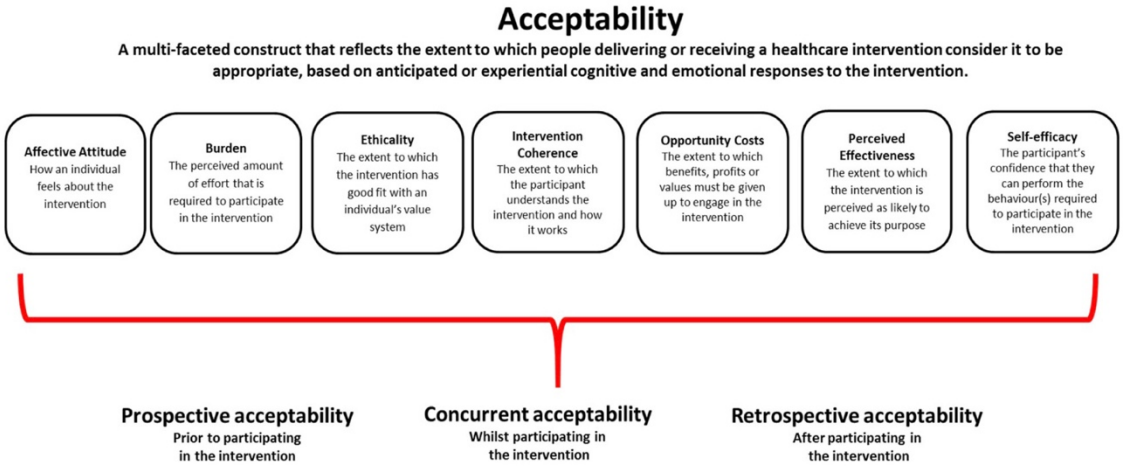


Figure 3.1: Framework of Acceptability

3.2.1 Affective attitude

Affective attitude focuses on a person's emotional reaction to a medical intervention (Sekhon et al., 2017). This concept measures how much a given intervention elicits either positive or negative feelings, such as joy and satisfaction, or fear and anxiety (Sekhon et al., 2017). A variety of elements pertaining to the person participating in the intervention must be considered when assessing affective attitude. These considerations include the person's prior experiences with related interventions, cultural beliefs and values, individual preferences and expectations, and the degree of trust and rapport built between the person and the healthcare professional. Because a person may believe the intervention will be effective or because the person may have faith in the healthcare professional, they could display a positive affective attitude to a particular intervention. A person may, on the other hand, display a negative affective attitude to an intervention due to worries about possible side effects or previous adverse experiences with similar interventions.

It is thus essential to evaluate this construct prior to, during and following the delivery of the healthcare intervention to fully capture the range of emotional attitude. This makes it possible to comprehend completely how a person's emotional response evolves when the intervention is being conducted. In addition, discussing any relief or discomfort resulting from the intervention might offer insight into elements that affect

affective attitude, and this may assist in customizing the intervention to the person's needs and preferences.

3.2.2 Burden

The burden construct refers to the perceived amount of difficulty or discomfort of participating in a healthcare intervention (Sekhon et al., 2017). The effort required to participate in the intervention, including any financial, emotional or physical costs, is included in this construct. For example, a patient may find it stressful to attend several appointments for a specific treatment, while a healthcare professional may consider it burdensome to do more paperwork or meet more training requirements related to a new intervention. All these challenges influence how well and how widely healthcare solutions are accepted and used, both by healthcare professionals and their patients.

3.2.3 Ethicality

The alignment of the healthcare intervention with a person's personal value system is examined by the third construct namely ethicality (Sekhon et al., 2017). If the intervention is viewed as moral and in line with a person's values, beliefs, and cultural or societal norms, it is ethical. This concept recognizes that everyone has a different set of values that influence how they define what is right or wrong, fair or unfair, and acceptable or unacceptable.

The various ethical dimensions include respect for autonomy, beneficence, non-maleficence and justice. These criteria assess how successfully an intervention upholds people’s rights, fosters their wellbeing, prevents harm, and distributes benefits and burdens equally (Sekhon et al., 2017). An intervention, for instance, is more likely to be regarded as ethically sound if patients' informed consent is respected and their privacy is protected. When developing and putting into practice healthcare solutions, researchers and practitioners avoid conflicts, resolve ethical issues and recognize potential ethical challenges using their understanding of the ethicality construct. It enables a thorough assessment of whether the intervention adheres to the moral principles and values of those involved, fostering better acceptance and involvement.

3.2.4 Intervention coherence

Intervention coherence focuses on how well healthcare practitioners and their patients understand and comprehend the functioning of the healthcare intervention (Sekhon et al., 2017). It focuses on the precision and understandability of the intervention's goals, processes and anticipated results. It evaluates whether healthcare practitioners and their patients comprehend how the intervention's various components work together to achieve its stated objectives. The availability of clear instructions, explanations and instructional resources about the intervention are significant considerations for assessing the coherence of the intervention. This includes making certain that people are aware of the justification for the intervention, the steps required and any possible advantages or hazards. Individuals' knowledge can be improved by open communication, which then encourages their participation and acceptance of the intervention (Sekhon et al., 2017).

The idea of theoretical coherence, which describes the alignment between an intervention's underlying theory or evidence base and its actual execution (Sekhon et al., 2017), is also strongly related to the concept of intervention coherence. The intervention is anchored in existing knowledge and its elements are logically related to produce the intended results towards theoretical coherence. Researchers and practitioners pinpoint areas that require improvement in communication, education or information provision by considering the coherence of interventions within the Theoretical Framework of Acceptance. The effectiveness and impact of healthcare interventions are eventually improved by increasing the coherence of the intervention. This facilitates the understanding of the intervention and encourages engagement and acceptance.

3.2.5 Opportunity costs

Opportunity costs focuses on what people believe they must give up when participating in the healthcare intervention to receive benefits, gains, favours or profits (Sekhon et al., 2017). Opportunity costs refer to the decisions people make when participating in the intervention, considering what they would have gained or done if they had allocated their resources (time, effort and money) to different endeavours. The value that people place on the options they must forego should be taken account of when calculating opportunity costs. For instance, a patient can perceive that

participating in a clinical trial could reduce socialising or limit other leisure activities. Similarly, a healthcare professional may believe that participating in a training program for a new solution could be time-consuming and could rather devote such time to their professional practice or research.

Understanding opportunity costs in the context of the Theoretical Framework of Acceptability offers valuable insights into the perceived priorities that people afford to the healthcare intervention and the related activities. This concept facilitates insight into the motives and incentives people require to overcome the apparent sacrifices. Researchers and practitioners can increase the acceptability and engagement of the intervention among participants by considering and resolving the opportunity costs associated with it. Thus, it may be helpful to use qualitative research techniques, such as focus groups or interviews, to examine people's viewpoints, preferences and trade-offs to capture the subtleties of opportunity costs. These could include quantitative tools like Likert scales or economic valuation methods. Overall, by including the opportunity costs construct into the Theoretical Framework of Acceptance, researchers design strategies to increase acceptance and engagement by developing a deeper knowledge of the perceived values and sacrifices people associate with a healthcare intervention.

3.2.6 Perceived effectiveness

The perceived effectiveness, gauges how likely people believe a healthcare intervention will succeed in its intended purpose (Sekhon et al., 2017). It measures the perception of an intervention's efficacy and how it affects a person's health, well-being or desired goals. When determining perceived effectiveness, it is necessary to consider how people view the intervention's efficacy, viability and potential benefits. This idea incorporates their individualized evaluations of whether the intervention will provide the desired results, address their unique needs or problems and improve their health outcomes. Previous experiences with similar interventions, trust in healthcare providers or organizations, and the availability of evidence or testimonials can all affect perceived effectiveness.

Knowing what influences people's acceptance and involvement with the intervention is essential for understanding aspects that lead to perceived effectiveness within the

Theoretical Framework of Acceptance. Researchers and practitioners can boost people's confidence and motivation to participate in the intervention by addressing and improving perceived effectiveness. This can be accomplished by presenting the intervention's potential advantages clearly and accurately, dispelling any questions or misunderstandings, and discussing the data that supports it.

Validated measures, surveys or qualitative evaluations that capture people's beliefs, expectations and perceptions of the intervention's efficacy can be used to measure perceived effectiveness. A thorough understanding of peoples' perspectives can be obtained by combining quantitative and qualitative methodologies, which also enables the development of tailored interventions and strategies to increase perceived efficacy. Overall, researchers can increase their knowledge about people's expectations and views towards the potential results of the intervention. This knowledge can assist with the design and execution of programs that people in healthcare settings are more likely to accept, embrace and use effectively.

3.2.7 Self-efficacy

This focuses on an individual's level of confidence in their ability to effectively complete the healthcare intervention (Sekhon et al., 2017). The term relates to a person's confidence in their ability to execute necessary tasks, overcome obstacles, and accomplish the intended objectives related to the intervention. Understanding people's perspectives of their own abilities, skills and knowledge pertinent to the intervention is necessary for measuring self-efficacy within the Theoretical Framework of Acceptance. It investigates whether people have faith in their capacity to adhere to rules, use advised techniques and overcome any hurdles that could emerge throughout the intervention. Individuals' motivation, perseverance and involvement during the intervention process are greatly influenced by their sense of self-efficacy.

Researchers can use a variety of techniques to assess participants' levels of self-efficacy, including structured interviews, self-report tests and direct behavioural observation. Researchers and practitioners can raise people's self-efficacy by identifying elements that support higher levels of self-efficacy, such as providing clear instructions, providing opportunities for skill development and creating a supportive environment. The Theoretical Framework of Acceptance must address self-efficacy if

it is to encourage people to actively participate, adhere to the programme and produce positive results. Individuals are more likely to feel empowered and capable of successfully completing the intervention if self-efficacy is fostered and nurtured through specialized assistance and resources. This can be accomplished with the assistance of individualized coaching, skill-building interventions, and chances for self-evaluation and feedback.

Overall, researchers can grasp people's trust in their capacity to conduct the intervention by including self-efficacy as a component within the TFA. Researchers and practitioners can increase people's confidence in their potential to succeed by addressing and strengthening self-efficacy, which will increase acceptability, engagement and successful implementation of the healthcare intervention.

3.3 Conceptual framework

The conceptual framework shown in Appendix G that is utilized in this study provides a visual representation of the conceptual framework including the factors influencing three key aspects: 1) students' acceptance of the proposed pedagogy for learning purposes, 2) their intention to use the pedagogy in the future for teaching purposes, and 3) the prediction of usage of the pedagogy for both teaching and learning purposes when these students become teachers. Within this conceptual framework, acceptance is defined as the degree to which a student embraces a pedagogy for learning purposes as influenced by three factors: 1) experience, 2) people, and 3) trust. Conversely, intention refers to the extent to which a student intends to adopt the intervention in the future for teaching purposes as predicted by three factors: 1) anticipated, 2) people, and 3) trust.

Through the conceptual framework it is postulated that by combining acceptance and intention, it is possible to predict the likelihood of future usage of the pedagogy. Usage refers to the way in which a prospective teacher is likely to use the pedagogy in the future as influenced by the factors of acceptance and intention. Usage is divided into four categories: 1) use as a deliverer, 2) use as a receiver, 3) use as both a deliverer and receiver, or 4) no use. These categories will be elaborated upon in Section 3.3.1.4 and 3.3.1.5

3.3.1 Acceptance and intention factors

3.3.1.1 Experienced and anticipated factors

To begin, the experienced and anticipated factors, as mentioned, refer to the positive or negative experiences that students associate with their participation in an intervention. These experiences can either be retrospective (experienced) or prospective (anticipated) and are influenced by three factors: 1) effectiveness, 2) burden, and 3) affection. Thus, in the context of the conceptual framework proposed, the experienced factors pertain to the students' lived experiences when taught (learning) using the intervention, while the anticipated factors represent the students' expectations of their experiences when using the intervention for teaching purposes in the future.

As previously mentioned, there are mainly three factors influencing what is experienced, namely: effectiveness, burden and affection. Effectiveness refers to the extent to which the intervention is perceived to have achieved its intended purpose. Burden is the perceived level of effort required for participation in the intervention. Affection, on the other hand, reflects the emotional response of the participant (in terms of enjoyment) to the intervention.

The factors influencing experience, which refers to the extent to which a student plans to use the proposed strategy in the future for teaching, are similar to those of anticipated factors. However, the experienced factors of effectiveness, burden and enjoyment are now transformed into anticipated factors, specifically examined from the perspective of students as future teachers. In addition, a new factor called self-efficacy is introduced.

Self-efficacy, in this context, represents the extent to which a student perceives themselves capable of performing at the required levels when utilizing the proposed intervention when they become a teacher. For a diagrammatic view of the various main and component factors and their interactions, refer to Appendix G, which provides a visual representation of the conceptual framework.

3.3.1.2 People factors

The extent to which peers, colleagues and experts affect a student's impression of an intervention, including both retrospective and prospective views is referred to as

people factors. While the retrospective people factors would represent the students' peers' lived experiences and views about being taught using the intervention, whereas their prospective people factors would relate to the students', colleagues' and experts' anticipated experiences and views of the intervention that they are using to teach.

Within this conceptual framework, there are two elements that constitute people factors, namely: 1) social influence, and 2) facilitator influence. Social influence refers to how much a student's perspective of an intervention is influenced by the opinions of others, such as friends, acquaintances or anybody with knowledge of the intervention. On the other hand, facilitator influence focuses on how much professionals in the field, like lecturers or tutors who are experts on the intervention, have an impact on the participant's affinity for the intervention.

3.3.1.3 Trust factors

Students' perceptions of an intervention's consistency and dependability are used to construct trust variables, which are influenced by two separate components: intervention coherence and reliability. Trust factors can be analysed from the viewpoints of a student (experienced) and a teacher (expected). Therefore, the retrospective trust factors are the extent to which a student deems an intervention as consistent and dependable for it to be used for learning. While the prospective trust factors would be the student's anticipated views of how consistent and dependable an intervention would be for their teaching in the future.

Trust factors consist of two components, namely coherence and reliability. In this context, coherence denotes the extent to which the participant comprehends the intervention and its relevance to their activities. It addresses how well the intervention aligns with their understanding and goals. On the other hand, reliability refers to the extent to which the participant perceives the intervention as dependable and trustworthy in supporting their activities.

3.3.1.4 Prediction of usage behaviour

In this conceptual framework, it is posited that both retrospective acceptance and prospective acceptance play a predictive role in determining usage behaviour. Usage behaviour refers to the anticipated way participants will use the intervention when they

become teachers. There are four possible outcomes for usage behaviour: 1) use as a deliverer, 2) use as a receiver, 3) use as both a deliverer and receiver, or 4) no use.

Use as a deliverer occurs when a student who has become a teacher employs the intervention solely for teaching purposes. Use as a receiver occurs when a student who is now a teacher utilizes the intervention exclusively for learning purposes, such as attending workshops or engaging in self-study. Use as both a deliverer and receiver indicate that a student when they become a teacher would employ the intervention for both their teaching and learning. No use signifies the absence of the intervention.

3.3.1.5 Combinations of acceptance and intention

The expected outcomes based on different combinations of acceptance and intention are as follows: high acceptance combined with high intention is anticipated to result in usage behaviour as both a deliverer and receiver. High acceptance with low intention is expected to lead to usage behaviour as a receiver only. Low acceptance with high intention is projected to result in usage behaviour as a deliverer only. Low acceptance combined with low intention is anticipated to lead to no use. For a simplified reference illustrating the impact of acceptance and intention on the different usage behaviours, refer to Appendix H.

3.3.2 Link between the Theoretical Framework of Acceptability and the conceptual framework

The conceptual framework of this study is based on the Theoretical Framework of Acceptability, which is often used to understand the acceptance of interventions by healthcare workers and patients. It provides a framework for evaluating acceptability in three different ways: 1) retrospective acceptability, 2) concurrent acceptability, and 3) prospective acceptability (Sekhon et al., 2017). In the researcher's conceptual framework and the Theoretical Framework of Acceptability only retrospective and prospective acceptability are closely related as they both determine the extent to which participants of a study accept an intervention, based on past and future experiences. Therefore, retrospective and prospective acceptability in the Theoretical Framework of Acceptance relates to acceptance and intention, respectively, in the researcher's conceptual framework. While the Theoretical Framework of Acceptability is a theory used in the health sciences to determine the extent to which an intervention is accepted by healthcare practitioners and their patients, the conceptual framework used in this

study is used to determine the extent to which a teaching and learning intervention is accepted by the participants.

In light of the above, retrospective acceptability, as described in the Theoretical Framework of Acceptability, relates to the combination of experiences a student undergoes during an intervention. These experiences encompass the factors of experience, people and trust in the researcher's conceptual framework. On the other hand, prospective acceptability in the Theoretical Framework of Acceptability refers to the anticipated experiences a student would encounter in the future as a teacher. These anticipated experiences are represented by the factors of anticipation, people and trust in the researcher's conceptual framework.

The affective attitude component of the Theoretical Framework of Acceptability corresponds to the affective attitude experienced or anticipated by the student as interpreted by the researcher's conceptual framework. The coherence component in the Theoretical Framework of Acceptability aligns with the intervention coherence experienced or anticipated by the student. Similarly, burden in the Theoretical Framework of Acceptability corresponds to the burden experienced or anticipated by the student according to the researcher's conceptual framework.

It should be noted that the component factor of intervention reliability in trust factors is not explicitly addressed in the Theoretical Framework of Acceptability. However, the researcher considered it necessary to include in the conceptual framework an investigation of the reliability of interventions.

Overall, the researcher's conceptual framework builds upon the Theoretical Framework of Acceptability, incorporating additional factors to provide a comprehensive understanding and assessment of intervention acceptability.

3.3.3 Strengths of the conceptual framework

Comprehensive: The conceptual framework covers multiple dimensions, including acceptance and intention, experienced and anticipated factors, people factors and trust factors. It provides a well-rounded view of the factors that may influence prospective teachers' acceptance and usage of a pedagogy in the future.

Clear definitions: The framework further provides clear definitions for key concepts like acceptance, intention, usage behaviour and their influencing factors. This clarity helps in understanding the constructs and their relationships better.

Predictive nature: By linking acceptance and intention to usage behaviour, the framework aims to predict how prospective teachers are likely to use the intervention when they become teachers. This predictive aspect enhances the practical value of the research.

Visual representation: Furthermore, the inclusion of a visual representation (such as the diagram in Appendix G) can aid in understanding the conceptual framework more effectively. Visuals often simplify complex relationships and improve communication.

3.3.4 Limitations of the conceptual framework

Lack of empirical evidence: At this stage, the conceptual framework has been postulated mainly as a theoretical and conceptual model, with insufficient evidence from empirical studies to support the relationships between the constructs. More empirical research is needed to validate the relationships proposed in the framework.

Overlapping constructs: Some constructs in the framework appear to have similarities and may overlap, which could lead to confusion or difficulties in distinguishing their individual impacts.

Complexity: While comprehensiveness is a strength, the complexity of the framework might make it challenging to apply in practice or to interpret without extensive explanation.

Limited generalizability: The framework's applicability might be limited to specific contexts, interventions or populations, and its generalizability to other settings or groups may be uncertain.

Potential measurement challenges: The framework involves various factors and constructs that may require multiple measures and tools for assessment, potentially leading to practical challenges in data collection and analysis.

3.3.5 Recommendations for the conceptual framework

Empirical validation: The researcher may need to further conduct empirical research to test and validate the relationships proposed in the conceptual framework. This will strengthen the theoretical foundation and enhance the framework's credibility.

Refine constructs: The above means that the researcher may need to review and refine constructs to minimize potential overlaps and ensure clarity. This can be achieved through expert opinions, literature reviews and pilot testing.

Consider practical implications: While the predictive nature of the framework is valuable, the researcher should also consider how it can be practically applied in educational settings or interventions to support decision-making and improve teaching and learning outcomes.

In summary, the researcher has opted to employ a conceptual framework instead of a theoretical framework. A conceptual framework serves as a visual or textual representation illustrating the anticipated interactions among the variables to be examined in a research project (Van der Waldt, 2020). Conversely, a theoretical framework provides the foundation for a research project's theory (Adom et al., 2018). The primary distinction between the two lies in the fact that a conceptual framework is developed by the researcher and comprises variables intended for study prior to conducting research, whereas a theoretical framework is based on extensive prior research and is utilized by the researcher to provide context to their findings (Adom et al., 2018).

3.4 Conclusion

In conclusion, this chapter has outlined the theoretical and conceptual foundations of the study. Section 3.2 provided an in-depth discussion of the Theoretical Framework of Acceptability, focusing on its key constructs that guide the understanding of the study's focus. Section 3.3 then introduced the conceptual framework adopted for the research, explaining how it integrates with the theoretical framework to address the study's objectives. Section 3.4 concludes the chapter.

CHAPTER 4: METHODOLOGY

4.1 Introduction

This chapter describes the design adopted to achieve the aims and objectives of the study. Briefly Section 4.2 discusses the methodology that was used to inform the study. Section 4.3 provides the timeline and activities of the study. Section 4.4 discusses the research design. Section 4.5 provides the ADDIE stages of this research, while Section 4.6 is a discussion on the sampling used. Instruments and data collection are discussed in Section 4.7 and 4.8, respectively. Section 4.9 and 4.10 discuss recording, reporting and data analysis in succession. Thereafter, validity and reliability are dealt with in Section 4.11, and ethics and limitations in Section 4.12. The chapter concludes in Section 4.13.

4.2 Methodology

This study uses a mixed methods research study with an emphasis on quantitative rather than qualitative data. Quantitative data is data that is numeric in nature and thus quantifiable, making statistical analysis possible (Creswell, 2014). This, for instance, can involve the collection of data in the form of numbers, ratings, measurements and weightings (Creswell, 2014). Whereas qualitative data is data that is descriptive in nature and non-numeric (Merriam & Tisdell, 2016). Qualitative data can, for instance, can be text, images, observations and even narratives. There are two main justifications for the use of mixed methods, and these are: 1) to ensure generalizability of quantitative data, and 2) to gather in-depth data that will reveal deep insights into the participants' perspectives about the intervention. This will then provide the researcher with comprehensive data as opposed to relying on any one form of data.

The intervention used in this study was based on Activated Classroom Teaching (ACT) methodology. This methodology consists of a set of five 21st century digital-age teaching pedagogies that use technological tools, namely: 1) curation (Mihailidis & Cohen, 2013), 2) conversation (Major et al., 2018), 3) correction (Gikandi et al., 2011), 4) creation (Graul et al., 2020), and 5) chaos (Schoenborn & Ress, 2013).

Curation pedagogy requires participants to use their technological devices to either collect information or Scratch programs on the concepts being taught. Since sharing and posting on the internet is also pivotal to curation pedagogy, participants were also

expected to synthesize, categorise and share their findings with each other using their technological devices. Hence, the participants were prompted to identify where they could find particular information, as well as collect, store and categorise that information using their technological devices. A key component of curation pedagogical activities is that participants are required to demonstrate an understanding of how a concept is generally used in Scratch programming, or to provide a synthesized definition of a concept. Therefore, the participants were required to use different sources to search, sift, categorise, synthesize and share findings when curation pedagogy was used to teach them Scratch.

Conversation and correction pedagogies revolve around deliberation and communication, with participants discussing their ideas and thinking processes. So, for both pedagogies, the participants were required to do code predictions, run code, and test their predictions while conversing with their peers. The participants were prompted to describe and discuss a particular concept and how it is used in the program or game provided. Further, they discussed how a particular game was coded and predicted how it would work. Additionally, the participants made corrections to incorrectly coded games. A key component of both conversation and correction pedagogy lies in participant conversation throughout the entire process.

During creation activities, participants were either given a clear scenario, flowchart or pseudocode with which they were expected to code a program. A key skill required for these activities was the ability to create and modify games based on clear and concise information. This information appeared in planning tools, games or simple scenario descriptions.

For the chaos pedagogical activities, the participants were expected to design a game from inception based on an information-rich scenario. Key for the participants in these activities was their ability to read and comprehend the scenario, and then construct the

required game. In the next subsection the list of activities that were used to teach the participants game development in Scratch using the ACT methodology are presented.

4.3 Timeline and activities

Below is the list of the activities that relate to each of the ACT methodology pedagogies and the day each was implemented as a part of the intervention.

Table 4.1: Timeline of activities

Timeline	Day 1 of Week 1	Day 2 of Week 1	Day 1 of Week 2	Day 2 of Week 2
Activities	Activity 1	Activity 2	Activity 3	Activity 4
ACT Methodology	Conversation & Correction	Conversation & Correction	Curation, Conversation, & Creation	Curation, Conversation & Chaos
Appendix	A	B	C	D
Game name	Pirate Brick	Traffic Dodge	Black Night	Shark Attack

4.4 Research design

While this study is a mixed methods research study, it is also based on the Design Science Research methodology to achieve all research objectives. The Design Science Research Methodology is used as a problem-solving blueprint to produce solutions, as well as to produce a structure that can be used to describe or understand why and how phenomena occur (Vom Brocke et al., 2020). Therefore, the two main outcomes of a Design Science Research study can be one of the following: 1) solutions that use gained knowledge to solve problems, create change or improve existing solutions, or 2) solutions that generate new knowledge, insights, and theoretical explanations (Vom Brocke et al., 2020). Many studies have used the Design Science Research methodology when crafting plans for instructional courses. For example, Hevner et al. (2004) iteratively designed a solution based on theories, models and frameworks of prior research to create a solution. In this study the researcher does this for the ultimate use of ACT pedagogies in the teaching and learning of block-based coding infused with Computational Thinking in game design and development. Hence, knowledge gained to solve problems, create change and improve existing solutions using Design Science Research methodology was used.

Hevner et al. (2004) further noted that the steps in Design Science Research methodology can be divided into four to six steps depending on the design model

chosen (Peffers et al., 2007). In the current study, the researcher used the ADDIE Design Science Research process to plan and structure both the games and the intervention used to teach the students. The stages in the ADDIE are: 1) analysis, 2) design, 3) development, 4) implementation, and 5) evaluation. The reason for choosing the ADDIE is that it provides researchers with a scientific and adaptable approach that emphasizes analysis and assessment of the research process (Branch, 2009), thus, placing thought, supported by reasoning, for procedures adopted in the current research. The ADDIE is also appropriate for designing, implementing and assessing instructional design courses and projects because it supports iterative improvement, enhances resource management, and allows for the scalability of a study. It also enables efficient communication between the researcher and other stakeholders (Branch, 2009). Below is a description of each step in the ADDIE process and its use in this study.

4.5 ADDIE

The analysis stage is the first step in the ADDIE and requires the researcher to analyse a problem that they intend to create or design a solution for (Molenda, 2003). The main goal of the researcher at this stage is to understand the problem and the participants, as well as do an analysis of any potential constraints and knowledge gaps that the participants might arrive with. Thus, at this stage, it is possible for the researcher to propose a layout for what will be taught based on the goals of the research and the knowledge to be imparted (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020).

The analysis stage is followed by the design stage during which the researcher drafts an overview of an intervention or solution. This overview is, in many cases, based on the literature reviewed, hence a substantial amount of reading and planning occurs at this stage (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). The main aim of the design stage is to provide a prototype that can be easily communicated with relevant stakeholders to demonstrate the importance of the research to be undertaken (Aldoobie, 2015). Hence, at this stage, the researcher outlays the strategy, delivery methods, structure, duration, assessment and feedback that will be part of the research process (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020).

Thereafter, in the development stage, the researcher develops the content of the course based on the previous two stages (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). Thus, at this stage, it is important to also check the content for consistency with the analysis and design stages of the ADDIE. It is also imperative to check for any possible issues that could ideally and potentially arise during the intervention – mainly in relation to content (development stage) and how it relates to the intervention (design stage) (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). Once the researcher is satisfied that all the requirements are met, the next stage of implementation can be considered.

During the implementation stage, the intervention is conducted (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). Initially, in the implementation stage, the researcher pays close attention to any practical issues that need consideration (Aldoobie, 2015). If there are any issues, the researcher ought to consider the need for re-development, re-design, or even re-analysis of the intervention and content, essentially deciding on how far back to go to prevent these issues from resurfacing (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). If no issues have arisen, the researcher proceeds to the last stage of the ADDIE – the evaluation stage.

During the evaluation stage the researcher assesses the intervention against the goals and standards that the intervention was intended for (Nichols Hess & Greer, 2016; Anggraini & Putra, 2020). The main aim of the evaluation stage is to assess how well the intervention was received, as well as the extent to which it was successful. Further improvements to the intervention can also be proposed at this stage. While the ADDIE follows the pattern of analysis, design, development, implementation and evaluation from start to end, the order of these stages can be adjusted if necessary. Table 4.2 demonstrates what each stage of the ADDIE focused on in relation to this study.

Table 4.2: Each stage of the ADDIE in relation to this study

ADDIE Stage	Phase in this study
Analysis	Proposal development
Design	Intervention design
Development	Activities/games and related content
Implementation	Teaching, learning and interviews
Evaluation	Data analysis

As shown in Table 4.2, the proposal development occurred primarily during the analysis stage of the ADDIE model, encompassing the study's plan. The design stage was predominantly dedicated to drafting the intervention and considering the proposal. During the development stage, the activities, games, and associated teaching materials were planned and created. The implementation stage involved conducting the study using the intervention, teaching, learning and conducting student interviews. Finally, the evaluation stage focused on data analysis.

4.6 Sampling

The population, from which participants were sampled, consisted of four-hundred-and-thirteen (413) prospective teachers registered for the module *Introduction to Computer Systems, Data Representation and Coding* (EDCM111) at the Edgewood Campus, College of Humanities, UKZN. A voluntary or self-selection sampling method was employed allowing the prospective teachers to choose to participate in the study or not. Therefore, this study used a non-probability sampling technique, since it cannot be guaranteed that the sample will reflect the population (Etikan et al., 2016). The reason for choosing a voluntary, self-selection and non-probability sampling technique is to ensure that data is generated by willing participants who also, potentially, have a keen interest in the study. Both reasons assist to increase the credibility of the participants. Since participation is voluntary, and participants go through a process of self-selection, this study can be said to have a self-extracted sample where the sample is defined as a portion of the population – a slice or part of it (Magwa & Magwa, 2015). To generate credible statistics during data collection, a sample must be representative of the entire population of interest (Fowler, 2014). The

premise is that the characteristics of this self-selected sample will approximate the characteristics of the population from which it is drawn both in terms of views and numbers (Tichapondwa, 2013). In this study, opting for self-selected sampling reduced investment in time and money – as recommended in the literature (Magwa & Magwa, 2015). With the entire population and the researcher being on the same campus (at the same geographical location) studying the entire population may have been feasible, but not within the constraints of the current study. Thus, in this case, the collection and organization of data from fewer representative people (a sample) was deemed manageable in terms of time, manpower, energy and money (Magwa & Magwa, 2015). Overall, the use of sampling increases the level of accuracy when analysing data, as well as manageability because, in both cases, it affords the researcher more control over the process (Magwa & Magwa, 2015).

The recruitment conditions specified for the self-selection process were: 1) university affiliation must be that of University of KwaZulu-Natal, Edgewood Campus, 2) the year of study must be third year or higher, 3) the phase registered for must be the Intermediate and Foundation Phase, and 4) each participant must also be registered for the module *Introduction to Computer Systems, Data Representation and Coding* (EDCM111).

At the very beginning of the semester, an email was sent to all prospective participants outlining the module and including details about the study, content and duration. In addition, the correspondence included the ethical clearance certificate and the university's permission to conduct the study. Thereafter, before the new content started, participants were emailed during the semester with information on the module's content and an informed consent letter to sign and return. While all students would be taught the content, only those consenting to participate would be considered for questionnaires and focus-group discussions.

4.7 Instruments

As previously stated, this study used a mixed method approach, which mixes quantitative and qualitative data gathering and analysis methods (Johnson & Onwuegbuzie, 2004). In this study, to obtain these different forms of data, the researcher used a questionnaire and an interview schedule. The questionnaire

contained closed-ended items for quantitative analysis, while the interview schedule collected qualitative data from open-ended questions.

The questionnaire contained seventy-four (74) items in which five (5) were negative to expose response inconsistencies, and outliers which were discarded as these were considered to not reflect the population the sample was drawn from. All of the items in the questionnaire each had five possible response options, ranging from 'strongly agree', 'agree', 'neutral', 'disagree' and 'strongly disagree' symbolized by A, B, C, D and E, respectively. This set of items enabled the researcher to have control over possible responses, thus making it possible for the researcher to quantitatively analyse the responses (Seliger & Shohamy, 1989).

An interview schedule was also administered to facilitate follow-up focus-group discussions with a randomly selected group of fifty (48) participants to provide responses requiring further elaboration and clarification with regards to data analysis obtained from the questionnaire. Moreover, the focus-group discussions enabled the researcher to further examine the extent to which the proposed intervention was accepted from a qualitative perspective, by allowing the prospective teachers to share their views and thoughts about the ACT Methodology without being limited by having to choose predefined options. Since the researcher could not predict the results of the questionnaire, the interview schedule consisted of two types of questions – rigid and known questions, as well as fluid questions which arose from a need to further explore the results of the quantitative data analysis.

The use of closed-ended items in the questionnaire followed by open-ended questions provided a method of bimodal validation (Creswell, 2014). Bimodal validation is a method in which two sources, methods or perspectives are employed to cross-validate data (Creswell, 2014). When these methods and perspectives are properly setup, they can be used to complement each other (Creswell, 2014) and, thus, further strengthen the choice of research instruments used in the study. Thus, the use of bimodal validation provided the researcher with a broader (from quantitative data) and a deeper (from qualitative data) understanding of the research objectives (Creswell, 2014).

4.8 Data collection

Data collection was conducted in two consecutive stages and thus based on a sequential mixed methods data collection process (Creswell & Plano-Clark, 2011). In such studies data is collected in sequence. In this study, qualitative data collected from interviews was used to better understand the results of the quantitative data collected using questionnaires (Creswell & Plano-Clark, 2011). Thus, a mixed data and sequential data collection process is best used when researchers cannot explicitly predict the results of their study from a single data collection event, and they need to conduct a second data collection phase based on the preliminary analysis before proceeding to the next phase of the research (Creswell & Plano-Clark, 2011). In this study questionnaires were firstly administered to the participants followed by interviews held on a different day. The two-staged data collection process allowed for the participants to think about their responses to the questionnaire, as a questionnaire with a long list of items can be daunting and challenging to complete. In this study questionnaires were suitable because they are time and cost effective, enabling the researcher to conveniently collect data from a convenient venue (Rowley, 2014).

Although questionnaires can be influenced, the researcher ensured reliability and validity by requesting participants to complete the questionnaire in the shortest time possible. Completed questionnaires were captured immediately online to avoid cooperative editions.

The questionnaires were designed to gather data on: (1) prospective teachers' retrospective acceptance of the ACT Methodology, (2) their prospective acceptance of the ACT Methodology, and (3) the planned future usage of the ACT Methodology. Since, this study was based on a sequential mixed methods data collection process, the administering of questionnaires was followed by group discussions. The group discussions were organised with willing participants during times convenient to both the researcher and participants. Voice and visual recordings were considered. The aim of the focus-group discussions was to provide the researcher with information regarding the participants' perspectives on the ACT Methodology when used to teach of programming. In this study, a sequential mixed methods data collection process was used, starting with questionnaires followed by interviews. This was deemed appropriate because the interviews enabled the researcher to clarify questions, probe

for unexpected responses as well as seek for clarity with regards to the results obtained in the analysis of the quantitative data generated by the questionnaires (Creswell & Plano-Clark, 2011). In turn, the qualitative analysis from the open-ended focus-group discussions helped to enhance the validity and credibility of the quantitative results (Patton, 2002).

4.9 Recording and reporting

The qualitative data was iteratively analysed using thematic analysis and grouped into categories of descriptions using tables based on associative meaning. Thematic analysis is defined as an empirical study of the qualitatively different ways in which people experience a particular phenomenon. The results of a thematic analysis are presented as categories of descriptions with each category of description being placed in a table where it represents a single idea suggested by more than one participant (Braun & Clarke, 2006). The qualitative questions in the interview schedule are given in Appendix F. The qualitative data from the interview schedule was recorded in tables and reported on using thematic analysis.

The quantitative data gathered from the closed questions of the questionnaire was collated and analysed using statistics. The statistics used were regression. Item responses were thus analysed statistically and placed into suitable tables. Since the study was not conducted on the entire population of prospective teachers enrolled for the module, an inferential rather than a descriptive statistical analysis approach was used (Creswell, 2012). Inferential statistical analysis uses data from an accurately selected sample to make conclusions about the population under study (Creswell, 2012).

Additionally, regression and correlation analysis were applied to items 1 to 14, 15 to 23, and 24 to 32 of the questionnaires. These statistics were recorded in a spreadsheet, and compared and contrasted with each other to obtain the best predictor for acceptance. Similarly, statistics for items 33 to 52, 53 to 62, and 63 to 71 were also recorded in a spreadsheet, and compared and contrasted to determine the best predictor for intention. The goal was to gather information to bring order and understanding to: (1) the relationship that exists between the factors acceptance and intention, and (2) to

determine the extent to which that relationship exists among the participants of this study.

Moreover, the regression analysis and correlation coefficient for items 1 to 32 (acceptance), 33 to 71 (intention), and 72 to 74 (usage behaviour) were also recorded in a spreadsheet and analysed using correlation and regression analysis to ascertain the effects that acceptance and intention have on usage behaviour. The aim was to partly explain how acceptance and intention affect usage behaviour. To understand this relationship, the researcher needed to determine the best predictor for usage behaviour, as well as the relationship that exists between acceptance and intention and usage behaviour. These results are reported in Chapter 5.

4.10 Analysis

As discussed, the current study follows a mixed methods design, combining quantitative and qualitative analysis approaches (Cresswell & Plano-Clark, 2011). Such hybrid analysis approaches achieve deeper understanding of the problems, diluting most of the weaknesses inherent in individual analysis methods when used on their own (Cresswell & Plano-Clark, 2011). On one hand, a qualitative approach allows researchers to provide their own perceptions and views as grounds for accepting or refuting claims (Merriam & Tisdell, 2016), thus the researcher uses thematic analysis to interpret qualitative data. On the other hand, the quantitative paradigm calls for descriptive statistical justification to arguments, thus the researcher uses statistics to analyse and interpret quantitative data. In this study, qualitative data arose from a set of open-ended items in the interview schedules (Patton, 2002) which helped to support the quantitative results; as well as provide qualitative data that can be analysed and converted into quantitative data (Patton, 2002).

In addition, the quantitative paradigm purports positivist views in which scientific reasoning and argumentation are deductively based on highly specific data generalizable from samples of the population, while on the other hand qualitative approaches emphasize interpretivist views in which theories arise from inductive observations (Lincoln & Guba, 1985). Thus, a hybrid theoretical framework of data analysis grounded in positivist and interpretivist ontologies is apparent in this study.

Data analysis occurred in two stages, the first stage included the analysis of the quantitative data using statistics, and in the second stage the researcher analysed the qualitative data gathered from interviews using codes and themes based on thematic analysis. Items 1 to 32 and 33 to 71 on the questionnaire relate to acceptance and intention of the ACT Methodology, respectively.

The result for acceptance refers to what extent the participants accept being taught using the ACT Methodology as students, while the results for intetnion indicates the extent of future acceptance by participants of the teaching methods used in the ACT Methodology when they are teachers in the future. The larger the sample, the more generalisable these findings are to the entire population of prospective teachers, which facilitates further assumptions about prospective teachers outside of the target population (i.e., at other universities).

Ultimately, the regression analysis results for items 1 to 32 and 33 to 71 addressed research question 2. To test the effects that acceptance and intention have on usage behaviour, participants were requested to respond to items 72 to 74 which related to usage behaviour. A regression analysis of participants' acceptance and intetnion described their relationship with regards to usage behaviour. The regression results obtained for items 1 to 32 and items 33 to 71, thus, helped to address research question 2 which sought to understand how acceptance and intention affect usage behaviour.

Items 1 to 14, 15 to 23 and 24 to 32 on the questionnaire related to intention comprising the factors experienced, trust and people. The aim was to determine how each of these factors relate to intention. Therefore, the statistics use were correlation and regression analysis. The correlation statistics determined the relationship between each individual factor and retrospective acceptance, while regression analysis determined to what degree each factor influenced the overarching construct of retrospective acceptance. Thereafter, a regression analysis for each of the factors determined the best predictor of retrospective acceptance. The results obtained from the regression analysis directly responded to research question 3. Correlation analysis was used as a supporting statistic to expand on the relationship between each factor and retrospective intention.

The factors that affect intention were similarly analysed. These included anticipated, trust and people factors as interrogated by items 33 to 52, 53 to 62 and 63 to 71 on the questionnaire. Correlation was used to determine the relationship between each factor and intention, while regression analysis was used to analyse the extent to which each factor influences intention. The results obtained from the regression analysis were compared to address research question 3 to shed light on the best predictors of intention. Thus, regression was the main statistic used for responding to research question 3, while correlation analysis was used as a supporting statistic.

The second stage of data analysis was the analysis of qualitative data gathered from the interviews. Specifically, the thematic analysis of this data addressed research questions 1. Thematic analysis is a technique that helps to investigate the qualitatively different ways in which people experience or view a particular phenomenon (Braun & Clarke, 2006). Therefore, after the focus-group discussions, responses to each item from each participant were transcribed, repeatedly read, and their core meaning highlighted. Thereafter, statements with closely associated meanings were coded. Closely associated codes were subsequently themed. Ultimately, this analysis addressed research question 1 and provided more insight into the students' views on and perceptions about the use of the ACT methodology as a teaching framework for programming.

4.11 Validity and reliability

Qualitative data arising from a set of open-ended questions were used to enhance validity and credibility of the respondents' views (Cresswell, 2014). Validity or credibility implies accurateness and appropriateness of data collection and data collected. Validity means trustworthiness, thoroughness, and quality (Golafshani, 2003). One of the ways in which a researcher can demonstrate data worthiness and credibility is through the use of multiple or dual sourcing (Magwa & Magwa, 2015). In this study dual sourcing was demonstrated by use of questionnaires and an interview schedule which incorporated both quantitative and qualitative approaches of research. Some of the questions from that arose from the interview schedule were based on data analysis of the questionnaire, therefore in this study these different modes of data collection were used to complement each other.

On the other hand, reliability or dependability implies that the procedures used to collect data give almost similar findings under constant conditions (Magwa & Magwa, 2015). While objectivity refers to whether findings are unbiased and how neutral and objective the researcher is (Magwa & Magwa, 2015). Therefore, validity, reliability and objectivity connote the extent to which the research results can be accurately interpreted, and results generalized to populations and conditions (Tichapondwa, 2013). In this study, the researcher made use of a randomly and self-selected sample to be participants which represents the diverse member of the population under study of which is bound by campus of registration, year of study, and module enrolment, thus increasing the validity, reliability and objectivity of this study by making sure that the participants meet these criteria.

Furthermore, for the questionnaire, in order to explore the structure of the items in the sub-constructs within each construct and validate the proposed scales of items in the model, factor analysis with promax rotation was applied to the items in each construct.

During the process, some items may be dropped either because they do not load strongly enough onto any factor or because they cross-load onto multiple factors.

The factor extraction is deemed to be successful if the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) exceeds 0.6 and Bartlett's test of sphericity is significant.

The factor structure that results from EFA is then used as a starting point for confirmatory factor analysis (CFA) in which the construct validity (both discriminant validity and convergent validity) and reliability are tested. Items that negatively affect either reliability or validity may be dropped in order to attain these important statistics. An additional statistic to measure reliability – Cronbach's alpha - will also be calculated. An alpha value of at least 0.7 is considered adequate.

4.12 Ethics and limitations

The proposal for this study went through a rigorous ethical clearance process to ensure that no ethical considerations were omitted, and no subsequent ethical problems arose

during the research. However, it is worth noting a few limitations to this study. Firstly, since this study was conducted on a sample of third-year students from the University of KwaZulu-Natal, Edgewood Campus, registered for the module EDCM111, the results have limited generalizability to students from other universities enrolled in a similar module.

Moreover, while other forms of statistics could have been used for the data analysis, the researcher chose to focus on correlation and regression analysis. This then limits the scope of argumentation and interpretation from various perspectives. These limitations are taken account of in the relevant discussions in subsequent chapters.

Furthermore, the researcher chose to conduct statistical analysis for the overarching acceptance and intention, as well as for the experienced, anticipated, trust and people factors, but not for the component constructs that make up these factors. This also limits this study in terms of the breadth and depth of the statistical analysis, which in turn influences argumentation and interpretation. Ultimately, while it is well known that questionnaire response rate decreases with the length of the questionnaire, it is hoped that the participants of this study were motivated to complete their questionnaires.

Also collaborated responses to questions by word-of-mouth were also possible between research participants fond of each other, but respondents were asked not to discuss the questions with peers who had not yet answered the questionnaire.

Furthermore, the number of responses decreases with the length of a questionnaire and hence some questions, especially towards the end might have not been answered not because of a lack of responses to them, but because the respondents were impatient to continue with the questionnaire. However, respondents were encouraged to fill in as much as possible, spending enough time on each question as needed by them.

4.13 Conclusion

In conclusion, this chapter has detailed the research design and methodology employed to meet the study's aims and objectives, and to address the research questions. Section 4.2 introduced the methodology, specifically how the ACT methodology was applied

to guide the intervention. The timeline and activities of the study were outlined in Section 4.3. Section 4.4 provided an overview of the research design, followed by a discussion on sampling methods in Section 4.4. Section 4.5 discussed the ADDIE process. Sampling and the data collection instruments were addressed in Sections 4.6 and 4.7, respectively. Sections 4.8 to 4.10 covered the processes of data collection, recording, reporting and analysis. A discussion of the study's validity and reliability was presented in Section 4.11, followed by considerations of ethics and limitations in Section 4.12. This chapter has thus laid a clear foundation for the subsequent analysis and interpretation of the study's findings.

CHAPTER 5: RESULTS

5.1 Introduction

In this chapter is a discussion of the results, specifically focusing on the interpretation and evaluation of the results in relation to the first three objectives of the study wherein the fourth research objective is discussed in the following chapter. Thus, the research objectives that will be dealt with in this chapter read as follows:

1. To determine students' perspectives towards the ACT methodology pedagogies when used to teach programming.
2. To determine the best component predictors of acceptance and intention on future usage of the ACT methodology's pedagogies.
3. To determine how the component factors of acceptance and intention affect future usage of the ACT methodology's pedagogies.

The Sections of this chapter prelude each other as follows: Section 5.2 discusses how the factors of acceptance and intention affect future usage of the ACT methodology, Section 5.3 discusses the best predictors of acceptance and intention on usage of the ACT methodology, Section 5.4 discusses student perceptions towards the ACT methodology, and the chapter is concluded in Section 5.5. Therefore, the research questions are discussed from research question 3 to 1. This is because the regression analyses (quantitative analyses) were conducted ahead of the thematic coding analyses (qualitative analyses) since the regression analyses results partly informed the thematic coding analyses.

5.2 How the component factors of acceptance and intention affect future usage

This Section responds to research question 3 which is stated as follows: How does the component factors of acceptance and intention affect future usage of the ACT methodology? The Section is divided into two parts: 1) How do the component factors of acceptance affect future usage of the ACT methodology's pedagogies for learning purposes, and 2) How do the component factors of intention affect future usage of the ACT methodology's pedagogies for teaching purposes? For each component factor, regression analysis is used, as discussed in Sections 5.2.1 and 5.2.2 below.

5.2.1 How do the component factors of acceptance affect future usage of the ACT methodology's pedagogies for learning purposes?

Acceptance is seen as consisting of three factors, namely: experienced, trust and people factors. Each one of these factors can be further divided into component factors that have are analysed for learning purposes. In Section 5.2.1.1 to 5.2.1.3 below, the effects of each of these component factors on future usage of the ACT methodology is discussed.

5.2.1.1 How do the experienced component factors of acceptance affect future usage of the ACT methodology for learning purposes?

Table 5.1 depicts the effects of the experienced factors of acceptance and how they affect future usage of the ACT methodology. In this table ACC is an abbreviation for acceptance, while SAT and BUR designate satisfaction and burden within acceptance.

Table 5.1: How satisfaction and burden within acceptance affect future usage of the ACT methodology

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	ACC_SAT	0.413	179.611	1, 255	< 0.001	0.761	13.402	< 0.001
2	ACC_BUR	0.018	4.239	1, 226	0.041	-0.191	-2.059	0.041
3	ACC_SAT	0.409	77.989	2, 225	< 0.001	0.766	12.205	< 0.001
	ACC_BUR					-0.019	-0.265	0.791

Based on the first regression analysis in Table 5.1 above, there is a strong relationship between ACC_SAT and usage. It is evident that ACC_SAT accounts for 41.3% (R^2 = 0.413) of the variance in future usage of the ACT methodology for learning purposes. The regression coefficient for ACC_SAT of 0.761 ($p < 0.001$) indicates that for every unit increase in ACC_SAT, usage is expected to increase by 0.761 units, assuming that all other variables are kept at a constant. This implies that a positive relationship exists between ACC_SAT and future usage of the ACT methodology for learning purposes. The associated t-value of 13.402 was also very significant with a p value of less than 0.5, which further proves this relationship. Therefore, this suggests that the more

satisfied the prospective teachers are with this intervention, the more likely they are to use it in the future for their studying and learning purposes.

When the second regression analysis in Table 5.1 above for ACC_BUR was considered, it was found that there was a statistically significant relationship with p value of 0.041, which is less than the chosen significance level of 0.05 between ACC_BUR and future usage of the ACT methodology for learning purposes. However, the strength of this relationship was recorded to be 1.8% (R2 = 0.018) of the variance in future usage of the ACT methodology for learning purposes. The regression coefficient of -0.191 implies that, with every increase in ACC_BUR, the future usage of the ACT methodology decreases by 0.191 units. This suggests that an indirect relationship exists between ACC_BUR and future usage of the ACT methodology for learning purposes. The t-value of -2.059 suggests that this relationship is statistically significant. Therefore, it can be concluded that the more ACC_BUR the prospective teachers experience, the less likely they are to use the ACT methodology's pedagogies in the future. However, while this conclusion is statistically true ($p < 0.001$), it has little bearing (R2 = 0.018) on convincing the prospective teachers to not use the intervention, with the percentage associated with this regression measured at 1.8%.

5.2.1.2 *How do the trust component factors of acceptance affect future usage of the ACT methodology for learning purposes?*

Table 5.2 depicts the effects of the trust component factors of acceptance and how they affect future usage of the ACT methodology for learning purposes. In this table, ACC stands for acceptance, while COH and REL stand for coherence and reliability, respectively.

Table 5.2: How coherence and reliability within acceptance affect usage

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	ACC_COH	0.314	116.849	1, 255	0.000	0.582	10.810	0.000
2	ACC_REL	0.277	97.836	1, 255	0.000	0.528	9.891	0.000
3	ACC_COH	0.344	66.736	2, 254	< 0.001	0.391	5.102	< 0.001
	ACC_REL					0.254	3.422	0.001

In the first regression analysis in Table 5.2 above, it is evident that there is a statistically significant relationship between ACC_COH, as the independent variable and future usage of the ACT methodology as the dependent variable. ACC_COH accounted for 31.4% (R2 = 0.314) variance in the dependent variable. The regression coefficient suggests a directly related relationship between ACC_COH and future usage of the ACT methodology for learning purposes. Statistically, with every unit increase in the ACC_COH, usage behaviour is expected to increase by 0.582 units ($p < 0.001$). The t-value was recorded to be 10.810 at a high significance of $p < 0.01$, thus further strengthening the assertion of this relationship. Therefore, it can be concluded that the more coherent the prospective teachers view is of the intervention, the more likely they are to use it in the future.

In the second regression analysis in Table 5.2 above, a statistically significant ($p < 0.01$) relationship exists between ACC_REL and future usage of the ACT methodology. It is evident that ACC_REL accounts for 27.7% of the variance in future usage of the ACT methodology for learning. The regression coefficient for ACC_REL was 0.528 with p value of less than 0.001. This indicates that for every unit increase in ACC_REL, future usage of the ACT methodology is expected to increase by 0.528 units if all other variables are constant. The t-value was recorded to be 9.891 with a high significance ($p < 0.001$), which further provides evidence of the strength of this relationship. Thus, it can be concluded that the more the prospective teachers view the intervention as reliable, the more likely they are to use it in the future for their own learning.

5.2.1.3 How do the people component factors of acceptance affect future usage of the ACT methodology for learning purposes?

Table 5.3 below depicts the effects of the people component factors of acceptance and how they affect future usage of the ACT methodology. In this table ACC is an abbreviation for acceptance, while SOC and FAC are the social and facilitator factors within acceptance.

Table 5.3: How social and facilitator factors within acceptance affect usage

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	t	p-value
1	ACC_SOC	0.267	92.450	1, 254	< 0.000	0.528	9.615	< 0.000
2	ACC_FAC	0.324	120.999	1, 253	< 0.000	0.609	11.000	< 0.000
3	ACC_SOC	0.353	68.855	2, 252	< 0.000	0.243	3.410	0.001
	ACC_FAC					0.434	5.818	< 0.000

The first regression analysis (see Table 5.3) revealed a statistically significant relationship between the independent variable ACC_SOC and the dependent variable. The model accounted for approximately 26.7% of the variance in the dependent variable. The regression coefficient for ACC_SOC was 0.528 ($p < 0.000$), indicating that for every one-unit increase in ACC_SOC, the dependent variable is expected to increase by 0.528 units, holding other variables constant. The associated t-value (9.615) was also highly significant ($p < 0.000$), providing further evidence of the strength of this relationship. Therefore, it can be concluded that the more socially accepted the intervention is, the more likely the prospective teachers are to use it in the future for learning.

The second regression analysis (see Table 5.3) revealed a statistically significant relationship between the independent variable ACC_FAC and the dependent variable. The model accounted for approximately 32.4% of the variance in the dependent variable. The regression coefficient for ACC_FAC was 0.609 ($p < 0.000$), indicating that for every one-unit increase in ACC_FAC, the dependent variable is expected to

increase by 0.609 units, holding other variables constant. The associated t-value (11.000) was also highly significant ($p < 0.000$), providing further evidence of the strength of this relationship. Therefore, it can be concluded that the more positive influence that the students receive from their lecturers in relation to the intervention, the more likely they are to use it in the future for learning.

5.2.2 How do the factors of intention affect usage behaviour?

Intention is seen as consisting of three factors, namely, anticipated, trust and people factors. Within intention each one of these factors further consist of component factors that are analysed for teaching purposes. In Section 5.2.2.1 to 5.2.2.3 below, the effects of each of these component factors on future usage of the ACT methodology is discussed.

5.2.2.1 How does the anticipated component factors of intention affect future usage of the ACT methodology?

Table 5.4 depicts the regression analysis for how the anticipated factors of intention affect future usage of the ACT methodology. In this table INT stands for intention, while FUL, EFF and BUR stand for fulfilment, effectiveness and burden respectively.

Table 5.4: How fulfilment, effectiveness and burden within intention affect usage

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	t	p-value
1	INT_FUL	0.480	234.725	1, 254	< 0.001	1.137	15.321	< 0.001
2	INT_EFF	0.421	185.004	1, 254	< 0.001	0.721	13.602	< 0.001
3	INT_BUR	0.029	5.972	1, 203	0.015	-217	-2.444	0.015
4	INT_FUL	0.479	61.540	3, 201	< 0.001	0.459	5.138	< 0.001
	INT_BUR					-0.020	-0.297	0.767
	INT_EFF					0.331	3.781	< 0.001

As shown in Table 5.4 above, the first regression analysis revealed a statistically significant relationship between the independent variable INT_FUL and the dependent variable. The model accounted for approximately 48.0% of the variance in usage

behaviour. The regression coefficient for INT_FUL was 1.137 ($p < 0.001$), indicating that for every one-unit increase in INT_ENG, the dependent variable is expected to increase by 1.137 units, holding other variables constant. The associated t-value (15.321) was also highly significant ($p < 0.001$), providing further evidence of the strength of this relationship. Therefore, this suggests that the more fulfilled the prospective teachers are with the intervention, the more likely they are to use it in the future for teaching purposes.

The second regression analysis demonstrates that a strong relationship exists between INT_EFF and usage behaviour. The model accounted for 42.1% ($R2 = 0.421$) of the variance in usage behaviour. The regression coefficient of 0.721 ($p < 0.001$) for INT_EFF indicates that for every unit increase in INT_EFF, usage behaviour is expected to increase by 0.721 units, assuming all other variable are kept at a constant. This implies a directly and positive relationship between INT_EFF and future usage of the ACT methodology for teaching purposes. The t-value associated with this was recorded to be 13.602 with a high significance ($p<0.001$), which further strengthens the assertion of the relationship that exists between INT_EFF and future usage of the ACT methodology for teaching purposes. This implies that the more effective the prospective teachers view the intervention as being, the more likely they are to use it in the future for teaching.

The third regression analysis revealed a statistically significant relationship between the independent variable INT_BUR and the dependent variable. However, the model accounts for only a small proportion, 2,9% ($R2 = 0.029$), of the variance in usage behaviour. The regression coefficient for INT_BUR is -217 ($p = 0.015$), indicating that for every one-unit increase in INT_BUR, future usage of the ACT methodology for teaching purposes is expected to decrease by 217 units, holding other variables constant. The associated t-value (-2.444) was also statistically significant ($p = 0.015$), indicating a significant relationship between INT_BUR and the dependent variable. Therefore, a negative and indirect relationship exists between INT_BUR and future usage of the ACT methodology, suggesting that the more difficulty (burden) the prospective teachers experience with the intervention, the more likely they are to not use the intervention in the future for teaching.

5.2.2.2 How does the trust component factors of intention affect future usage of the ACT methodology for teaching purposes?

Table 5.5 below depicts the regression analysis for how the trust component factors of intention affect future usage of the ACT methodology for teaching reasons. In this table INT stands for intention, while the preluding COH and REL stand for coherence and reliability.

Table 5.5: shows the regression analysis for how the trust factors of intention affect usage

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	INT_COH	.454	210.844	1, 254	.000	.673	14.520	.000
2	INT_REL	.457	213.390	1, 254	.000	.736	14.608	.000
3	INT_COH	514	133.633	2, 253	.000	.375	5.453	.000
	INT_REL					.420	5.593	.000

Based on the first regression analysis (see Table 5.5), INT_COH had a statistically significant relationship with future usage of the ACT methodology for teaching purposes. The model accounted for 45.4% of variance in usage behaviour with a high significance of $p < 0.001$. The regression coefficient of 0.673 suggests that with every unit increase in INT_COH, there will be an increase of 0.673 units in future usage of the ACT methodology for teaching purposes, thus implying a direct and positive relationship between INT_COH and future usage, with a significance of $p < 0.001$. The associated t-value was recorded to be 14.520, also with a high significance of $p < 0.001$, which provides further evidence of this relationship. Therefore, this suggests that the more coherent the intervention is to the prospective teachers, the more likely they are to use it in the future for teaching purposes.

The second regression analysis in Table 5.5 shows that there was a statistically strong ($p < 0.001$) relationship between INT_REL and future usage of the ACT methodology for teaching purposes. The model accounts for 45.7% ($R2 = 0.457$) of variance in future usage of the ACT methodology, which implies a moderately strong relationship between INT_REL and future usage. The regression coefficient of 0.736 implies that,

for every unit increase in INT_REL, future usage of the ACT methodology is expected to increase by 0.736 units. This assertion is further supported by the t-value of 14.608 with a high significance of $p < 0.01$, implying that a positive and direct relationship exists between INT_REL and future usage of the ACT methodology for teaching purposes. Thus, the more reliable the prospective teachers view the intervention as being, the more likely they are to use it in the future for teaching.

5.2.2.3 How do people component factors of intention affect future usage of the ACT methodology for teaching purposes?

Table 5.6 shows how people factors of intention affect future usage of the ACT methodology for teaching purposes. In this table, INT stands for intention while SOC and FAC stand for social and facilitator factors, respectively.

Table 5.6: The regression analysis for how the people factors of intention affect usage

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	INT_SOC	0.503	258.289	1, 255	0.000	0.772	16.071	0.000
2	INT_FAC	0.422	187.657	1, 255	0.000	0.671	13.699	0.000
3	INT_SOC	0.534	145.761	2, 254	0.000	0.551	7.763	0.000
	INT_FAC					0.277	4.125	0.000

The first regression analysis in Table 5.6 shows that there was a statistically significant ($p < 0.001$) relationship between INT_SOC and future usage of the ACT methodology for teaching purposes. The model is responsible for 50.3% (R2 = 0.503) of variance in future usage of the ACT methodology for teaching purposes, thus indicating a strong relationship. The regression coefficient of 0.772 suggests that for every unit increase in INT_SOC, future usage of the ACT methodology can be expected to increase by 0.772 units, holding all other variables constant. The associated t-value is 17.071 at a p value of 0.000, both of which indicate to a strong statistical significance between INT_SOC and future usage of the ACT methodology for teaching purposes. This

implies that a positive and direct relationship exists between INT_SOC and future usage of the ACT methodology for teaching purposes. It can, therefore, be concluded that the more positive the social influence is on the prospective teachers regarding the intervention, the more likely they are to use the intervention in the future.

Regression analysis two in Table 5.6 indicates a statistically significant relationship between INT_FAC and future usage of the ACT methodology for teaching purposes. The model accounts for 42.2% (R2 = 0.422) of variance in future usage of the ACT methodology, implying a moderately strong relationship. The regression coefficient of 0.671 suggests that, with every unit increase in INT_FAC, future usage of the ACT methodology for teaching purposes can be expected to increase by 0.671 units. This assertion is further supported by the t-value of 13.699 with a high significance of 0.000, both of which suggests a strong statistical significance. Thus, the relationship that exists between INT_FAC and future usage of the ACT methodology for teaching reasons is positive and directly related. This implies that the more positive the INT_FAC influence is on the prospective teachers, the more likely they are to use the intervention in the future.

5.3 The best component predictors of acceptance and intention on future usage of the ACT methodology

This section seeks to address research question 2 which is stated as follows: What are the best component predictors of acceptance and intention on future usage of the ACT methodology?

The Section is presented in two Subsections. Subsection 5.2.1 deals with the regression analysis of the acceptance component factors and its best predictors of future usage of the ACT methodology for learning purposes, while Subsection 5.2.2 deals with the intention component factors and its best predictors of future usage of the ACT methodology. Within each of these Sections, the interpretation and reporting of the best component construct predictors of usage behaviour are compared and contrasted, followed by the interpretation and reporting of the best predictors of acceptance and intention when all are considered together. For clarity, the component constructs will be headed under their main factors.

5.3.1 The best predictors of acceptance for future usage of the ACT methodology for learning purposes

5.3.1.1 The best component predictors of experienced factors of acceptance on future usage of the ACT methodology for learning purposes

Table 5.7 depicts the best predictors of experienced component factors on future usage of the ACT methodology for learning purposes. In this table ACC stands for acceptance, while SAT and BUR stand for satisfaction and burden, respectively.

Table 5.7: How experienced factors within acceptance compare

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	ACC_SAT	0.409	77.989	2, 225	< 0.001	0.766	12.205	< 0.001
	ACC_BUR					-0.019	-0.265	0.791

Taking into account the first regression analysis in Table 5.7 for ACC_SAT and ACC_BUR together: For the first regression analysis with ACC_SAT as the independent variable, the results indicate a statistically significant relationship between ACC_SAT and future usage of the ACT methodology for learning reasons. The model explains approximately 40.9% of the variance in the dependent variable, and both the F-test and the t-test for ACC_SAT are highly significant ($p < 0.001$).

For the second regression analysis with ACC_BUR as the independent variable: The results revealed that ACC_BUR was not statistically significant ($p = 0.791$) in predicting future usage of the ACT methodology for learning reasons. Moreover, the regression coefficient for ACC_BUR was not significantly different from zero, as indicated by the non-significant p-value ($B = -0.019$).

Therefore, in summary, while ACC_SAT demonstrates a significant relationship with the dependent variable and is thus considered a significant predictor of future usage, ACC_BUR does not appear to be a significant predictor of future usage of the ACT methodology for learning reasons in this analysis. Thus, when prospective teachers experience an intervention, satisfaction with the intervention plays a larger role in predicting future usage than how difficult it was to use the intervention.

5.3.1.2 The best predictors of trust component factors of acceptance on future usage of the ACT methodology for learning.

Table 5.8 below depicts the best predictors of trust component factors of acceptance on future usage of the ACT methodology for learning reasons. In this table ACC stands for acceptance, while COH and REL stand for coherence and reliability, respectively.

Table 5.8: How trust factors within acceptance compare

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	ACC_COH	0.344	66.736	2, 254	<0.001	0.391	5.102	< 0.001
	ACC_REL					0.254	3.422	0.001

As seen in Table 5.8, when both ACC_COH and ACC_REL are considered together, the analysis shows a statistically significant relationship ($p < 0.001$) between ACC_COH, ACC_REL and future usage of the ACT methodology. Together these account for 34.4% ($R2 = 0.344$) of variance in usage behaviour. Individually, both ACC_COH and ACC_REL have a statistically significant ($p < 0.001$) regression coefficient with future usage of the ACT methodology. Moreover, with every unit increase in ACC_COH and ACC_REL, future usage of the ACT methodology can be expected to increase by 0.391 and 0.254 units, respectively.

Thus, the relationship is directly related and positive between ACC_COH, ACC_REL and future usage of the ACT methodology. Therefore, it can be concluded that ACC_REL and ACC_COH are significant predictors of future usage of the ACT methodology for learning. However, ACC_COH has a higher regression coefficient than ACC_REL. This implies that, for these prospective teachers, future usage of the ACT methodology for learning can be expected to increase more with ACC_COH than with ACC_REL. Thus, intervention cohesion has a much higher bearing than reliability in predicting future usage.

5.3.1.3 The best predictors of people component factors of acceptance on future usage of the ACT methodology for learning

Table 5.9 below shows how people factors within acceptance compare when combined pared against each other all at once. In this table ACC stands for acceptance, while SOC and FAC stand for social and facilitator factors, respectively.

Table 5.9: How people factors within acceptance compare

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	ACC_SOC	0.353	68.855	2, 252	< 0.000	0.243	3.410	0.001
	ACC_FAC					0.434	5.818	< 0.000

The regression analysis, as shown in Table 5.9 above, revealed a statistically significant relationship between the independent variables ACC_SOC and ACC_FAC, and usage behaviour. In combination, these variables account for approximately 35.3% of the variance in future usage of the ACT methodology for learning.

For every one-unit increase in ACC_SOC, the usage behaviour is expected to increase by 0.243 units, holding ACC_FAC constant. While for ACC_FAC, a one-unit increase results in an increase of 0.434 units in future usage of the ACT methodology for learning, holding ACC_SOC constant. However, while both ACC_SOC and ACC_FAC have statistically significant regression coefficients, as indicated by their respective p-values ($p = 0.001$ for ACC_SOC and $p < 0.000$ for ACC_FAC), ACC_FAC has a higher future usage of the ACT methodology for learning than ACC_SOC. This implies that ACC_FAC is the better predictor of future usage of the ACT methodology for learning.

5.3.1.4 Comparison of all the best component predictors of acceptance for future usage of the ACT methodology for learning

Table 5.10 below depicts the comparison of all the best predictors of acceptance for future usage of the ACT methodology for learning. In this table ACC stands for acceptance, while the preluding SAT, BUR, COH, REL, SOC and FAC stand for satisfaction, burden, coherence, reliability, social and facilitator factors, respectively.

Table 5.10: How factors within acceptance compare

I	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
ACC_SAT	0.662	28.455	6, 219	0.000	0.504	2.353	0.000
ACC_BUR					-0.012	4.118	0.866
ACC_COH					0.106	1.100	0.273
ACC_REL					0.014	0.169	0.866
ACC_SOC					0.003	0.041	0.967
ACC_FAC					0.196	2.328	0.021

When compared with each other, the regression coefficient for ACC_SAT is the highest, with a measurement of 0.504. This implies that for every one-unit increase in ACC_SAT, the future usage of the ACT methodology for learning increases by 0.504 units on average. The t-value associated with ACC_SAT is 2.353, with a p-value of 0.000, indicating that the coefficient for ACC_SAT is statistically significant.

The second highest regression coefficient is for ACC_FAC, which is recorded as 0.196. This suggests that for every one-unit increase in ACC_FAC, the future usage of the ACT methodology for learning increases by 0.196 units on average. The t-value associated with ACC_FAC is 2.328, with a p-value of 0.021, indicating that the coefficient for ACC_FAC is statistically significant.

Overall, ACC_SAT and ACC_FAC are, therefore, statistically significant predictors of the dependent variable. This means that both satisfaction and facilitator have a strong bearing on student future usage of the intervention, while ACC_BUR, ACC_COH, ACC_REL and ACC_SOC do not appear to have statistically significant effects on future usage.

5.3.2 The best component predictors of intention on future usage of the ACT methodology for teaching

5.3.2.1 The best predictors of the anticipated component factors of intention on future usage of the ACT methodology for teaching

Table 5.11 below depicts the best predictors of the anticipated factors of intention on future usage of the ACT methodology for teaching. In this table INT stands for

intention, while the preluding ENG, BUR and EFF stand for engagement, burden and effectiveness, respectively.

Table 5.11: How anticipated factors within intention compare

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	INT_ENG	0.479	61.540	3, 201	< 0.001	0.459	5.138	< 0.001
	INT_BUR					-0.020	-0.297	0.767
	INT_EFF					0.331	3.781	< 0.001

The regression analysis shown in Table 5.11 revealed a statistically significant relationship between the independent variables INT_ENG, INT_BUR and INT_EFF, and the dependent variable, future usage of the ACT methodology for teaching. In combination, these variables account for approximately 47.9% of the variance in the dependent variable.

The regression coefficients for INT_ENG and INT_EFF are recorded at 0.459 and 0.331, respectively. This suggests that for every unit increase in INT_ENG and INT_EFF, future usage of the ACT methodology for teaching is expected to increase by 0.459 and 0.331 units, respectively. However, the regression coefficient for INT_BUR is -0.020 with no statistically significant relationship between INT_BUR and future usage of the ACT methodology for teaching ($p = 0.767$). This suggests that with every unit increase in INT_BUR, future usage of the ACT methodology for teaching is expected to decrease by -0.20 units, which has little statistical significance and can be discarded.

However, both INT_ENG and INT_EFF have statistically significant regression coefficients, as indicated by their respective p-values (< 0.001 for both). This suggests that INT_ENG and INT_EFF significantly predict the future usage of the ACT methodology for teaching. Of the two, INT_ENG has a greater coefficient regression than INT_EFF, and is therefore is the best predictor of usage. INT_BUR does not significantly predict the dependent variable, as its p-value is greater than 0.05.

Therefore, it can be concluded that instructional engagement and instructional effectiveness significantly predict the dependent variable, while instructional burden does not.

5.3.2.2 The best component predictors of trust factors of intention on future usage of the ACT methodology for teaching.

Table 5.12 below depicts the best predictors of the trust factors of intention on usage behaviour. In this table, INT stands for intention, while COH and REL stand for coherence and reliability, respectively.

Table 5.12: How trust factors within intention compare

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	INT_COH	514	133.633	2, 253	0.000	0.375	5.453	0.000
	INT_REL					0420	5.593	0.000

When considered together, both INT_COH and INT_REL are significant predictors ($p < 0.001$) of usage behaviour. They are responsible for 51.4 ($R2 = 0.514$) variance in future usage of the ACT methodology for teaching.

The regression coefficient for INT_COH is 0.375. This implies that for every one-unit increase in INT_COH, the dependent variable, future usage of the ACT methodology for teaching, increases by 0.375 units on average. The t-value associated with INT_COH is 5.453, with a p-value of 0.000, indicating that the coefficient for INT_COH is statistically significant. The coefficient for INT_REL is 0.420. This suggests that for every one-unit increase in INT_REL, the dependent variable increases by 0.420 units on average. The t-value associated with INT_REL is 5.593, with a p-value of 0.000, indicating that the coefficient for INT_REL is statistically significant. Since INT_REL has a higher regression coefficient than INT_COH, this means that INT_REL is a best predictor of future usage of the ACT methodology for teaching within trust factors.

5.3.2.3 The best component predictors of people factors of intention on future usage of the ACT methodology for teaching

Table 5.13 below depicts the best predictors of the people factors of intention on future usage of the ACT methodology for teaching. In this table INT stands for intention, while SOC and FAC stand for social and facilitator factors, respectively.

Table 5.13: How people factors within intention compare

Regression analysis	IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
1	INT_SOC	0.534	145.761	2, 254	0.000	0.551	7.763	0.000
	INT_FAC					0.277	4.125	0.000

When considered together, both INT_SOC and INT_FAC account for 53.4% variance in the dependent variable, future usage of the ACT methodology for teaching. However, the regression analysis for INT_SOC is 0.551, while that of INT_FAC is 0.277. This implies that for both INT_SOC and INT_FAC there is a direct and positive relationship between them and future usage of the ACT methodology for teaching. This relationship is one that for every unit increase in INT_SOC and INT_FAC, future usage of the ACT methodology for teaching is expected to increase by 0.551 and 0.277 units, respectively. Therefore, between the two independent variables of INT_SOC and INT_FAC, the variable INT_SOC has a higher regression coefficient. Therefore, this means that for the variables of people factors, INT_SOC is the best predictor of future usage of the ACT methodology for teaching. Thus, the prospective teachers rely more on the views of their peers than those of experts as to whether they use an intervention or not. The more positive those views are, the more likely the prospective teachers are to use the intervention in the future for teaching.

5.3.2.4 Comparison of all the best predictors of intention on future usage of the ACT methodology for teaching

Table 5.14 below depicts the comparison of all the best predictors of acceptance on future usage of the ACT methodology for teaching. In this table, INT stands for intention, while the preluding ENG, EFF, BUR, COH, REL, SOC and FAC stand for engagement, effectiveness, burden, coherence, reliability, social and facilitator factors.

Table 5.14: How factors within intention compare

IV	R^2	F	df1, df2	p-value	B (regression coefficient)	T	p-value
INT_ENG	0.621	46.166	7, 197	0.000	0.096	0.928	0.354
INT_EFF					0.117	1.448	0.149
INT_BUR					0.062	-1.039	0.300
INT_COH					0.227	2.700	0.008
INT_REL					0.002	-0.022	0.982
INT_SOC					0.290	3.391	0.001
INT_FAC					0.231	3.309	0.001

When the factors of acceptance are compared, the regression coefficients for INT_EFF, INT_BUR and INT_REL are 0.117, 0.062 and 0.002, respectively. These coefficients indicate the expected change in the dependent variable for every one-unit increase in each of these predictors. The t-values associated with these variables are 1.448, -0.039, and -0.022, respectively, are relatively low, indicating a low statistical significance. The high p-values for these variables further indicates that none of these coefficients are statistically significant.

However, the regression coefficients for INT_COH, INT_SOC and INT_FAC are 0.227, 0.290 and 0.231, respectively. This suggests that for every one-unit increase in INT_COH, INT_SOC and INT_FAC, the dependent variable increases by 0.227, 0.290 and 0.231 units, respectively. The t-values associated with these variables are 2.700, 3.391 and 3.309, respectively. The p-values for INT_COH, INT_SOC and INT_FAC are 0.008, 0.001 and 0.001, respectively, indicating that the coefficients for these variables are statistically significant.

Overall, therefore, INT_ENG, INT_COH, INT_SOC and INT_FAC are statistically significant predictors of future usage of the ACT methodology for teaching, while INT_EFF, INT_BUR and INT_REL do not appear to have statistically significant effects on usage behaviour.

5.4 Students' perspectives towards the ACT pedagogies when used to teach programming

This Section seeks to address research question 1 which looked at the prospective teachers' perspectives on the ACT pedagogies that were used to teach them programming. In general, these perspectives were mostly positive, which suggests that the views that students held pertaining to the ACT pedagogies were favourable. These views are discussed in Section 5.4.1 to 5.4.2 below.

5.4.1 Perspectives on creation

Table 5.15 below depicts the students' perspectives on the creation pedagogy.

Table 5.15: Prospective teachers' perspectives on the creation pedagogy

CODE	THEME
Perspectives on creation	• Experiential learning: Actively creating and experimenting with code transforms the learning process into a practical and enjoyable experience. • Tangible outcomes: The ability to witness immediate results of coding efforts reduces the abstract nature of programming, making it more accessible and understandable for learners. • Application-oriented learning: Engaging in hands-on coding allows learners to apply theoretical concepts directly to their own game projects, moving beyond rote memorization towards practical skill development.

5.4.1.1 Experiential learning

Students' perspectives on the creation pedagogy were largely positive. The prospective teachers appeared to find that the hands-on creation of coding projects was effective. This perspective is supported by the following excerpts from Focus Group 2:

> *Creation worked best for me. We learned Scratch coding by creating our projects, making it practical and enjoyable.* (Student 1 Focus Group 2)

> *I agree with creation. It allowed us to experiment and see the immediate results. It's hands-on and engages students actively in coding projects...* (Student 2 Focus Group 2)

> *I also found creation most effective because it allowed me to actively apply coding concepts through hands-on projects.* (Student 3 Focus Group 2)

When prompted further to explain how hands-on projects contributed to their understanding, they responded that:

> *It allowed me to experiment with different coding blocks, seeing how they interact in real-time. For instance, when I wanted my sprite to move in a specific way, I could try different code blocks until it worked.* (Student 1 Focus Group 2)

> *For me, the traffic dodge game and especially the black night game were very useful in teaching us coding. In these games creation allowed us to actively apply what we learned and see the immediate results in the games we built.* (Student 2 Focus Group 2)

Students 2, 3 and 5 from Group 4 also supported this notion by substantiating that:

> *I liked creation because it allowed us to apply what we learned practically, reinforcing theoretical concepts through hands-on experience.* (Student 5 Focus Group 4)

> *What I think is that creation allowed us to actively apply what we learned and we were able to see the immediate results in the games we built.* (Student 2 Focus Group 4)

> *If I think about just how complex the coding concepts are, prioritizing creation to provide clear and organised learning resources enhanced our understanding.* (Student 3 Focus Group 4)

The narratives above positively support the hands-on aspects of the creation pedagogy, and this was attributed to factors such as experimentation with various blocks of code which made the learning of coding easier. The ease with which the concepts could be applied in their coding projects then enhanced and furthered their understanding of coding.

5.4.1.2 Tangible outcomes

A concomitant aspect of creation pedagogy that was also mentioned by several group members in Focus Group 3 – that creation rendered coding concepts less abstract thus solidifying understanding as mentioned below by Student 5 and others from this group:

> *Creation was my personal best. We got firsthand experience of coding, creating our own games, and suddenly coding wasn't this abstract thing anymore. It just clicked.* (Student 5 Focus Group 3)

> *Yes, we made this other game where we had to guide a bird through the dark night. Simple game. Coding the logic and sprites – it was very helpful and made everything clearer.* (Student 3 Focus Group 3)

> *Yes. All of the detailed guides were useful actually. We also had to build a racing game where we applied concepts that we learned in class, which solidified our understanding of those coding concepts.* (Student 2 Focus Group 3)

When prompted to "…describe how creation" helped reinforce theoretical concepts effectively", Student 3 and 4 from Group 3 responded that:

> *We built a racing game where we applied concepts that we learned in class. This solidified our understanding of those coding concepts.* (Student 3 Focus Group 3)
>
> *True, when students actively build projects and see the direct application of coding, it solidifies their understanding. For instance, creating a simple game helped grasp coding logic effectively.* (Student 4 Focus Group 3)

Therefore, the students were aware of the abstract nature of coding concepts. However, when they learnt coding in Scratch this assisted in making coding less abstract and facilitated their understanding. Primarily, the immediacy and ease with which Scratch projects can be run is attributed to this visual representation of the concepts in Scratch.

5.4.1.3 Enjoyment of application-oriented learning

Moreover, students also felt that learning coding through creation made their learning more practical and enjoyable. To support this view, Student 1, 4 and 5 from Group 3 found:

> *… creation appealing. Applying what we learned in practical projects made coding more enjoyable.* (Student 4 Focus Group 3)

> *I agree, coding games made it fun. The creation approach was my personal favourite.* (Student 1 Focus Group 3)

> *It (creation) was fun, and seeing the result of our efforts was rewarding.* (Student 4 Focus Group 3)

> *Applying what we learned in practical projects made coding more enjoyable.* (Student 1 Focus Group 3)

Student 1, 3 and 5 from Group 5 further stated that in relation to creation that they:

> *… created a simple game where the sprite had to navigate its way around other sprites through the city. Trying out different codes to make the game challenging and then seeing our classmates enjoy playing it was a rewarding experience.* (Student 3 Focus Group 5)

> *Yeah. Having me to create my own games from a guide encouraged me to also apply my own ideas on top of the ones instructed in the guide, and this made my learning fun and interactive.* (Student 5 Focus Group 5)

> *Absolutely! Coding games made it fun. The creation approach was my personal favourite.* (Student 1 Focus Group 5)

Furthermore, numerous students thought that the guides were useful for learning to code. Student 3 from group 3 communicated that they:

> *… liked creation … where the guides were very useful in assisting us to code. Without the detailed guides, I do not think that I would have been able to cover as much progress as I did.* (Student 3 Focus Group 3)

Yes, creation is hands-on and engages students actively in coding projects since it included well-structured guides for students to follow. (Student 6 Focus Group 3)

I will also say creation. The step-by-step guide, practical application was powerful in teaching me coding. (Student 7 Focus Group 3)

This further strengthens and emphasises the significance of self-realisation, which reaffirms that the hands-on component of the creation pedagogy is effective in the teaching of coding. The students seemed to appreciate learning from actually conducting coding practically using the guides, and suggested this pedagogy as an effective one. They further attested to enjoying the learning of coding through the creation pedagogy, which emphasizes the important role of practical learning in making coding concepts less abstract.

5.4.2 Perspectives on conversation pedagogy

Below is a table that depicts the students' views on the conversation pedagogy of the ACT methodology.

Table 5.16: Prospective teachers' perspectives on the conversation pedagogy

CODE	THEME
Perspectives on conversation	• Collaboration enriches the learning experience, broadening understanding and allowing for exchange of ideas. • Facilitates problem solving which enhances understanding, helping students grasp coding concepts more easily.

5.4.2.1 Collaborative learning

Two perspectives were consistent across all the groups when considering conversation pedagogy. The first perspective was that the conversation pedagogy enriches the learning experience, broadening understanding and allowing for the exchange of ideas. The interaction below supports this notion.

For me, conversation worked best. Discussing coding challenges with peers provided diverse insights and improved my problem-solving skills. (Student 5 Focus Group 4)

When prompted how did these discussions contribute to their understanding of coding the following was asserted:

> *Yes, talking through mistakes we made with peers helped me to see different solutions and this helped to improve my ability to read through code effectively.* (Student 2 Focus Group 4)

> *I agree with you, through discussions, students can share different approaches to problem-solving, learn from each other's mistakes, and collectively develop a deeper understanding of coding principles.* (Student 1 Focus Group 4)

Conversation provided opportunity for students to combine pedagogies, in this case combining the conversation pedagogy with the correction pedagogy. This was achieved by having a conversation between group members and allowing them to use another pedagogy. However, this was not the only collaborative learning that was possible through the conversation pedagogy that students were exposed to. For example, in another group, the students were able to identify that collaboration would also occur among the students, facilitated by their conversation, as inferred below:

> *conversation would be my choice for frequent use. It encourages collaboration, peer learning, and sharing diverse perspectives.* (Student 6 Focus Group 8)

> *Yes, with group discussions, students clarified doubts, corrected each other, shared diverse problem-solving approaches, and collectively deepened their understanding of coding.* (Student 2 Focus Group 8)

> *I also agree, conversation also worked for me. The group discussions helped me understand different approaches to coding problems.* (Student 5 Focus Group 8)

> *Definitely, we shared different ways of tackling problems. It broadened my perspective on coding.* (Student 6 Focus Group 8)

Therefore, this implies is that when students are using the conversation pedagogy, they can use it to collaborate in two ways. The first way is to use it by combining conversation with another pedagogy, in this case the correction pedagogy. The second

way is to learn from each other through conversation, thus collaborating with each other in a group. Both of these collaborations then led to innovative solutions. When this group of students was prompted to provide an example of a coding challenge in which conversation led to innovative solutions, enhancing problem solving, one student responded as follows:

> *We were stuck on some difficult concept when working on the shark project, and a peer shared a unique perspective that helped us solve it.* (Student 3 Focus Group 8)

While the shark game was based on the chaos pedagogy, it is encouraging to observe that the students identified the necessity to use the conversation pedagogy and converse with each other on complex concepts, finding various solutions and improving their problem-solving skills, which has a direct effect on their coding abilities. This further strengthening the notion that collaborative learning under the conversation pedagogy occurred in two ways, namely, by combining one or more pedagogies with the conversation pedagogy, as well as mutual and interdependent learning.

5.4.2.2 Shared problem solving

The second perspective that the students alluded to with reference to the conversation pedagogy suggested that the conversation pedagogy helps facilitates shared problem solving, which enhanced understanding, helping students grasp coding concepts more easily. Since the problem solving is shared, problems become easier to resolve. To support this assertion, the students substantiated:

> *Personally, I found conversation effective. Discussing ideas with classmates helped me grasp coding concepts more easily.* (Student 3 Focus Group 2)

When requested to provide an instance where conversation pedagogy aided their understanding of a coding concepts, the students responded:

> *Certainly. We had a project where we had to create a racing car game using code. Discussing the structure and coding techniques with*

classmates helped us come up with creative solutions and improve our project. (Student 2 Focus Group 2)

I will say that I also found conversation appealing. It created a collaborative environment, and discussing coding challenges with peers was beneficial. (Student 5 Focus Group 2)

Yes. During coding discussions, different perspectives were shared, and we often found creative solutions to problems. It made the learning experience more dynamic. (Student 6 Focus Group 2)

Yes, that is true. Like for instance during a discussion about how to code for collision detection and the different ways this could be done in, this made us to share different perspectives, helping me to see coding challenges from different angles. (Student 1 Focus Group 2)

Similar views were expressed by students from Group 5, where they alluded to the conversation pedagogy as enhancing their understanding. This is evident in the following interaction between Student 4 and his group members below when questioned about the most effective pedagogy for learning coding.

I prefer conversation. Collaborative learning fosters a supportive environment, enhancing understanding. (Student 4 Focus Group 5)

Yes, I also agree with you. During all of our group projects, discussing different approaches with peers helped me grasp coding concepts from various perspectives. (Student 5 Focus Group 5)

When prompted further to discuss how the conversation pedagogy enhanced their understanding the students mentioned:

During group coding projects, discussing ideas and problem solving together improved our understanding. (Student 4 Focus Group 5)

True, the discussions encouraged teamwork and sharing different coding approaches. I think that the collaboration fosters a supportive environment, enhancing understanding. (Student 2 Focus Group 5)

*I agree with you, group discussions helped me understand different approaches to coding problems. This was very beneficial for my understanding of coding. (*Student 1 Focus Group 5)

It appeared, therefore, that students appreciated the collaborative nature of the conversation pedagogy as it facilitated the understanding of coding concepts, especially through discussion. The understanding is that when a task, or coding project, is shared it is less of a burden than trying to work on it alone, hence, this makes the learning of coding easier, enhancing understanding in the process. When the students were asked exactly how they had used the conversation pedagogy to enhance their understanding, students from Group 5 responded as follows:

I had a concept that I was struggling with, so I talked about it with my group members and I was able to understand where I was going wrong through talking about it. (Student 2 Focus Group 5)

Yes, in my case, one of our members was good with coding, so he would discuss concepts with us which helped us to enhance our understanding of those concepts. (Student 5 Focus Group 5)

Ultimately, the two themes that emanated for the conversation pedagogy were not contrasting but were closely related and interlinked . These themes suggested that the students had a positive outlook on the conversation pedagogy. It was evident that the collaborative learning opportunities afforded by conversation, both of pedagogical collaboration and interpersonal collaboration, enhanced the understanding of coding concepts. In addition, the conversation pedagogy facilitated problem solving, which enhanced understanding. The students valued discussing their ideas with their peers, as they were able to both talk and think about them simultaneously – as opposed to simply thinking when not in a conversation with another person.

5.4.3 Perspectives on curation

Below is a table that depicts the students' views on the curation pedagogy of the ACT methodology.

Table 5.17: Prospective teachers' perspectives on the curation pedagogy

CODE	THEME
Perspectives on curation	• Efficient planning: Structuring and organising the coding process in advance minimizes errors and enhances efficiency, facilitating a smoother learning experience. • Selective block utilization: Deliberately considering and selecting the essential coding components streamlines the learning process by focusing on key concepts and reducing complexity. • Centralized resources: Consolidating all necessary materials in one location saves time and effort, streamlining the learning process and fostering better engagement.

5.4.3.1 Efficient planning

Three perspectives were consistent amongst the students in relation to the curation pedagogy of the ACT methodology. The first perspective was that curation emphasized prior planning or organization, which was time efficient when coding as they would make less mistakes when doing the actual coding. This made the learning of coding easier as opposed to learning coding without planning. The interaction between Student 4 and others from Group 1 below illustrates this.

> *I think curation was effective. Having to think about and discuss different blocks of code and how we'd put them together made it easier to navigate and understand and use different code blocks.* (Student 4 Focus Group 1)

> *Absolutely. When we were learning about different blocks of code, having to think about how to put these together with clear explanations helped save coding time. It allowed us to focus on planning and to see its importance rather than simply jumping into coding as many of us like to do.* (Student 2 Focus Group 1)

Two other students from Group 2 shared similar views:

> *It simplifies learning by emphasising prior thinking and planning of a game, what blocks to use and how to organise those blocks.* (Student 3 Focus Group 2)

> *I agree, having to think about the different blocks to use and how to use them makes it easier to code, saving time and making the learning process more efficient as now I've thought about what blocks to use.* (Student 5 Focus Group 2)

> *For me I'd say curation worked best because it enabled me to plan ahead as to which blocks of code I'd use and how I'd put them together. This then helped facilitated a more smoother learning journey for me.* (Student 4 Focus Group 3)

When the students from Group 2 were asked how would they plan, they responded as follows:

> *I would use flowcharts and sometimes a bit of pseudocode.* (Student 2 Focus Group 2)

> *I preferred to use pseudocode.* (Student 3 Focus Group 2)

> *Yes, using pseudocode helped me to spend less time when coding and making less mistakes as I'd have a written down plan for how I'd go about in creating my project.* (Student 4 Focus Group 2)

These narratives emphasise the importance of planning and its contribution to assisting the students to learn coding through the curation pedagogy. While these views are positive, they were not widely shared, which suggests that not many of the students appreciated prior planning before coding. The narrative below exemplifies this:

> *Planning for me took away most of my time, as I wanted to use it for coding which I enjoyed doing.* (Student 5 Focus Group 2)

5.4.3.2 Centralised resources

The second perspective was that the students commended the centralization of resources, which then helped them to gather different blocks of code from various

sections, similar to curating only the blocks that are needed. This centralization of resources made it possible for them to easily identify where to find the blocks that they needed and increased their learning. This perspective is exemplified in the conversation between Student 3 of Group 1 and his peers.

> *I found curation appealing as it saved time, all the resources we needed were in one place.* (Student 3 Focus Group 1)
> *Yes, it allowed us to focus on coding rather than spending time searching for materials.* (Student 2 Focus Group 1)
>
> *I liked curation because it saved time. Having resources organised made it easier to find what we needed.* (Student 3 Focus Group 1)
>
> *When working on projects, identifying the relevant blocks quickly and planning around how I'd put those blocks together helped me focus more on coding.* (Student 5 Focus Group 1)
>
> *Having curated resources reduced the time spent searching for information, allowing more focus on learning.* (Student 6 Focus Group 1)

This perspective emphasizes the importance of having curated resources that assist in finding what is needed. This makes the learning of coding faster than if the resources (or blocks of code in this case) were not all in one place and first needed to be curated by collecting and placing the blocks of code into a Scratch program.

5.4.4 Perspectives on correction pedagogy

Two perspectives were dominant among the students on the correction pedagogy of the ACT methodology. The table below depicts these perspectives.

Table 5.18: Prospective teachers' perspectives on the correction pedagogy

PEDAGOGY	THEME
Perspectives on correction	• Error awareness: Recognizing and understanding potential errors enables learners to avoid repeating them, leading to improvements in coding skills over time. • Feedback loop: Receiving guidance and feedback on errors facilitates the development of better coding practices and enhances overall learning outcomes.

5.4.4.1 Error awareness

The first perspective that was common was that the students viewed this pedagogy as assisting them to recognize errors and to not repeat them in the future. This led to an improvement of their coding skills over time, as discussed below between students from Group 2:

> *I liked correction because it helped refine our coding skills by pointing out errors and suggesting improvements.* (Student 4 Focus Group 2)

> *Yes, exactly, like in the 'jumping unicorn' game the unicorn wasn't sensing when it hit the rock which must make the game end. The correction for this highlighted a way for me to identify and fix errors in my code.* (Student 6 Focus Group 2)

> *I would say correction was the best for me because it made me to be aware of the possible errors that can be made. Also, the feedback on the errors that we would make was very clear and easy to understand and this helped to enhance my coding skills which helped me understand and rectify mistakes for future improvement.* (Student 3 Focus Group 2)

When Student 3 of Group 3 was prompted to elaborate on how feedback impacted on their learning of coding, they responded as follows:

> *Getting and giving feedback on errors that were committed by many students helped me a lot. Also having the lecturer make suggestions for improvements helped me refine my approach and avoid similar mistakes in the future.* (Student 3 Focus Group 3)

Student 2 and 4 of Group 1 shared a similar view about correction assisting in identifying errors and, thus, committing fewer mistakes in future by improving coding skills:

> *Correction was useful because it provided guidance on improving our coding skills.* (Student 4 Focus Group 1)

> *True, the feedback on our code helped us understand errors and learn better practices.* (Student 2 Focus Group 1)

From the above interactions, it is evident that the correction pedagogy can be used to assist students to identify errors, which helps to avoid similar errors being made in the future. One such instance was when the students worked on a Scratch project where they had to find errors in the project. In order to do this, they were required to, firstly, study how the project was behaving and then go through the guide to understand how it was expected to behave. Thereafter, the students had to correct the project so it behaved in the expected manner. In doing this, the students had to be able to identify errors on their own and then fix those errors, which improved their coding skills.

Another case where students had to identify errors and then fix them was while their lecturer was doing live coding sessions. During these live coding sessions, the lecturer would choose one student's Scratch project to use for identifying and correcting errors. This was done with the entire class. A small number of students maintained that this was helpful, and good for them to learn coding. This is clarified by Group 1:

> *Correction was useful because it provided guidance on improving our coding skills.* (Student 4 Focus Group 1)

When requested to elaborate how guidance improved this student's coding skills, the following response was offered:

> *The feedback on our code helped us understand errors and learn better practices.* (Student 4 Focus Group 1)

However, for a vast number students of students this was not a good technique to use as they had opposing views:

> *I'd say correction was the least effective. It often demotivated and felt like criticism rather than constructive feedback.* (Student 1 Focus Group 1)

> *Correction didn't work for me either. It discouraged risk-taking and stifled creativity in coding.* (Student 4 Focus Group 1)

> *For me I will say correction was the least effective because for the mistakes that I made it felt more like criticism than constructive feedback, which impacted my confidence.* (Student 2 Focus Group 1)

When these students were questioned about how correction pedagogy negatively impacted their confidence, Student 2 responded:

> *When we had to discuss corrections from my project with the whole class, this made me not to like the experience of sharing my project as this made receiving feedback to be focused solely on errors and criticism. This just made the learning process discouraging and hindered my enthusiasm for coding.* (Student 2 Focus Group 1)

5.4.4.2 Feedback loop

However, another perspective widely shared by the students was that they appreciated the feedback that was associated with the correction pedagogy. The quote below illustrates this:

> *I liked correction because it helped refine our coding skills by pointing out errors and suggesting improvements.* (Student 4 Focus Group 2)

When prompted to provide a specific example where correction helped refine their coding skills, Student 4 responded:

> *Certainly. In the jumping unicorn game the unicorn wasn't sensing when it hit the rock which must make the game end. The correction for this highlighted a way for me to identify and fix errors in my code.* (Student 4 Focus Group 2)

I would say correction was the best for me because it made me to be aware of the possible errors that can be made. Also, the feedback on the errors that we would make was very clear and easy to understand and this helped to enhance my coding skills which helped me understand and rectify mistakes for future improvement. (Student 3 Focus Group 2)

Getting and giving feedback on errors that were committed by many students helped me a lot. Also having the lecturer make suggestions for improvements helped me refine my approach and avoid similar mistakes in the future. (Student 3 Focus Group 2)

While a small percentage of students felt that the correction and feedback from the correction pedagogy was demotivating, many viewed this as having a positive impact on their coding development journey. Hence, it is important for teachers of coding to always opt for a motivating approach of teaching over a monotonous or even demotivating manner of teaching.

5.4.5 Perspectives on chaos pedagogy

Below is a table depicting the students' views on the chaos pedagogy of the ACT methodology.

Table 5.18: Prospective teachers' perspectives on the chaos pedagogy

CODE	THEME
Perspectives on chaos	• Unappealing Learning: Unappealing, disorganised and overwhelming for the students. • Disruptive learning: Disruptive and disorganised learning • Experimental learning: Freedom to experiment, learn through trial and error. • chaos for testing: chaos for testing, hard, confusing, overwhelming and unappealing.

5.4.5.1 Unappealing learning

A consistent view across all the groups of students with regards to the chaos pedagogy was that it was unappealing, disorganised and overwhelming. The little guidance offered by the chaos pedagogy meant that many students did not know what to do

when confronted with a coding challenge. Thus, many of the students attested to the chaos pedagogy as being uncontrolled as highlighted below:

> *I think chaos was least effective. It made learning feel disorganised and confusing.* (Student 3 Focus Group 2)

> *Certainly. During coding exercises, there were times when instructions were unclear, and everyone was doing different things. It made it challenging to follow a structured learning path.* (Student 5 Focus Group 2)

> *That is true. Like with the 'shark' game the scenario did not have instructions and this made it disorganised, it made things challenging for me to follow in a logical learning path.* (Student 2 Focus Group 2)

Similar views were also repeated in Group 2 as evident in the discussion below:

> *chaos would be my choice for less frequent use. It can overwhelm students and hinder effective learning.* (Student 4 Focus Group 2)

> *Yes, when there's too much disorganization or unclear instructions, students may struggle to focus on specific coding tasks, leading to confusion.* (Student 6 Focus Group 2)

> *I agree with chaos being unappealing. It made learning coding extremely hard since we do not have any prior coding experience.* (Student 5 Focus Group 2)

> *I would also say chaos would be less frequent in my approach. It can be confusing and difficult to code and this can be overwhelming for students.* (Student 2 Focus Group 2)

When prompted to elaborate on how chaos "made it difficult" and "might overwhelm them", Student 2 from Group 2 gave the following explanation:

> *Like, for instance, when the task lacks organization and clarity, students struggle to code, leading to confusion and frustration.* (Student 2 Focus Group 2)

5.4.5.2 Disrupts learning.

Another perspective that was common amongst the students was that chaos was disruptive towards their learning. Even though the students were expected to work on their projects individually, they could assist each other. Since the instructions for the coding tasks under chaos were unclear, self-interpretation prevailed, which meant that reaching an agreement within a group or as individuals took a considerable amount of time. This shifted the students' focus away from coding and onto what to do and how to do it, with not much success:

> *I will agree with the one that said chaos was the least appealing. It disrupted the structured learning environment we needed for coding and it made it seem like I had learnt nothing as I battled with creating the shark game on my own. But perhaps if I was with my friends, maybe I would not have struggled as much.* (Student 4 Focus Group 2)

When the students were prompted to provide an example of how chaos pedagogy disrupted their structured learning and made it challenging they offered the following:

> *chaos in the shark game created a scattered learning experience where everyone was doing their own thing and this would make some of us feel like we are off track.* (Student 4 Focus Group 2)

> *Like the different views that people had disrupts structured learning, making it challenging for students to stick to one plan and have a good understanding of coding.* (Student 1 Focus Group 2)

> *Yes, when there's too much disorganization and little information in terms of exactly what to do, students struggle, hindering their understanding. Maybe it's good when we're more experienced.* (Student 5 Focus Group 2)

> *For me too, chaos didn't work for me. The unclear path disrupted structured learning and made it challenging for me to understanding and learn coding concepts.* (Student 4 Focus Group 2)

> *Again, I must also admit, chaos in the shark game was a headache for me. It just confused me and I often got lost.* (Student 1 Focus Group 2)

> *Yes, I also agree with you, chaos was unappealing. It disrupted our learning flow, making it challenging to stay on track.* (Student 4 Focus Group 2)

When requested to elaborate on a situation where chaos disrupted their learning flow, students from Group 5 responded as follows:

> *In group assignments, it was hard to coordinate when the approach was chaotic. It slowed down the entire process as everyone had their own view for how to code the project.* (Student 4 Focus Group 5)

> *In a chaotic learning environment, it was hard to follow a clear path of understanding. It felt overwhelming.* (Student 2 Focus Group 5)

> *Yes, like with the Shark project we all had our own views for how to do it, we debated this and ended up being more confused. So, for me, chaos disrupts structured learning, making it challenging for students.* (Student 5 Focus Group 5)

While the views shared by the students on the chaos pedagogy can be considered as negative, they are insightful and provided a glimpse into students' views about the chaos pedagogy in the early stages of learning coding. Expectedly, coding within the chaos pedagogy posed a challenge to the students as they found it unclear as to how to go about the task. There was vast amounts of information to go through in order to understand this, and this can be challenging to students, especially if they are not used to learning within the chaos pedagogy and still have to acquaint themselves with this approach.

5.4.5.3 chaos pedagogy for testing

One of the main reasons why many students did not appreciate the use of the chaos for teaching purposes was its greater orientation towards testing rather than teaching. Hence, a small number of students viewed chaos as more of an assessment pedagogy than a teaching pedagogy. The students noted that this pedagogy was not teaching them, but rather testing them too soon into their coding learning. The narrative below illustrates this:

> *With the shark game the scenario I did not have instructions and this made it disorganised, it made things challenging for me to follow in a logical learning path. It created confusion and hindered my understanding of coding concepts at the learning stage. I think chaos is better suited for testing and assessment than for teaching coding.* (Student 2 Focus Group 2)

Therefore, this student valued clarity.

When probed for an explanation on how their views of chaos pedagogy as a testing technique affected their learning experience, the students responded in the following manner:

> *I didn't find chaos appealing. Coding without clear instructions made me feel like I was being tested before I had a good understanding. (Student 4 Focus Group 2)*
> *Yes, it made learning feel harsh and confusing. It created confusion and hindered my understanding of coding concepts.* (Student 1 Focus Group 2)

Many students also alluded to the need to use the chaos pedagogy less frequently. The narrative below illustrates this:

> *Chaos would be less frequent for me. It disrupts structured learning, making it challenging for students to grasp coding concepts.* (Student 2 Focus Group 2)

This meant that structure is essential for this student. Students were then requested to share an example of how chaos pedagogy disrupts structured learning in a coding class. The following response was offered:

> *When there's too much disorganization and little information in terms of exactly what to do, students struggle, hindering their understanding. Maybe it's good when we're more experienced.* (Student 2 Focus Group 2)

> *Chaos would be my choice for less frequent use. It can overwhelm students and hinder effective learning.* (Student 4 Focus Group 2)

Being overwhelmed is a valid concern. When requested to offer an example, Student 4 said:

When there's too much disorganization or unclear instructions, students may struggle to focus on specific coding tasks, leading to confusion. (Student 4 Focus Group 2)

5.4.5.4 Experimental learning

However, surprisingly, one student attested to having positive views about the chaos pedagogy. This student communicated that this pedagogy offered freedom to experiment and explore the different blocks of code, how they work and how to use them. Through trial and error, this student was able to figure out how to code in Scratch using the chaos pedagogy. The conversation below illustrates this:

Chaos was surprisingly good. We had freedom, experimented, learned by trial and error. (Student 3 Focus Group 5)

When prompted to share an example of how the chaos approach assisted them to learn coding, the student responded in the following manner:

Well, with my group members we accidentally realised that we could code in so many different ways, but the results always being the same. This was so eye opening for me. (Student 3 Focus Group 5)

Upon reviewing the student's work, it was evident that this was one of the stronger students in coding. This student was also passionate about coding and this all likely contributed to the positive attitude. Therefore, in order for students to appreciate coding in the chaos pedagogy they must have a good understanding of coding concepts beforehand and enjoy coding. Thus, it is important to take note of how teachers use the chaos pedagogy and how often they use it. While it was expected that more students would have mentioned that chaos pedagogy allowed them to experiment and work with different blocks of code as they pleased, this perspective was only found in one of the students. With increased competence in coding, it is anticipated that more students will feel comfortable with the chaos pedagogy.

5.5 Conclusion

In this chapter, the analysis of data based on the first three research questions provided critical insights into the factors influencing the acceptance and intention to adopt the ACT methodology among prospective teachers. It also highlighted students'

perspectives on the pedagogies involved in the ACT methodology and their perceived effectiveness for learning programming.

The findings underscored that satisfaction and perceived effectiveness are significant determinants of both acceptance and intention to use the ACT methodology. Satisfaction, particularly when tied to experiential and practical learning, was found to be a key predictor of future use. Trust factors, such as coherence and reliability, also played an essential role, although coherence tended to have a stronger influence on learning, while reliability was more influential for teaching. Social influences, including peer collaboration and lecturer support, further enhanced the likelihood of adoption, underscoring the importance of community in educational environments.

Students' perspectives on the ACT methodology revealed varying degrees of acceptance for its five pedagogical components: creation, conversation, curation, correction and chaos. The creation pedagogy was widely praised for fostering experiential and application-oriented learning, aligning with educational theories that prioritize hands-on engagement. The conversation pedagogy received positive feedback for promoting collaborative learning and shared problem-solving, enhancing understanding through dialogue. The curation pedagogy was appreciated for its emphasis on efficient planning and resource centralization, which minimized errors and streamlined learning. The correction pedagogy stood out for its focus on error identification and iterative improvement. However, the chaos pedagogy elicited mixed reactions; while a few students valued its potential for fostering creativity and experimental learning, the majority found it disorganized and overwhelming, particularly for novice learners. These insights emphasize the importance of balancing structure and freedom in pedagogical design to cater to varying student needs and learning preferences. By leveraging the strengths of the ACT methodology while addressing its challenges, educators can create more engaging, effective, and inclusive learning experiences.

CHAPTER 6: DISCUSSION

6.1 Introduction

This chapter discusses research question four in conjunction with the results of the study as a whole. Research question four read as follows: Why does Acceptance and Intention affect Usage Behaviour the way they do? The Sections are presented as follows: Section 6.2 discusses why acceptance and intention affects usage of a pedagogy the way they do, Section 6.3 discusses the best predictors of acceptance and intention on usage. Thereafter, Section 6.4 deals with the perspectives of the prospective teachers on the ACT methodology, after which the chapter concludes in Section 6.5.

6.2 Why acceptance and intention affect usage behaviour the way they do

In conjunction with relevant literature, this Section discusses the results that address research question 4, which was stated as follows: Why does acceptance and intention affect future usage of the ACT methodology the way they do? This Section is divided into two sub-sections: Section 6.2.1 discusses the acceptance factors and why they affect future usage the way they do, while Section 6.2.2 focusses on intention factors and why they affect future usage of the ACT methodology's pedagogies the way they do. The factors of acceptance are experienced, trust and people factors, while those of intention are anticipated, trust and people factors. Each factor is made up of component factors and this Section discusses each factor by addressing each component factor individually.

6.2.1 Why do the factors of acceptance affect future usage of a pedagogy the way they do?

6.2.1.1 Why the experienced component factors of acceptance affect usage of a pedagogy the way they do.

The results of this study demonstrated that the more satisfied the prospective teachers were with the intervention for their own learning purposes, the more likely they were to use it in the future for their studying and learning. Thus, these results affirmed that there is a strong link between being satisfied with a pedagogy of learning and the likelihood of using the pedagogy in the future for the same purposes. In this study, satisfaction was composed of two variables, namely, enjoyment and effectiveness, where enjoyment was defined as the extent to which the prospective teachers enjoyed the pedagogy and effectiveness was defined as the extent to which the pedagogy was perceived as having achieved its purpose.

Literature has established that when prospective teachers enjoy learning using a particular pedagogy, this tends to boost their level of motivation and engagement with the pedagogy and content being learnt (Ebrahimzadeh & Alavi, 2016; Koutromanos et al., 2024). Moreover, when the pedagogy being used is effective and the students are enjoying it, they tend to remember the content of the subject better (Hernik & Jaworska., 2018). The vast majority of the participants agreed that they enjoyed the pedagogy of teaching and attested to the pedagogy being effective at teaching them Scratch coding.

Moreover, the prospective teachers indicated being positively engaged with coding their Scratch projects. The performance of the prospective teachers in their assessment task (including assignments, tests and exams) was also good, which affirms the pedagogy of teaching them Scratch coding. Since the performance of the students was good, this implies that the pedagogy was effective in teaching the prospective teachers coding, and hence improving their performance. Therefore, it can be concluded that this pedagogy assisted them assimilate, learn and remember the content of the module better as compared to traditional pedagogies of learning. Overall, since the prospective teachers were satisfied with the pedagogy when using it for learning, there is a high likelihood that they will use this pedagogy in the future for learning.

However, when the difficulty of learning using the pedagogy was tested, the results revealed that the harder it was for the prospective teachers to learn using the pedagogy, the less likely they were to use it in the future for learning purposes. A different study found similar results when it revealed that pre-service teachers' perceived ease of use significantly affected their desire to adopt technology-enabled learning methods in the future (Hou et al., 2022). Specifically, this study by Hou et al. (2022) found that the harder it is for prospective teachers to use a pedagogy when learning, the less likely it is that they will use it in the future. This finding is consistent with the findings of the present study. Moreover, while this difficulty decreases the chances of usage, the results also showed that the prospective teachers were aware of this, and asserted that they did not want the pedagogy to be difficult for them to use for their learning in the future. This result strongly suggests that lecturers and teachers alike should consider 1) how they use a pedagogy of teaching with prospective teachers, and 2) the difficulty imposed by the teaching pedagogies that they employ as these have a strong bearing

on whether the prospective teachers choose to use it or not in the future, in this case for learning. However, satisfaction which consisted of enjoyment and effectiveness tended to have a high acceptance, meaning that they both increased the likelihood of future usage.

6.2.1.2 Why the trust factors of acceptance affect future usage of a pedagogy the way they do

The results for trust factors, which consisted of coherence and reliability also revealed that the prospective teachers felt that the more coherent a pedagogy of learning was, the more likely they were to use it in the future for learning purposes. Therefore, this suggests that the prospective teachers were interested in the process of learning and not simply the results of learning. Moreover, this process of learning must make sense to them in order to influence future use. This implies that teachers and lecturers must be intentional with a pedagogy's use and how it will be used. When teachers and lecturers are intentional about their use of a pedagogy they tend to focus on certain aspects of that pedagogy and how to make use of the best and most positive aspects of that pedagogy. When the pedagogy makes sense, and is coherent in the minds of the prospective teachers, there is a good chance that they will want to use that pedagogy of teaching in the future for their own learning. Two separate studies by Puerta (2024) and Rissanen et al. (2021) revealed similar results when the views of coherence and sense making of a pedagogy were tested among prospective teachers. These results revealed that when prospective teachers view a pedagogy of teaching as coherent and sensible to them, there is a high chance that they will use it in the future.

Moreover, even though the studies by Puerta (2024) and Rissanen et al. (2021) used different pedagogies than those employed in this study, they arrived at the same conclusion. Both of these studies justified similar results even though their methodologies were different. The study by Puerta (2024) focused on the use of gamification as a pedagogy of teaching and learning, while that of Rissanen et al. (2021) was based on the growth mindset pedagogy, and the results from both studies revealed that the more coherent and sensible prospective teachers viewed a pedagogy of teaching and learning, the greater the likelihood that they would use it in the future. Therefore, this implies that irrespective of the pedagogy of teaching and learning that

is employed, if the prospective teachers view it as coherent and sense making, they will use it in the future.

Furthermore, this study revealed that the more reliable the prospective teachers viewed a pedagogy of teaching, the more likely they were to use it in the future for their own learning. Therefore, reliability of a pedagogy (in the opinion of a prospective teacher) also plays a crucial role in determining if the prospective teacher would like to be taught in this pedagogy in the future or not. The results by Zamir and Ali (2023) support this finding, i.e., prospective teachers who find information and communication technology (ICT) pedagogies reliable for learning are more likely to integrate it into their future teaching practices, suggesting that reliability is a key factor in the adoption of pedagogical methods for future use. This finding concurs with the premise of the conceptual framework posed in this study, i.e., that a high trust in terms of acceptance in relation to coherence and reliability of a pedagogy will result in a high likelihood of future use of that pedagogy for learning purposes.

6.2.1.3 Why people factors of acceptance affect future usage of a pedagogy the way they do

When the influence of peers and the community was investigated, it was revealed that the more positive the social and peer influence on the prospective teachers of a pedagogy of teaching, the more likely they were to use the pedagogy in the future for learning purposes. Therefore, it is important that other prospective teachers and the community, such as parents and other stakeholders, share positive views about a plausible pedagogy of teaching. This finding is supported by Vandeyar and Adegoke (2024) who highlighted that peer influence and societal norms significantly impact prospective teachers' willingness to adopt and use innovative pedagogical approaches in their future teaching practices. The support and validation of peers and the broader educational community enhance the likelihood of these innovative pedagogical approaches being integrated into the teachers' repertoire. Thus, within the South African context it is important to spread positive views about progressive pedagogies that utilize technology, especially those that have been proven or have potential to produce good outcomes.

In this study it was also established that the more positive the influence that the prospective teachers receive from their lecturers in relation to a pedagogy, the more likely they are to use it in the future for learning. Akbulut and Hill (2020) confirmed that when prospective teachers receive strong, positive support and influence from their lecturers regarding specific pedagogical approaches, they are more likely to adopt and utilize these methods in their future practices. Another study by Basilotta-Gómez-Pablos et al. (2022) highlighted how support from lecturers can significantly enhance pre-service teachers' confidence and their willingness to adopt digital pedagogical practices. In their study, these authors suggest that positive reinforcement from faculty members can lead to a higher likelihood of prospective teachers integrating these pedagogies into their future practice. In relation to the current study, the prospective teachers experienced positive reinforcement from tutors and lecturers when using the ACT methodology, which helped to create positive perspectives about the pedagogy among the prospective teachers, giving them reason to use the pedagogy in the future for learning purposes. The conceptual framework used in this study supports the finding that the more positive a prospective teacher's views are about a pedagogy, the more likely they are to use it in the future for learning purposes.

6.2.2 Why do the factors of intention affect usage behaviour the way they do?

6.2.2.1 Why anticipated component factors of intention affect usage behaviour the way they do

This study established that the more satisfied the prospective teachers were with a pedagogy for teaching, the more likely they were to use it in the future for teaching purposes. Du et al. (2023) concurs that teachers' degree of satisfaction with online teaching significantly influences their performance and willingness to continue using online teaching methods in the future. Their study found that when teachers find online teaching platforms easy to use and effective, their satisfaction increases, which then makes them more likely to use these platforms in the future for teaching purposes. In the current research, the prospective teachers' views on how satisfying the use of the pedagogy was, influences their willingness to adopt the pedagogy in the future. Since we see a small number of teachers utilizing technology in their teaching practices, we can link this to how satisfied they are with the results that they get when using technology to teach.

Another study by Pedditzi et al. (2021) discusses how job satisfaction, which includes fulfilling interactions with students and working within a supportive environment influences teachers' professional commitment and continued use of certain teaching practices. In their study, Pedditzi et al. (2021) found that the perceived satisfaction with a pedagogy of teaching played a significant role in determining whether or not prospective teachers are likely to use that pedagogy of teaching in the future. This finding further strengthens the view that prospective teachers' opinions on how satisfying they perceive a pedagogy of teaching to be, has a strong influence in determining the likelihood of them using the pedagogy in the future for teaching purposes. Another study that supports this notion revealed that prospective teachers are more likely to implement pedagogies they perceive as effective in their future teaching (Margot & Kettler, 2019) and thus support the continued use of the pedagogy. The present study emphasises the understanding that when prospective teachers recognize the benefits and effectiveness of particular teaching methods, they are more inclined to adopting them in their own future teaching.

This current study also reported that the more negative the prospective teachers' views were on the use of a teaching pedagogy, the less likely they were to consider its future use for teaching purposes. This finding concurs with other studies, for example, Margot and Kettler (2019) found that teachers' negative perceptions about the use of a pedagogy reduces the likelihood of future use. That study argues that the perceived challenges and barriers posed by the use of a pedagogy can greatly deter teachers from using a pedagogy of teaching (Margot & Kettler, 2019). Moreover, a study by Akram et al. (2022) discussed how teachers' beliefs about the complexity of using a pedagogy of teaching can influence their willingness to use it in the future. In both these research studies the researchers provided insights into how the difficulty of using certain pedagogical methods impacts prospective teachers' future use of those pedagogies.

6.2.2.2 Why trust factors of intention affect future usage of a pedagogy the way they do

When perceived trust (which includes coherence and reliability of a pedagogy of teaching) was considered, the results revealed that the more coherent the prospective teachers view of the pedagogy was, the more likely they were to use it in the future. In a review by Margot and Kettler (2019) it was highlighted that when prospective

teachers view a pedagogy as coherent and well-structured, they are more likely to adopt it in their future teaching practices. That study also suggests that clear, comprehensive and coherent instructional methods enhance teachers' confidence and willingness to implement pedagogies of teaching in their classrooms (Margot & Kettler, 2019). Therefore, in order to ensure that prospective teachers use pedagogies of best practices in the future, lecturers should ensure that they use clear, coherent and reliable resources. When prospective teachers use these on a daily basis, they will be more inclined to adopt these pedagogies in their future practice.

Additionally, a study conducted by Li et al. (2022) explored how the coherence and perceived pedagogical ease of use of virtual reality technology influence prospective teachers' intentions to integrate it into their teaching. The findings revealed that the more coherent and user-friendly teachers perceived a technology-based pedagogy to be, the more likely they were to use it in the future for teaching. The same can be said for the prospective teachers in this study, i.e., that the more coherent a pedagogy of teaching is perceived to be, the more likely the prospective teachers are to use it in the future for teaching.

6.2.2.3 Why people factors of intention affect future usage of a pedagogy the way they do

The prospective teachers also felt that when they become teachers, the perceptions of their fellow teachers will also play a role in whether or not they use a pedagogy of teaching. The findings revealed that the more positive the perspectives of the prospective teachers were about the views of their peers, the more likely they would be to use the pedagogy in their future teaching. Other research related to this indicates that teachers are more likely to adopt new pedagogical methods when they receive positive feedback and support from their peers (Chang et al., 2021).

Similarly, research on student-centered teaching models, such as the ones used in this study, demonstrated that teachers' professional identities and classroom practices were significantly influenced by supportive and collaborative environments (Keiler, 2018). This notion further strengthens the idea that teachers are more likely to adopt and sustain student-centred approaches when they observe their positive impacts as well as receive encouragement from their peers.

Additionally, in a different study it was shown that teachers who shared positive views about a pedagogy and observed its benefits in practice were more likely to persist in using these methods and to encourage their colleagues to do the same (Rissanen et al., 2021). These findings underscore the importance of positive peer influence and supportive professional communities in the adoption of new teaching practices. This finding further asserts that the views held by fellow teachers impacts their counterparts in deciding whether to use a pedagogy of teaching in the future or not.

Another study on the influence of fellow teachers and experts on teachers' choices, explored a framework for selecting effective pedagogies based on their relevance to educational theories, research evidence of their effectiveness, their contribution to developing 21st century skills, and the effect of these factors on the level of adoption in educational practice (Herodotou et al., 2019). One of the key aspects that was emphasized was the role of evidence, including expert opinions, in determining the level of adoption of a pedagogy. The study found that expert endorsements, when combined with robust evidence from studies, significantly influenced teachers' willingness to adopt new pedagogical methods. The current study found that prospective teachers, similarly, were more likely to integrate pedagogical methods into their future practice when they see strong evidence and hear positive evaluations from recognized experts in the field.

A different but related study on how teachers influence each other in relation to the use of a pedagogy, investigated the transition of educators from traditional teaching methods to technology-integrated learning environments (Hartman et al., 2019). That study showed the importance of self-efficacy and support from mentors and colleagues, who often served as change agents. These mentors, experts and experienced peers, provide reassurance and just-in-time support, helping teachers feel more confident in adopting new technologies and pedagogical approaches (Hartman et al., 2019). The positive influence and support from these experts played a crucial role in overcoming resistance and enhancing teachers' adoption of innovative teaching methods. That study also showed that when teachers receive positive feedback and observe successful implementation by respected colleagues or experts, they are more likely to embrace and persist with these new methods (Hartman et al., 2019). Together, these research studies illustrate the significant impact that positive views and

endorsements from fellow teachers have on encouraging other teachers to adopt new pedagogical methods. These results were also seen in the current study where the prospective teachers tended to agree that they were influenced by their fellow teachers and experts when choosing to use pedagogies of teaching in their future practice. Thus, the prospective teachers perceived that support and validation from fellow teachers, combined with evidence of effectiveness, motivated them to implement and sustain innovative teaching practices in the future (Hartman et al., 2019).

6.3 The best predictors of acceptance and intention on usage behaviour

This Section discusses the best predictors of acceptance and intention on usage behaviour. Section 6.3.1 discusses the best predictors of acceptance on usage behaviour, followed by Section 6.3.2 on the best predictors of intention on usage.

6.3.1 The best predictors of acceptance

The best predictors of acceptance are discussed below, namely, experienced, trust and people factors.

6.3.1.1 Experienced factors

For experienced factors within acceptance, the results of this study showed that, for the prospective teachers, satisfaction with a pedagogy of learning had the most influence on decisions about future use – greater than how hard or difficult it was to learn using that pedagogy. A similar study found that students' learning satisfaction had a significant and direct effect on students' learning effectiveness, which means that the more satisfied students were with a pedagogy of learning (Du et al., 2023), the greater the likelihood of them using the pedagogy in the future for learning purposes. When it came to how hard it was to use a pedagogy, the prospective teachers felt that difficulty of learning had the least effect on determining future usage. In a different study that discussed factors influencing teacher satisfaction with online resources during the Covid-19 pandemic, it was found that teacher satisfaction was influenced by perceived usefulness, ease of use and other factors, which in turn affected their performance and likelihood of continuing to use those online methods (Du et al., 2023). These results suggest that satisfaction with a pedagogy is dependent on how easy it is to use, among other smaller factors that combine to make up satisfaction with a pedagogy. Similarly, prospective teachers in the current study felt that satisfaction

with the pedagogy for learning purposes played a bigger role in determining future use as compared to difficulty of usage.

6.3.1.2 The best predictors of trust factors

When the trust factors of the study were investigated, which included coherence and reliability of a pedagogy for learning purposes, results showed a strong link between them and future usage. However, it was also established that coherence had a stronger influence than reliability. A similar study found that coherence in educational programmes significantly impacted teachers' satisfaction and their willingness to adopt those pedagogical methods, potentially more so than the perceived reliability of the pedagogy for learning outcomes (Hammerness, 2006). Thus, coherence plays a larger role in determining future use of a pedagogy for learning purposes than reliability.

6.3.1.3 The best predictors of people factors

The results also showed that, while both peers and educators might have a strong effect on prospective teachers' choice of pedagogy for future use, this study showed that the prospective teachers were more inclined to be swayed by their lecturers and tutors over their peers. Therefore, they appeared to place greater value on the opinions of lecturers and tutors.

6.3.1.4 The best predictors of acceptance

When comparing all the predictors of acceptance against each other, it was shown that satisfaction and the opinion of lecturers and tutors had a strong bearing on determining future usage of a pedagogy for learning purposes. However, satisfaction with a pedagogy had a more determining effect on future use. Additionally, It was also shown that, when compared together, difficulty in learning, coherence, reliability and peers had a small bearing on future usage.

6.3.2 The best predictors of intention on usage behaviour

6.3.2.1 Anticipated factors of intention

When the prospective teachers considered engagement with a pedagogy, satisfaction and how effective a pedagogy is seen to be, had a greater determining influence than how hard it is to use and its effectiveness. However, satisfaction was shown to have the greatest determining influence on future usage. The difficulty of using a pedagogy for teaching appeared to have the least influence on future usage. In a study discussing

factors influencing teachers' satisfaction with online teaching, findings suggested that perceived ease of use and satisfaction with a pedagogy significantly impact teachers' decisions to use it in the future for teaching purposes. That study indicated that while both ease of use and satisfaction were important, satisfaction played a more crucial role in determining usage, highlighting its influence over the perceived difficulty of the pedagogy (Du et al., 2023).

6.3.2.2 The best predictors of trust factors of intention on usage behaviour

Within the trust factors of intention, it was established that how reliable a pedagogy is perceived as being had a greater influence on usage than coherence. Therefore, reliability had more value among the prospective teachers than coherence. This suggests that reliability is the more significant predictor of usage behaviour than coherence.

6.3.2.3 The best predictors of people factors of intention on usage behaviour

The results for people factors of intention showed that the way the prospective teachers viewed their future students and colleagues was a strong predictor of usage behaviour. However, the prospective teachers showed that they would rely more on the views held by their students than those held by fellow teachers. Thus, the prospective teachers in this study appeared to value the views of their future students above those of future colleagues.

6.3.2.4 Comparison of all the best predictors of intention on usage behaviour

When all of the factors of intention are compared together to ascertain which have the most influence on determining future use of a pedagogy for teaching purposes, it was found that overall engagement, coherence, and the anticipated views of future students and of future colleagues, all predicted usage behaviour. However, the views of future students had the most bearing.

6.4 Perspectives of prospective teachers on the ACT methodology

6.4.1 Perspectives of prospective teachers on the creation pedagogy

The creation pedagogy, which is a key component of Professor Blewett's Activated Classroom Teaching (ACT) methodology, has had outstanding reviews by students and teachers alike praising the approach’s efficacy in experiential learning, producing tangible outcomes, and enhancing the enjoyment of application-oriented learning.

Findings from the current research align well with this existing educational research, underscoring the pedagogical benefits of active learning strategies in the digital age. In this study, three perspectives emerged in relation to the creation pedagogy used. Namely: 1) that the hands-on creation (experiential learning) of coding projects was effective, 2) that creation rendered coding concepts less abstract, thus solidifying understanding (tangible outcomes), and 3) that learning coding through creation made learning more practical and enjoyable. These three perspectives are discussed below.

6.4.1.2 Tangible outcomes

Also, several of the prospective teachers agreed that the creation pedagogy rendered coding concepts less abstract and more concrete, thereby solidifying their understanding. This observation is supported by Cognitive Load Theory, which suggests that tangible, practical applications of theoretical concepts help reduce cognitive load and facilitate learning (Sweller et al., 2011). By translating abstract coding principles into concrete projects, students are able to see the real-world applications and outcomes of their work, which reinforces their comprehension and retention. Similar results were seen in a study conducted by Hattie (2009) where the authors emphasized the importance of visible learning, i.e., when students' awareness of their learning processes and outcomes enhances their academic achievement.

6.4.1.3 Enjoyment of application-oriented learning

The enjoyment derived from application-oriented learning was another recurrent theme among prospective teachers. This perspective is supported by the Self-Determination Theory (Deci & Ryan, 2000), which posits that intrinsic motivation, driven by interest and enjoyment, plays a crucial role in effective learning. The creation pedagogy's focus on practical application not only makes learning more engaging but also helps students develop a positive attitude towards the subject matter. A study by Isen and Reeve (2005) found that positive affection and enjoyment significantly enhance students' intrinsic motivation and overall academic performance. Moreover, the integration of enjoyable, practical tasks has a potential to foster a deeper connection to the learning material, as highlighted by Jenkins (2015) in his exploration of playful learning environments.

Therefore, it can be concluded that participant feedback on the creation pedagogy within the ACT methodology highlighted the pedagogy's alignment with established educational theories and research findings. The hands-on, experiential nature of the pedagogy facilitated a deeper understanding and retention of coding concepts, while the tangible outcomes and enjoyment associated with the practical application enhanced students' intrinsic motivation and engagement. These insights affirm the efficacy of the creation pedagogy in fostering a dynamic and effective learning environment in the digital age.

6.4.2 Conversation pedagogy and student perceptions

The conversation pedagogy, another essential component of Professor Blewett's Activated Classroom Teaching (ACT) methodology, was positively received by the participants, highlighting its benefits in collaborative learning and shared problem solving. These insights are corroborated by extensive research in educational theory and practice, demonstrating the value of dialogue and interaction in enhancing the learning process.

6.4.1.1 Experiential learning

In this study, the students emphasized the effectiveness of the hands-on creation of coding projects, highlighting the importance of experiential learning. This approach aligns with Kolb's Experiential Learning Theory, which posits that knowledge is constructed through transformative experiences (Kolb, 1984). The hands-on aspect of the creation pedagogy allows students to engage directly with the material, fostering deeper understanding and the retention of coding concepts. Research indicates that the active engagement in learning activities significantly enhances students' grasp of complex subjects (Prince, 2004). In addition, Freeman et al. (2014) found that active learning strategies, including project-based learning, lead to improved performance in STEM fields. Therefore, the creation pedagogy's hand-on approach enabled the prospective teachers to achieve a better understanding of coding concepts quickly.

6.4.2.1 Collaborative learning

Students noted that the conversation pedagogy enriches the learning experience by broadening their understanding and facilitating the exchange of ideas. This perspective aligns with Vygotsky's Social Development Theory, which emphasizes the importance of social interaction in cognitive development (Vygotsky, 1978). Collaborative

learning, as fostered by conversation pedagogy, allows students to articulate their thoughts, question assumptions, and build upon each other's ideas, leading to a deeper and more comprehensive understanding of coding concepts. Research by Johnson and Johnson (2009) supports this view, indicating that cooperative learning environments promote higher achievement, greater retention, and more positive attitudes towards learning. Additionally, Gokhale (1995) found that collaborative learning enhances critical thinking skills, as students must analyse, synthesize, and evaluate information collectively.

6.4.2.2 Shared problem solving

The second perspective from students highlighted that conversation pedagogy facilitates shared problem solving, which enhances their understanding and helps them grasp coding concepts more easily. This approach resonates with constructivist theories of learning, particularly the idea that knowledge is constructed through interaction and collaboration (Piaget, 1954; Bruner, 1996). Shared problem solving in a conversational context encourages students to engage in joint inquiry, negotiate meaning, and co-construct solutions, making complex concepts more accessible. Research by Webb (2009) has indicated that collaborative problem solving leads to improved learning outcomes as students benefit from diverse perspectives and collective reasoning. Furthermore, Hmelo-Silver (2004) noted that problem-based learning environments, which often involve collaborative dialogue, help students develop deeper understanding and transferable problem-solving skills.

The positive feedback from students regarding conversation pedagogy within the ACT methodology underscored its effectiveness in fostering collaborative learning and shared problem-solving environments. These findings are consistent with established educational theories and research, which highlight the critical role of social interaction and dialogue in enhancing cognitive development and learning outcomes. By integrating conversational elements into the learning process, educators can create dynamic and interactive environments that support deeper understanding and deeper engagement with the subject matter.

6.4.3 Curation pedagogy and student perceptions

Curation pedagogy, a core element of Professor Blewett's Activated Classroom Teaching (ACT) methodology, also received favourable responses from participants in this study, particularly in terms of efficient planning and centralized resources. These aspects are critical in enhancing the coding learning process and are well-supported by educational research.

6.4.3.1 Efficient planning

Students appreciated the emphasis on prior planning and organization that curation pedagogy promotes. They noted that this approach helped them save time and reduce mistakes during the actual coding process. This observation is consistent with the principles of Cognitive Load Theory, which suggests that well-structured learning environments can alleviate the cognitive burden on learners, thereby enhancing their efficiency and effectiveness (Sweller et al., 2011). By organising and planning their coding tasks in advance, students can streamline their workflow, leading to more efficient problem solving and reduced error rates. Research by Clark and Mayer (2011) highlighted the importance of structured instructional design in improving learning outcomes, emphasizing that pre-organised content can significantly enhance learner performance.

Furthermore, the importance of planning in coding is echoed by research in computer science education, which suggests that pre-planning activities, such as pseudocode and flowchart creation, can lead to more successful coding outcomes (Winslow, 1996). These activities enable students to conceptualize and outline their coding tasks before implementation, reducing the likelihood of errors and facilitating a smoother coding process.

6.4.3.2 Centralized resources

The participants also commended the centralization of resources, which allowed them to effectively gather various blocks of code from different Sections. This method, that involves the curating of only the necessary blocks of code, aligns with the principles of resource-based learning, which advocates for the strategic selection and organization of learning materials to support specific learning objectives (Hill & Hannafin, 2001). Centralizing resources helps students to quickly access the

information they need, reducing the time spent searching for relevant materials and allowing more time for actual coding and problem solving.

The benefits of resource centralization are supported by studies on the use of repositories and libraries in coding education. For example, Krutz and Vasa (2014) found that access to well-organised code repositories can significantly enhance the learning process by providing students with ready-made solutions and examples that they can adapt and integrate into their projects. This approach not only aids in understanding coding concepts but also promotes the efficient use of time and resources.

The positive feedback received from participants regarding the curation pedagogy within the ACT methodology highlighted its effectiveness in promoting efficient planning and resource centralization. These findings are supported by educational research, which underscores the importance of structured learning environments and strategic resource management in enhancing learning outcomes. By integrating curation strategies into the learning process, educators can help students optimize their coding activities, leading to more efficient and effective learning experiences.

6.4.4 Correction pedagogy and student perceptions

Correction pedagogy is also an integral part of Professor Blewett's Activated Classroom Teaching (ACT) methodology, and was positively received by participants, particularly regarding error awareness and the feedback loop. These insights are well-supported by educational research, demonstrating the effectiveness of corrective feedback in learning processes.

6.4.4.1 Error awareness

Participants perceived the correction pedagogy as crucial in helping them to recognize errors and to avoid repeating them. This perspective aligns with the theories of formative assessment, which emphasize the importance of error detection and correction in learning (Black & Wiliam, 1998). By identifying errors, students engage in metacognitive processes, becoming more aware of their learning, and understanding where they need improvement. Research by Hattie and Timperley (2007) highlighted that feedback, particularly when it addresses specific errors, can significantly enhance

learning outcomes by promoting self-regulation and adaptive learning strategies. Additionally, studies in computer science education suggest that the ability to recognize and correct errors is fundamental to developing coding proficiency (Lahtinen et al., 2005).

The process of recognizing errors also relates to the concept of deliberate practice, where learners focus on specific areas of improvement through targeted feedback and correction (Ericsson et al., 1993). This approach has been shown to be highly effective in skill acquisition and mastery, particularly in fields that require precision and accuracy, such as coding.

6.4.4.2 Feedback loop

A widely shared perspective among the participants was their appreciation of the feedback inherent in the correction pedagogy. Effective feedback loops are critical in the learning process, as they provide students with timely and specific information about their performance, guiding them towards improvement (Shute, 2008). Feedback helps bridge the gap between current performance and desired outcomes, allowing students to adjust their strategies and approaches accordingly.

Research supports the notion that feedback, particularly when it is clear, constructive and actionable, can significantly enhance learning and performance (Kluger & DeNisi, 1996). In the context of coding education, immediate and specific feedback helps students understand their mistakes and learn the correct approaches, thereby reinforcing learning and improving coding skills (Denny et al., 2008). The iterative process of receiving feedback, making corrections and receiving further feedback, fosters a deep and sustained learning experience, promoting long-term retention and the application of knowledge.

The positive feedback received from students regarding the correction pedagogy within the ACT methodology underscored its effectiveness in promoting error awareness and providing valuable feedback loops. These findings are consistent with established educational theories and research that highlight the critical role of error recognition and corrective feedback in enhancing learning outcomes. By integrating correction strategies into the learning process, educators can support students in

developing self-regulation, improving their skills, and achieving higher levels of proficiency.

6.4.5 Chaos pedagogy and student perceptions

The chaos pedagogy, a component of the ACT methodology, received mixed reactions from participants. While some students found the approach unappealing and disruptive, others appreciated the freedom to experiment and explore. These varied perspectives highlighted the complex nature of this pedagogy and its impact on the learning process.

6.4.5.1 Unappealing learning

Many students described the chaos pedagogy as unappealing, disorganised and overwhelming. This reaction is consistent with research on Cognitive Load Theory, which suggests that excessive disorganization and lack of structure can overwhelm learners, leading to increased cognitive load and reduced learning efficiency (Sweller et al., 2011). When students are faced with chaotic learning environments, they may struggle to process and integrate new information effectively. This can result in frustration and disengagement, as noted by Kirschner et al. (2006), who argue that minimally guided instruction can be less effective for novice learners.

6.4.5.2 Disrupts learning

Another common perspective among participants was that chaos pedagogy disrupted their learning. This disruption could be attributed to the lack of clear guidance and structure, which are essential for effective learning, especially in complex subjects like coding. Research by Mayer (2004) supports the notion that guided learning approaches, where students receive appropriate scaffolding and support, are more effective than unguided methods. The disruptive nature of the chaos pedagogy may hinder students' ability to develop a coherent understanding of coding concepts, as they struggle to make sense of the information on their own.

6.4.5.3 Chaos pedagogy for testing

Several participants perceived the chaos pedagogy as more appropriate for assessment than for teaching. They felt that it tested their skills prematurely, rather than providing the necessary instruction to build those skills. This perception aligns with the concept of formative assessment, which is intended to support learning by providing feedback

and guidance, rather than simply evaluating performance (Black & Wiliam, 1998). The premature assessment aspect of the chaos pedagogy could leave students feeling unprepared and unsupported, as they are not given adequate opportunities to learn and practice before being assessed.

6.4.5.4 Experimental learning

Despite the general negative feedback, one student appreciated the experimental nature of chaos pedagogy. This student valued the freedom to experiment and explore different blocks of code, which aligns with the principles of Experiential Learning Theory (Kolb, 1984). Experiential learning emphasizes the importance of hands-on, exploratory activities that allow learners to construct knowledge through direct experience. This approach can foster creativity, problem-solving skills, and a deeper understanding of coding concepts through trial and error.

The mixed feedback on chaos pedagogy within the ACT methodology reflects the complexities and challenges of implementing such an approach in a coding education context. While the unstructured nature of the chaos pedagogy may overwhelm and disrupt the learning process for many students, it also offers opportunities for experiential learning and exploration for others. These findings highlight the need for a balanced approach that incorporates elements of structure and guidance while allowing for experimentation and creativity.

Overall, the students showed positive perspectives with regards to the ACT methodology, which touches at the heart of the use of technology and the affinity that the new prospective teacher had with technology. This affinity translates to easy acquaintance with the technology and the pedagogy being used because this is how the new prospective teacher now learns and teaches.

6.5 Conclusion

This chapter has examined the factors influencing prospective teachers' acceptance and intention regarding the future use of the Activated Classroom Teaching (ACT) methodology. In doing so it addressed the fourth research question: "Why do acceptance and intention affect usage behavior the way they do?" alongside other findings integral to the study. The results revealed that satisfaction, trust, and social

influence are pivotal in shaping acceptance and intention, with satisfaction emerging as the most significant predictor.

The findings emphasize the importance of coherent, reliable, and engaging pedagogical approaches that foster positive perceptions and intrinsic motivation among prospective teachers. Participants highlighted the strengths of the ACT methodology, particularly the creation, conversation, and correction pedagogies, which were widely appreciated for enhancing experiential learning, promoting collaboration, and providing constructive feedback. However, the mixed reactions to the chaos pedagogy underscore the need for a balanced approach that combines structure with opportunities for exploration. This suggests that refinements are necessary to ensure the pedagogy better supports diverse learners.

Overall, this chapter demonstrates that prospective teachers are more likely to adopt pedagogies they perceive as satisfying, effective, and supported by their peers, educators, and broader learning communities. These insights lay a valuable foundation for refining and promoting innovative teaching methodologies that address the evolving needs of educators and students in the digital age.

CHAPTER 7: CONCLUSION

7.1 Introduction

This study explored how acceptance and intention impact the future usage of the ACT methodology, providing insights into how different factors influence prospective teachers' likelihood of adopting and sustaining new pedagogical practices. The views of prospective teachers about the ACT methodology as a pedagogy of teaching and learning were also explored. The findings revealed nuanced understandings of the factors influencing both acceptance and intention, which are crucial for shaping future educational practices. In Section 7.2 below, the predictors for future use of a pedagogy are discussed, followed by the prospective teachers' perspectives on the ACT methodology in Section 7.3. The limitations, recommendations for future research, and recommendations for results of study are discussed in Sections 7.4, 7.5, and 7.6 respectively. Thereafter, the chapter is concluded in Section 7.7.

7.2 Predictors of future use of a pedagogy

The results obtained from this study emphasize that acceptance factors, particularly satisfaction with the pedagogy, play a significant role in determining future usage of a pedagogy. Prospective teachers who reported high levels of satisfaction with the pedagogy, measured through enjoyment and effectiveness, had a high likelihood of using the pedagogy in the future for their own learning. This finding is supported by other published research, which underscores the importance of enjoyment and perceived effectiveness in enhancing engagement and retention of pedagogical methods. During the times when the prospective teachers enjoyed the pedagogy and found it effective, it was observed that their performance in assessment improved, demonstrating the pedagogy's efficacy. However, the perceived difficulty of using the pedagogy negatively influenced its future use, supporting the notion that ease of use is a critical factor for the adoption of pedagogies, especially those that are heavily reliant on the use of technology.

Further, the results shown that trust factors, that consist of coherence and reliability, have an influence on acceptance of a pedagogy for learning purposes. It was found that the prospective teachers showed a preference for pedagogies that they perceived as coherent and sense making. This finding is in keeping with past research that has shown that pedagogies that make sense and are well-structured are more likely to be adopted and used again in the future, as opposed to pedagogies that are not seen as

such. Additionally, while both coherence and reliability are important, coherence had a slightly stronger impact on future use than reliability, suggesting that how well the pedagogy integrates into prospectives teachers' learning processes is crucial in determining their future use of the pedagogy.

The influence of peers and lecturers on acceptance for learning purposes was also significant. Positive social influences and strong support from lecturers enhanced the likelihood of adopting the pedagogy in the future. This result reinforces the importance of a supportive educational community that consists of peers, and the role of lecturers, in shaping prospective teachers' attitudes towards new pedagogical methods and their future use for learning.

On the other hand, factors affecting intention to use a pedagogy in the future were equally telling. Prospective teachers who were satisfied with the pedagogy and perceived it as effective had a high likelihood of future usage. Satisfaction and perceived effectiveness emerged as strong predictors of future usage, with satisfaction being the most influential factor for teaching purposes. These findings highlight that the perceived benefits of a pedagogy significantly impact prospective teachers' willingness to continue using it for teaching purposes.

The perceived ease of use of a pedagogy for teaching also played a role, but its impact was less pronounced compared to satisfaction and effectiveness. Similar results were also found in research conducted by Du et al. (2023). Their results emphasized that, while ease of use was important, its effect on intention to use a pedagogy for teaching purposes in the future appeared less important than satisfaction.

Moreover, while the trust factors, coherence and reliability, were also important predictors of intention – reliability slightly outweighing coherence as a predictor of future usage. This suggests that the prospective teachers valued pedagogies that were dependable and well-structured, but that reliability was a slightly more critical factor than coherence.

Lastly, the influence of other factors, particularly the prospective teachers' future students, on intention was significant. The prospective teachers placed considerable

weight on how they perceived their future students' views on the pedagogy, which affected their likelihood of future usage. The results showed that the prospective teachers would prioritise the views and perspectives of their students over what experts said about a particular pedagogy. Therefore, the more positive the future students' views were perceived to be, the greater the likelihood of prospective teachers' future usage. This underscores the importance of considering student feedback and perspectives when evaluating the potential success of pedagogical methods.

Overall, the results suggest that both acceptance and intention are multifaceted constructs influenced by various factors. Satisfaction with the pedagogy, its perceived effectiveness, and the support of peers and lecturers emerged as key determinants of future usage, whether for learning or teaching purposes. Trust in the pedagogy's coherence and reliability, along with positive social influences, further shaped prospective teachers' likelihood of adopting and maintaining new pedagogical practices. These insights provide valuable guidance for educators and policymakers for developing and implementing effective teaching-and-learning methodologies that are likely to be embraced and sustained in the future.

7.3 Perspectives of prospective teachers

The results of this study also provided a comprehensive analysis of the perspectives of prospective teachers on the ACT methodology, revealing nuanced insights into its effectiveness and areas for improvement as a pedagogy of teaching and learning. The findings underscore the strengths and challenges associated with each component of the methodology, offering valuable implications for the design and implementation of pedagogical strategies in the digital age.

The creation pedagogy, which is the cornerstone of the ACT methodology, was positively received by the prospective teachers. Its hands-on, experiential learning approach aligns well with Kolb's Experiential Learning Theory, which emphasizes the importance of active engagement in knowledge construction. The prospective teachers appreciated the practical application of coding concepts, which not only enhanced their understanding, but also made learning more enjoyable and intrinsically motivating. The tangible outcomes and enjoyment derived from this pedagogy support established

educational theories, highlighting its efficacy in fostering a dynamic and effective learning environment.

The conversation pedagogy was also well-regarded by the prospective teachers, and it played a role in promoting collaborative learning and shared problem solving. This aligns with Vygotsky's Social Development Theory, which underscores the significance of social interaction in cognitive development. The pedagogy's emphasis on dialogue and collaborative problem solving enriched the learning experience, leading to deeper understanding and enhanced critical thinking skills. The positive feedback from the prospective teachers regarding this pedagogy confirmed its effectiveness in creating interactive and supportive learning environments.

The curation pedagogy has been praised for its focus on efficient planning and centralized resources. The prospective teachers recognized the benefits of structured planning and organised resources in streamlining the coding process and reducing errors. This perspective is supported by Cognitive Load Theory and other research in computer science education (Berssanette & de Francisco, 2022.; Sandoval-Medina, 2024), which highlight the importance of well-organised instructional design and resource management in improving learning outcomes. The curation pedagogy's ability to facilitate efficient learning aligns with these principles, making it a valuable component of the ACT methodology.

In contrast, the chaos pedagogy received mixed reactions. While some prospective teachers valued the experimental freedom it offered, many found it disorganised and disruptive to their learning process. The negative feedback aligns with research on Cognitive Load Theory, which suggests that excessive disorganization can hinder learning. The perception of chaos pedagogy as a tool for assessment rather than instruction also reflects concerns about its effectiveness in providing adequate guidance. However, the appreciation shown by participants for its experimental aspects highlights the potential for fostering creativity and problem-solving skills through exploratory learning.

Overall, the study revealed that, while the ACT methodology was generally well-received, each pedagogical component had both strengths and areas for improvement.

The positive feedback received on creation, conversation and curation pedagogies indicates their effectiveness in enhancing learning experiences through active engagement, collaboration and structured planning. In contrast, the mixed responses to chaos pedagogy suggest the need for a balanced approach that integrates structure with opportunities for experimentation. These insights provide valuable guidance for educators and policymakers for refining and implementing pedagogical methods. By addressing the challenges associated with chaos pedagogy; while leveraging the strengths of the other pedagogies, the ACT methodology can continue to evolve and adapt to the needs of prospective teachers, ultimately contributing to more effective and engaging learning environments in the digital era.

7.4 Limitations

In conducting this study, several limitations were encountered that could have affected the scope and interpretation of the results. One significant limitation lies in the chosen methodology, specifically the use of focus groups and questionnaires, rather than one-on-one interviews. While these methods allowed for the efficient gathering of data from a larger number of participants, they may have constrained the depth of the responses. Focus groups, in particular, can sometimes lead to groupthink, where individual voices are overshadowed by the collective, and questionnaires may not provide the nuance that in-depth, personal interviews could have captured.

A further limitation relates to the study's emphasis on quantitative rather than qualitative research objectives. This choice led to the consideration of fewer prospective teachers' perspectives and placed more weight on the expectations of the researcher. As a result, the data collected may lack the richness and depth that qualitative research methods, such as one-on-one interviews or open-ended survey responses, could have provided. Had more attention been paid to gathering and analysing student viewpoints, the study might have offered more detailed insights into their experiences and perspectives, potentially leading to different conclusions.

Moreover, the study focused on third-year students who were not majoring in computer science, which raises questions about the potential impact of this choice on the findings. It remains unclear how the results might have differed if data had been collected from third-year computer science students, or from students in other fields

of study where they could have been taught their majors using the ACT methodology. Thus, the decision to exclude other majors limits the scope of the research, reducing the potential for broader applicability across different academic disciplines.

The research was also conducted exclusively with prospective teachers from the University of KwaZulu-Natal (UKZN), which further limits the generalizability of the results. It is unclear whether the findings could be applied to institutions outside of KwaZulu-Natal, or in different geographical or educational contexts. Additionally, as none of the prospective teachers were computer science majors, it is again worth questioning whether similar results would have been obtained if the study had included prospective teachers specializing in computer science, or had the study been conducted on students doing other majors.

Finally, many prospective teachers expressed that the questions posed in the questionnaire were difficult to understand, which may have compromised the quality of some of their responses. Additionally, the complexity of the questions likely contributed to students' reluctance to participate in the focus groups. In hindsight, one-on-one interviews might have been a more effective method for gathering additional data which would have provided some in-depth analysis and more accurate and thoughtful responses.

7.5 Recommendations for future research

Based on the limitations encountered in this study, several recommendations can be made for future research to address these challenges and enhance the validity and generalizability of the findings. First, future research should consider employing a combination of data collection methods that includes one-on-one interviews together with focus-group interviews and questionnaires. While focus groups can generate rich, dynamic discussions, and questionnaires allow for data collection from a large number of participants, one-on-one interviews could provide deeper insights into individual experiences and perspectives. Interviews would allow participants to articulate their thoughts in a more personal and reflective manner, minimizing the risk of groupthink and potentially revealing nuances that might be overlooked in group settings.

Additionally, to address the issue of focus-group participation, future studies should take steps to ensure a more representative sample in focus-group discussions. Researchers could employ strategies to increase focus-group participation, such as offering incentives, simplifying the research questions, or providing more flexible scheduling options. Additionally, researchers should aim to align the size of focus groups more closely with the larger survey population to improve the reliability and validity of the focus-group data.

With regards to research design, a more balanced approach that incorporates both quantitative and qualitative research objectives is recommended. While quantitative data allows for generalizations and statistical analysis, qualitative research is essential for capturing the richness of participants' lived experiences. Future studies should strive to give greater weight to qualitative data, ensuring that the voices of prospective teachers are more prominently featured and that their perspectives are fully explored. By doing so, researchers can gain a more comprehensive understanding of the phenomena under study, providing a more holistic view of the research topic.

Expanding the sample population is another critical recommendation. This study focused exclusively on third-year students who were not computer science majors, and who did only one computer science related course, which limits the generalizability of the findings to other disciplines. Future research should include students from various academic backgrounds, including computer science and other fields of study, to explore how different subject areas may influence the outcomes. A wider range of prospective teachers would not only broaden the scope of the study, but also enhance its applicability across different academic settings.

Furthermore, future research should consider collecting data from multiple institutions. A more geographically and institutionally diverse sample would allow researchers to assess whether the findings are replicable in different educational environments and regions. By expanding the study beyond a single institution, future research could determine whether the results hold across a wider range of educational contexts, providing a more generalizable understanding of the research topic.

To ensure the consistent and effective implementation of the ACT methodology, it is recommended to provide comprehensive training and ongoing support for lecturers and tutors who will deliver these pedagogies. This could include professional development workshops, instructional guides, and peer-mentoring programmes. Ensuring instructors are well-versed in the methodology will help maintain the quality and fidelity of its implementation across different educational settings.

To better understand the impact of each pedagogical approach within the ACT methodology, future research could conduct controlled experimental studies. These studies would involve randomly assigning participants to different pedagogical interventions and comparing their learning outcomes. This would help isolate the effects of each pedagogy and provide stronger evidence of their relative effectiveness.

In addition to focusing on prospective teachers' perceptions and experiences only, future studies should evaluate the impact of the ACT methodology on student learning outcomes. This could involve tracking student performance, engagement and motivation over time to determine whether the pedagogies positively influence students' educational experiences or not. By addressing all of these recommendations, future research will be better equipped to overcome the challenges encountered in this study and produce findings that are more reliable, valid and generalizable across different educational settings and populations.

7.6 Recommendations for results of study

This study has provided significant insights into the factors that influence prospective teachers' acceptance and intention to use the ACT methodology. These findings have important implications for educators, policymakers, and designers of pedagogical frameworks, offering a pathway for enhancing the adoption, effectiveness, and sustainability of this approach.

One of the most compelling findings of this study is the crucial role that satisfaction and perceived effectiveness play in determining whether prospective teachers will continue using a pedagogy in the future. Given that enjoyment and a clear sense of learning benefits are strong predictors of acceptance, it is essential that teacher training programs actively integrate pedagogies that foster engagement while demonstrating

tangible educational outcomes. Training modules should be designed to highlight the practical applications of the ACT methodology, ensuring that prospective teachers can see its relevance and effectiveness in real-world teaching and learning scenarios.

Beyond individual experience, the study also underscores the influence of social and institutional support in shaping pedagogical acceptance. The encouragement and reinforcement provided by lecturers and peers were shown to be key factors in determining whether prospective teachers would adopt and continue using the methodology. Therefore, institutions should work towards fostering a collaborative learning environment where lecturers actively promote innovative pedagogies, not just as theoretical concepts but as effective teaching tools. Furthermore, mentorship programs could serve as a valuable means of supporting new educators in their adoption of the ACT methodology, helping them navigate challenges and build confidence in their teaching practices.

An additional finding that carries significant implications is the weight that prospective teachers place on the perspectives of their future students when deciding whether to use a particular pedagogy. This suggests that curriculum designers and educators must take student feedback into account when refining pedagogical methods. Encouraging reflective teaching practices that integrate student perspectives will not only help educators adjust their methodologies but will also create more inclusive and student-centered learning environments. If prospective teachers perceive that their students respond positively to the ACT methodology, they will be more likely to adopt and sustain it in their classrooms.

The study further reveals that coherence and reliability are central to the acceptance of a pedagogy, with coherence emerging as slightly more influential. To ensure that the ACT methodology is widely adopted, its design must emphasize logical integration into existing curricula. Clear, well-structured lesson plans and instructional materials should be developed to provide prospective teachers with a sense of cohesion when implementing this approach. While reliability remains an important factor, ensuring a consistent learning experience, coherence is particularly crucial in making pedagogical methods feel intuitive and effective. The stronger the alignment between the ACT

methodology and the prospective teachers' expectations of structured learning, the greater the likelihood of its continued use.

A critical aspect of this study is the evaluation of each individual pedagogy within the ACT methodology. Based on the findings, specific recommendations can be made for improving each pedagogical component:

7.6.1 Curation pedagogy

The curation pedagogy was highly valued for its ability to streamline learning by organizing and structuring knowledge resources effectively. However, for curation to be more impactful, it is recommended that educators emphasize the development of skills in selecting, categorizing, and synthesizing information. Training programs should incorporate strategies for efficient digital curation, ensuring that prospective teachers can manage and present information in a way that reduces cognitive overload. Additionally, the integration of collaborative curation tools, such as shared repositories and digital resource platforms, can enhance the effectiveness of this pedagogy by allowing for peer-to-peer knowledge exchange.

7.6.2 Conversation pedagogy

Conversation pedagogy was one of the most well-received components of the ACT methodology, as it fosters collaborative learning and encourages knowledge-sharing among students. To enhance its effectiveness, educators should be trained to facilitate meaningful discussions that promote critical thinking and engagement. Incorporating structured discussion techniques, such as Socratic questioning or guided debates, can provide a framework for deeper learning. Furthermore, digital tools such as discussion forums, and peer review platforms should be utilized to extend conversational learning beyond the classroom. These approaches will ensure that conversation pedagogy remains a central and effective component of the learning experience.

7.6.3 Correction pedagogy

Correction pedagogy, which focuses on iterative learning and refinement of knowledge, requires a structured approach to be most effective. The study suggests that while prospective teachers recognize the value of correction, they may benefit from clearer feedback mechanisms that guide them toward improvement. Educators

should be encouraged to provide timely, constructive feedback that not only highlights errors but also offers actionable steps for correction. Additionally, integrating automated assessment tools can support continuous learning by providing instant and personalized guidance. By reinforcing a growth mindset, correction pedagogy can help prospective teachers develop resilience and adaptability in their learning process.

7.6.4 Creation pedagogy

As a cornerstone of the ACT methodology, creation pedagogy was found to be particularly effective in promoting hands-on, experiential learning. To maximize its impact, educators should encourage students to engage in project-based learning where they apply theoretical concepts to real-world scenarios. Providing opportunities for open-ended exploration and innovation will help students develop critical problem-solving skills. Furthermore, integrating collaborative creation experiences, such as group projects and interdisciplinary work, can further enhance the learning process. The use of digital tools, coding platforms, and interactive media should also be promoted to support creativity and experimentation within this pedagogy.

7.6.5 Chaos pedagogy

Among all the pedagogical components, chaos pedagogy received the most mixed reactions. While some prospective teachers appreciated the freedom and experimentation it allowed, others found it disorganized and difficult to navigate. This highlights the need for a more structured approach to managing chaos pedagogy. One way to address this challenge is by introducing adaptive scaffolding techniques, where students are given different levels of guidance based on their proficiency and confidence levels. Educators should also be trained to manage chaos effectively, ensuring that while students are encouraged to explore and experiment, they are not left without a clear learning trajectory. Providing checkpoints, structured reflection exercises, and goal-oriented challenges can help maintain a balance between structure and exploration, making chaos pedagogy a more effective and inclusive learning tool.

Future research should continue to build on these findings by exploring the long-term impact of the ACT methodology on teaching practices. Longitudinal studies tracking how prospective teachers implement the methodology once they enter the profession could provide valuable insights into its sustainability. Furthermore, as technology

continues to advance, there is an opportunity to examine how emerging tools such as virtual reality, and adaptive learning technologies could enhance the ACT methodology, making it more engaging and personalized. Additionally, since education is shaped by cultural and contextual factors, further studies should investigate how different institutional and national contexts influence the acceptance of pedagogical methods. Comparative research across diverse educational settings could inform adaptations of the ACT methodology to ensure its relevance across various learning environments.

Overall, the findings of this study offer a strong foundation for enhancing pedagogical practices through the ACT methodology. By prioritizing satisfaction and effectiveness, fostering supportive learning communities, considering student perspectives, refining pedagogical coherence, and leveraging technology to enhance both structured and experimental learning, educators and policymakers can ensure that this methodology continues to evolve and meet the needs of future generations of teachers and students alike.

7.7 Conclusion

This chapter has drawn together the findings and insights from the study, which explored the factors influencing the acceptance and intention of prospective teachers to adopt the ACT methodology. The predictors of future use of a pedagogy, as well as the nuanced perspectives of prospective teachers, were discussed in detail. Limitations and recommendations were also outlined, offering critical reflections and directions for future research.

Key findings revealed that satisfaction and perceived effectiveness are pivotal in shaping both acceptance and intention for future use of pedagogies. These factors not only enhance the likelihood of adoption but also foster improved learning outcomes and engagement among prospective teachers. While trust factors, such as coherence and reliability, further contributed to acceptance, the significance of social influences, including peer and lecturer support, underscored the collaborative nature of effective learning environments.

The study also highlighted the varying impacts of the ACT methodology's five pedagogies—creation, conversation, curation, correction and chaos pedagogies. The first four were widely regarded as effective, aligning with established educational theories and contributing positively to learning experiences. However, the chaos pedagogy elicited mixed reactions, pointing to the need for careful implementation and balance between structure and freedom to ensure it supports rather than hinders learning.

Despite its contributions, the study faced notable limitations, including methodological constraints and a narrow participant scope. Recommendations were provided to address these issues, emphasizing the need for diverse, representative samples, and more comprehensive research designs that integrate both qualitative and quantitative approaches.

Ultimately, the findings of this study provide valuable insights for educators, policymakers, and researchers. By addressing the identified challenges and leveraging the strengths of the ACT methodology, it is possible to refine pedagogical practices that not only meet the needs of prospective teachers but also adapt to the evolving demands of education in the digital era. Through ongoing research and practical applications, the ACT methodology has the potential to foster dynamic, engaging, and effective learning environments for future generations of teachers and learners.

REFERENCE LIST

AbdulRab, H. M. A. (2023). Teacher professional development in the 21st century. *African Journal of Education and Practice*, *9*(4), 39-50. https://doi.org/10.47604/ajep.2237

Acosta, Y., Alsina, A. & Pincheira, N. (2023). Computational thinking and repetition patterns in early childhood education: Longitudinal analysis of representation and justification. *Education and Information Technologies*, *29*, 7633-7658. https://doi.org/10.1007/s10639-023-12051-6

Adeoye, B. F. & Ojo, B. Y. (2014). Pre-service teachers' perceived Technological Pedagogical Content Knowledge at selected colleges of education in Lagos State, Nigeria. *Africa Higher Education Review*, *8*(2), 4-16. https://eric.ed.gov/?id=EJ1072738

Adom, D., Hussein, E. K. & Agyem, J. A. (2018). Theoretical and conceptual framework: Mandatory ingredients of a quality research. *International Journal of Scientific Research*, *7*(1), 438-441. https://doi.org/10.36106/IJSR

Aivaloglou, E. & Hermans, F. (2016). How kids code and how we know: An exploratory study on the Scratch repository. In *ICER 2016: Proceedings of the 2016 ACM Conference on International Computing Education Research* (pp. 132-137). Association for Computing Machinery, Inc

Ajzen, I. (1991). The theory of planned behavior. *Organisational Behavior and Human Decision Processes*, *50*(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Akbulut, M. S. & Hill J. R. (2020). Case-based pedagogy for teacher education: An instructional model. *Contemporary Educational Technology*, *12*(2), 1-17. https://doi.org/10.30935/cedtech/8937

Akinnagbe, O. M. & Baiyeri, P. (2011). Training needs analysis of lecturers for information and communication technology (ICT) skills enhancement in Faculty of Agriculture, University of Nigeria, Nsukka. *African Journal of Agricultural Research*, *6*(32), 6635–6646.

Akl, S. G. (1997). *Parallel computation: Models and methods*. Prentice Hall.

Akram, H., Abdelrady, A. H., Al-Adwan, A. S. & Ramzan, M. (2022). Teachers' perceptions of technology integration in teaching-learning practices: A systematic review. *Frontiers in Psychology*, *13*, 1-9. https://doi.org/10.3389/fpsyg.2022.920317

Akturk, A. O., Izei, K., Caliskan, G. & Sahin, I. (2015). Analyzing preservice teachers' attitudes towards technology. *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, *9*(12), 3960-3966.

Aldoobie, N. (2015). ADDIE model. *American International Journal of Contemporary Research*, *5*(6), 68-72. http://aijcrnet.com/journals/Vol_5_No_6_December_2015/10.pdf

Anggraini, P. A. D. & Putra, S. (2021). Developing learning video with ADDIE model on science class for 4th grade elementary school students. In *Proceedings of the 2nd International Conference on Technology and Educational Science (ICTES 2020)*. Atlantis Press. https://doi.org/10.2991/assehr.k.210407.273

Apuke, O. D. (2017). Quantitative research methods: A synopsis approach. *Arabian Journal of Business and Management Review*, *6*(10), 40-47. https://doi.org/10.12816/0040336

Avacheva, T. & Prutzkow, A. (2020). The evolution of imperative programming paradigms as a search for new ways to reduce code duplication. *IOP Conference Series: Materials Science and Engineering*, *714*(1), 012001. https://doi.org/10.1088/1757-899X/714/1/012001

Baptista, G. & Oliveira, T. (2015). Understanding mobile banking: The unified theory of acceptance and use of technology combined with cultural moderators. *Computers in Human Behaviors, 50*, 418-430. https://doi.org/10.1016/j.chb.2015.04.024

Basar, Z. M., Mansor, A. N., Jamaludin, K. A. & Alias, B. S. (2021). The effectiveness and challenges of online learning for secondary school students: A case study. *Asian Journal of University Education*, *17*(3), 14514. https://doi.org/10.24191/ajue.v17i3.14514

Basilotta-Gómez-Pablos, V., Matarranz, M., Casado-Aranda L. & Otto, A. (2022). Teachers' digital competencies in higher education: A systematic literature review. *International Journal of Educational Technology in Higher Education*, *19*, 8. https://doi.org/10.1186/s41239-021-00312-8

Belmar, H. (2022). Review on the teaching of programming and computational thinking in the world. *Frontiers in Computer Science*, 4, 997222. https://doi.org/10.3389/fcomp.2022.997222

Berssanette, J. H., & de Francisco, A. C. (2022). Cognitive load theory in the context of teaching and learning computer programming: A systematic literature review. *IEEE Transactions on Education, 65*(3), 440–449. https://doi.org/10.1109/TE.2022.3153347

Bhattacherjee, A. (2012). *Social science research: Principles, methods, and practices* (2nd ed.). University of Southern Queensland. https://scholarcommons.usf.edu/oa_textbooks/3

Black, P. & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7-74. https://doi.org/10.1080/0969595980050102

Blewett, C. (2017). *Wake up class!*: *5 activating digital-age pedagogies that will revolutionize your classroom.* Teachernology Publishers.

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Brennan, K. & Resnick, M. (2012, April 13-17). *Using artifact-based interviews to study the development of computational thinking in interactive media design*. [Paper presentation]. American Educational Research Association Annual Meeting, Vancouver, BC, Canada.

Bruner, J. S. (1996). *The culture of education*. Harvard University Press.

Burke, Q. & Kafai, Y. B. (2010). Programming & storytelling: Opportunities for learning about coding & composition. In *IDC '10: Proceedings of the 9th International Conference on Interaction Design and Children* (pp. 348-351). Association for Computing Machinery. https://doi.org/10.1145/1810543.1810611

Cai, Z., Fan, X. & Du, J. (2016). Gender and attitudes toward technology use: A meta-analysis. *Computers & Education*, *105*, 1-13. https://doi.org/10.1016/j.compedu.2016.11.003

Carstens, K. J., Mallon, J. M., Bataineh, M. & Al-Bataineh, A. (2021). Effects of technology on student learning. *The Turkish Online Journal of Educational Technology*, *20*(1), 105-113. https://files.eric.ed.gov/fulltext/EJ1290791.pdf

Chang, Z., Schwartz, M. S., Hinesley, V. & Dubinsky, J. M. (2021). Neuroscience concepts changed teachers' views of pedagogy and students. *Frontiers in Psychology*, *12*, 685856. https://doi.org/10.3389/fpsyg.2021.685856

Chin, K., Chi, E. H. & Danescu-Niculescu-Mizil, C. (2021). Exploring automation in novice-friendly parallel programming environments. *Journal of Educational Computing Research, 59*(2), 224-243. https://doi.org/10.1177/07356331211035315

Clark, R. C. & Mayer, R. E. (2011). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. John Wiley.

Colley, A. & Comber, C. (2003) Age and gender differences in computer use and attitudes among secondary school students: What has changed? *Educational Research*, *45*(2), 155-165. https://doi.org/10.1080/0013188032000103235

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Pearson.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage Publications.

Creswell, J. W. & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). Sage Publications.

Crocker, M. E., & Stout, J. W. (2023). A qualitative study of perspectives on the acceptability and feasibility of "virtual home visits" for asthma. *BMC Public Health, 23*, 2546. https://doi.org/10.1186/s12889-023-17485-8

Cropley, A. J. (2002). *Qualitative research methods: An introduction for students of psychology and education.* Zinatne.

Dagdilelis, V., Satratzemi, M. & Evangelidis, G. (2004). Introducing secondary education students to algorithms and programming. *Education and Information Technologies*, *9*, 159–173. https://doi.org/10.1023/B:EAIT.0000027928.94039.7b

Davidovitch, N. & Yavich, R. (2021). Teachers' attitudes to use of advanced technological tools as teaching and learning aids: From an inter-generational perspective. *The European Educational Researcher*, *4*(3), 329-354. https://doi.org/10.31757/euer.434

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340. https://doi.org/10.2307/249008

Deci, E. L. & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01

Denny, P., Luxton-Reilly, A. & Simon, B. (2008). Evaluating a new exam question: Parsons problems. In *ICER'08 - Proceedings of the ACM Workshop on International Computing Education Research* (pp. 113-124). Association for Computing Machinery. https://doi.org/10.1145/1404520.1404532

Department of Basic Education. (2012). *Curriculum and assessment policy statement: Digital technology*. https://www.education.gov.za/LinkClick.aspx?fileticket=dx1_Dj3M5kE%3D&tabid=2656&portalid=0&mid=9311

Du, W., Liang, R., Zhang, J. & Wang, L. (2023). Factors influencing teachers' satisfaction and performance with online teaching in universities during the COVID-19. *Frontiers in Psychology*, *14*, 1120662. https://doi.org/10.3389/fpsyg.2023.1120662

Ebrahimzadeh, M. & Alavi, S. (2016). Motivating EFL students: E-learning enjoyment as a predictor of vocabulary learning through digital video games. *Cogent Education*, *3*, 1255400. http://doi.org/10.1080/2331186X.2016.1255400

Ericsson, K. A., Krampe, R. T. & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, *100*(3), 363-406. https://doi.org/10.1037/0033-295X.100.3.363

Escobar-Rodríguez, T. & Carvajal-Trujillo, E. (2014). Online purchasing tickets for low-cost carriers: An application of the unified theory of acceptance and use of technology (UTAUT) model. *Tourism Management*, *43*, 70-88. https://doi.org/10.1016/j.tourman.2014.01.017

Etikan, I., Musa, S. A. & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Faja, S. (2014). Evaluating effectiveness of pair programming as a teaching tool in programming courses. *Information Systems Education Journal*, *12*(6), 36-45. https://files.eric.ed.gov/fulltext/EJ1140923.pdf

Fitriati, F., Rosli, R., & Iksan, Z. H. (2023). Enhancing prospective mathematics teachers' lesson planning skills through lesson study within school-university partnership program. *Journal on Mathematics Education, 14*(1), 69–84. https://doi.org/10.22342/jme.v14i1.pp69-84

Fowler, F. J. (2014). *Survey research methods* (5th ed.). Sage Publications.

Franklin, D., Skifstad, G., Rolock, R., & Mehrotra. (2017). Using upper-elementary student performance to understand conceptual sequencing in a blocks-based curriculum. In *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education*, (pp. 911-917).

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H. & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410-8415.

Gillespie, B. (2022). Using digital storytelling and game-based learning to increase student engagement and connect theory with practice. *Teaching & Learning Inquiry, 10*, Article 14. https://doi.org/10.20343/teachlearninqu.10.14

Gikandi, J. W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. Computers & Education, 57(4), 2333–2351.

Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education*, *7*(1), 22-30. https://doi.org.10.21061/jte.v7i1.a.2

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report*, *8*(4), 597-607. https://doi.org/10.46743/2160-3715/2003.1870

Graul, B., Rollins, M. L., Powers, N., & Della Corte, D. (2020). Student-created video content for assessment, experiential learning, and service. arXiv preprint arXiv:2010.14632.

Gresse von Wangenheim, C., Araújo e Silva de Medeiros, G., Missfeldt Filho, R., Petri, G., Da Cruz Pinheiro, F., Ferreira, M. N. F. & Hauck, J. C. R. (2019). SplashCode: A board game for learning an understanding of algorithms in middle school. *Informatics in Education*, *18*(2), 259-280 https://doi.org/10.15388/infedu.2019.12

Grover, S. & Basu, S. (2017). Measuring student learning in introductory block-based programming: Examining misconceptions of loops, variables, and Boolean logic. In *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education* (pp. 267-272).

Grover, S., Pea, R. & Cooper, S. (2015). Expanding computational thinking in K-12: Designing for learning and assessing instruction. *Computer Science Education*, *25*(1), 21-43.

Gyawali, Y. P. & Mehndroo, M. (2023). The 21st century model for pedagogical transformation: Exploring teachers' identity and professional responsibility. *Journal of NELTA Gandaki*, *6*(1), 13-25. https://doi.org/10.3126/jong.v6i1-2.59707

Hammerness, K. (2006). From coherence in theory to coherence in practice. *Teachers College Record*, *108*(7), 1241-1265. Columbia University.

Harms, K. J., Kapp, D. & Yoder, B. (2016). Automatic feedback for Scratch projects. In *Proceedings of the 47th ACM Technical Symposium on Computer Science Education* (pp. 295-300). https://doi.org/10.1145/2839509.2844556

Harris, J. & Hofer, M. J. (2009). Grounded tech integration: An effective approach based on content, pedagogy, and teacher planning. *Learning & Leading with Technology*, *37*(2), 22-25. https://scholarworks.wm.edu/articles/28

Hartman, R. J., Townsend, M. B. & Jackson, M. (2019). Educators' perceptions of technology integration into the classroom: A descriptive case study. *Journal of Research in Innovative Teaching & Learning*, *12*(3), 236-249. https://doi.org/10.1108/JRIT-03-2019-0044

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.

Hattie, J. & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81-112. https://doi.org/10.3102/003465430298487

Hernik, J. & Jaworska, E. (2018). The effect of enjoyment on learning.In *Proceedings of INTED2018 Conference* (pp. 508-514).

Herodotou, C., Sharples, S., Gaved, M., Kukulska-Hulme, A., Rienties, B., Scanlon E. & Whitelock, D. (2019). Innovative pedagogies of the future: An evidence-based selection. *Frontiers in Education*, *4*, 113. https://doi.org/10.3389/feduc.2019.00113

Hevner, A. R., March, S. T., Park, J. & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(1), 75-105. https://dl.acm.org/doi/10.5555/2017212.2017217

Hill, J. R. & Hannafin, M. J. (2001). Teaching and learning in digital environments: The resurgence of resource-based learning. *Educational Technology Research and Development*, *49*(3), 37-52. https://doi.org/10.1007/BF02504914

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, *16*, 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Hou, M., Lin, Y., Shen, Y. & Zhou, H. (2022). Explaining pre-service teachers' intentions to use technology-enabled learning: An extended model of the theory of planned behavior. *Frontiers in Psychology*, *13*, 1-12. https://doi.org/10.3389/fpsyg.2022.900806

Holvikivi, J. (2010). Conditions for successful learning of programming skills. In N. Reynolds & M. Turcsányi-Szabó (Eds.), *Key competencies in the knowledge society: IFIP TC 3 International Conference, KCKS 2010, held as part of WCC 2010, Brisbane, Australia, September 20-23, 2010, proceedings* (pp. 155-164). Springer. https://doi.org/10.1007/978-3-642-15378-5_15

Isen, A. M. & Reeve, J. (2005). The influence of positive affect on intrinsic and extrinsic motivation: Facilitating enjoyment of play, responsible work behavior, and self-control. *Motivation and Emotion*, *29*(4), 295-323. https://doi.org/10.1007/s11031-006-9019-8

Islam, N., Sheik, G. S., Fatima, R. & Alvi, F. (2019). A study of difficulties of students in learning programming. *Journal of Education and Social Sciences*, *7*(2), 38-46.

Janeček, L. & Pergl, R. (2017). Analysing functional paradigm concepts. In Á.Rocha, A. Correia, H. Adeli, L. P. Reis & S. Costanzo (Eds.), *Recent advantages in information systems and technologies: World CIST 2017* (pp. 882-891). Springer, Cham. https://doi.org/10.1007/978-3-319-56535-4_86

Jenkins, H. (2015). *Games, learning, and society: Learning and meaning in the digital age*. Cambridge University Press.

Jennings, N. R., Sycara, K. & Wooldridge, M. (1999). A roadmap of agent research and development. *Autonomous Agents and Multi-Agent Systems*, *1*, 7-38.

Johnson, D. W. & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher*, *38*(5), 365-379. https://doi.org/10.3102/0013189X09339057

Johnson, R. B. & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, *33*(7), 14–26. https://doi.org/10.3102/0013189X033007014

Kafai, Y. B. & Burke, Q. (2015). *Connected code: Why children need to learn programming*. MIT Press.

Kahneman, D. (2011) *Thinking fast and slow*. Farrar, Straus and Giroux Publishers.

Kalelioğlu, F. & Gülbahar, Y. (2014). The effects of teaching programming via Scratch on problem solving skills: A discussion from learners' perspective. *Informatics in Education*, *13*(1), 33-50. https://files.eric.ed.gov/fulltext/EJ1064285.pdf

Keiler, L. S. (2018). Teachers' roles and identities in student-centered classrooms. *International Journal of STEM Education*, 1-20. https://doi.org/10.1186/s40594-018-0131-6

King, W. R. & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & Management*, *43*(6), 740-755. https://doi.org/10.1016/j.im.2006.05.003

Kirschner, P. A., Sweller, J. & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75-86. https://doi.org/10.1207/s15326985ep4102_1

Klenin, A. I., Donskov, A. V., Spasskaya, D. D. & Khussein, A. M. A. (2020). Digital technologies in teacher training: New experience. *ITM Web of Conferences*, *35*(10), 06002. https://doi.org/10.1051/itmconf/20203506002

Kluger, A. N. & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin*, *119*(2), 254-284. https://psycnet.apa.org/doi/10.1037/0033-2909.119.2.254

Koehler, M. J. & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60-70. https://citejournal.org/volume-9/issue-1-09/general/what-is-technological-pedagogicalcontent-knowledge

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.

Koutromanos, G., Mikropoulos, A. T., Mavridis, D. & Christogiannis, C. (2024). The mobile augmented reality acceptance model for teachers and future teachers. *Education and Information Technologies*, *29*, 7855-7893. https://doi.org/10.1007/s10639-023-12116-6

Krishnamurthi, S. & Fisler, K. (2019). Programming paradigms and beyond. In S. Fincher & A. Robins (Eds.), *The Cambridge handbook of computing education research* (pp. 1-38). Cambridge University Press. https://doi.org/10.1017/9781108654555

Krutz, R. & Vasa, R. (2014). Code repository mining: A systematic review. *Empirical Software Engineering*, *19*(6), 1829-1868.

Kumari, S., Yadav, P. & Rani, K. S. (2015). Programming paradigms in the context of the programming language. *International Journal of Engineering and Computer Science*, *4*(11), 14953-14959.

Kwon, K. & Cheon, J. (2019). Exploring problem decomposition and program development through block-based programs. *International Journal of Computer Science Education in Schools*, *3*(1), 1-14. https://doi.org/10.21585/ijcses.v3i1.54

La Fleur, J. & Dlamini, R. (2022). Towards learner-centric pedagogies: Technology-enhanced teaching and learning in the 21st century classroom. *Journal of Education*, (88), 4-20. https://doi.org/10.17159/10.17159/2520-9868/i88a01

Laal, M. & Laal, M. (2011). Collaborative learning: What is it? *Social and Behavioral Sciences*, *31*, 491-495. https://doi.org/10.1016/j.sbspro.2011.12.092

Lahtinen, E., Ala-Mutka, K. & Järvinen, H.-M. (2005). A study of the difficulties of novice programmers. *ACM SIGCSE Bulletin*, *37*(3), 14-18. https://doi.org/10.1145/1067445.1067453

Lalejini, A. & Ofria, C. (2018). Evolving event-driven programs with SignalGP In *GECCO '18: Proceedings of the Genetic and Evolutionary Computation Conference* (pp. 1135-1142). Association for Computing Machinery. https://doi.org/10.1145/3205455.3205523

Larsson, A. (2018*). Embodied understanding in computer programming: A semiotic analysis of metaphors used in programming.* [Master's Thesis, Linköping University]. Semantic Scholar.

Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Routledge.

Law, R. (2020). A pedagogical approach to teaching game programming: Using the PRIMM approach. In P. Fotaris (Ed.), *European Conference on Games Based Learning* (pp. 816-819). Academic Conferences International. https://doi.org/10.34190/GBL.20.071

Lei, J. (2009). Digital natives as preservice teachers: What technology preparation is needed? *Journal of Computing in Teacher Education*, *25*(3), 87-97.

Let's Talk Science. (2018). *Computational thinking framework*. https://letstalkscience.ca/sites/default/files/2019-10/LTS-Computational_Thinking_Framework-2018.pdf

Li, Q., Liu, Q. & Chen, Y. (2022). Prospective teachers' acceptance of virtual reality technology: A mixed study in rural China. *Education and Information Technologies*, *28*, 3217–3248. https://doi.org/10.1007/s10639-022-11219-w

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

Lui, K. M., Barnes, K. A. & Chan, K. C. (2010). Pair programming: Issues and challenges. In T. Dingsøyr, T. Dybå & N. Moe (Eds.), *Agile software development* (pp. 143-163). Springer. https://doi.org/10.1007/978-3-642-12575-1_7

Lui, K. M., & Chan, K. C. C. (2006). Pair programming productivity: Novice-novice vs. expert-expert. *International Journal of Human-Computer Studies, 64*(9), 915–925. https://doi.org/10.1016/j.ijhcs.2006.04.010

Luik, P. & Taimalu, M. (2021). Predicting the intention to use technology in education among student teachers: A path analysis. *Education Sciences*, *11*(9), 564. https://doi.org/10.3390/educsci11090564

Machaba, F. & Bedada, T. (2022). University lecturers' preparedness to use technology in teacher training of mathematics during Covid-19: The case of Ethiopia. *South African Journal of Higher Education*, *36*(1), 171-192. https://doi.org/10.20853/36-1-4560

Magwa, S. & Magwa, W. (2015). *A guide to conducting research: A student handbook*. Strategic Book Publishing and Rights.

Major, L., Warwick, P., Rasmussen, I., Ludvigsen, S., & Cook, V. (2018). Classroom dialogue and digital technologies: A scoping review. *Education and Information Technologies, 23*(5), 1995–2028. https://doi.org/10.1007/s10639-018-9701-y

Maloney, J. H., Resnick, M., Rusk, N., Silverman, B. & Eastmond, E. (2010). The Scratch programming language and environment. *ACM Transactions on Computing Education*, *10*(4), 1-15. https://doi.org/10.1145/1868358.1868363

Margot, K. C. & Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *International Journal of STEM Education*, *6*, 2. https://doi.org/10.1186/s40594-018-0151-2

Marimuthu, M. & Govender, P. (2018). Perceptions of Scratch programming among secondary school students in KwaZulu-Natal, South Africa. *The African Journal of Information and Communication*, (21), 51–80. https://doi.org/10.23962/10539/26112

Mathieson, K. (1991). Predicting user intentions: Comparing the technology acceptance model with the theory of planned behavior. *Information Systems Research*, *2*(3), 173-191. http://www.jstor.org/stable/23010882

Mayer, R. E. (2004). Should there be a three-strikes rule against pure discovery learning?: The case for guided methods of instruction. *American Psychologist*, *59*(1), 14-19. https://doi.org/10.1037/0003-066X.59.1.14

McCauley, R., Fitzgerald, S., Lewandowski, G., Murphy, L., Simon, B., Thomas, L. & Zander, C. (2008). Debugging: A review of the literature from an educational perspective. *Computer Science Education*, *18*(2), 67-92. https://doi.org/10.1080/08993400802114581

Meerbaum-Salant, O., Armoni, M. & Ben-Ari, M. (2013). Learning computer science concepts with Scratch. *Computer Science Education*, *23*(3), 239-264. https://doi.org/10.1080/08993408.2013.832022

Merriam, S. B. & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Mihailidis, P., & Cohen, J. N. (2013). *Exploring Curation as a Core Competency in Digital and Media Literacy Education*. Journal of Interactive Media in Education, 2013(1), Art. 2.

Mikum, S., Suksakulchai, S. & Chaisanit, S. (2014). *Developing problem-solving skills and pair programming strategy for a fundamental computer programming course* [Conference presentation]. The Asian Conference on Education.

Mishra, P. & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Mohajan, H. K. (2018). Qualitative research methodology in social sciences and related subjects. *Journal of Economic Development, Environment and People*, *7*(1), 23-48. https://mpra.ub.uni-muenchen.de/85654/

Molenda, M. (2003). In search of the elusive ADDIE model. *Performance Improvement*, *42*(5), 34-36. https://doi.org/10.1002/pfi.4930420508

Nichols Hess, A. K. & Greer, K. (2016). Designing for engagement: Using the ADDIE model to integrate high-impact practices into an online information literacy course. *Communications in Information Literacy*, *10*(2), 264-282. https://files.eric.ed.gov/fulltext/EJ1125456.pdf

Nikiforos, S., Kontomaris, C. & Chorianopoulos, K. (2013, October 1-5). *MIT Scratch: A powerful tool for improving teaching of programming* [Conference presentation]. Conference on Informatics in Education, Greece.

Nikou, S. A. (2024). Factors influencing student teachers' intention to use mobile augmented reality in primary science teaching. *Education and Information Technologies*, *29*, 15353-15374. https://doi.org/10.1007/s10639-024-12481-w

Nwokoro, I., Okonkwo, O., Alo, U. & Nwatu, A. (2021). Object-oriented programming and software development paradigm. *Academia Letters*, https://doi.org/10.20935/AL3443

O'Byrne, W. I., Houser, K., Stone, R., & White, M. (2018). Digital storytelling in early childhood: Student illustrations shaping social interactions. *Frontiers in Psychology, 9*, Article 1800. https://doi.org/10.3389/fpsyg.2018.01800

Ohei, K., Mantzaris, E., Ntshangase, B. A. & Olutade, E. O. (2023). Incorporating new technologies into teaching in South Africa. *Research in Business & Social Science*, *12*(6), 286-295. https://doi.org/10.20525/ijrbs.v12i6.2715

Patnaik, S. & Pandey, S. C. (2019). Case study research. In R. N. Subudhi & S. Mishra (Eds.), *Methodological issues in management research: Advances, challenges, and the way ahead* (pp.163-179). Emerald Publishing. https://doi.org/10.1108/978-1-78973-973-220191011

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Sage Publications.

Pavlou, P. A. & Fygenson, M. (2006). Understanding and predicting electronic commerce adoption: An extension of the theory of planned behavior. *MIS Quarterly*, *30*(1), 115-143. https://doi.org/10.2307/25148720

Pedditzi, M. L., Nonnis, M. & Nicotra, E. F. (2021). Teacher satisfaction in relationships with students and parents and burnout. *Frontiers in Psychology*, *12*, 703130. https://doi.org/10.3389/fpsyg.2021.703130

Peffers, K., Tuunanen, T., Rothenberger, M. A. & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, *24*(3), 45-77.

Pervin, N. & Mokhtar, M. (2022). The interpretivist research paradigm: A subjective notion of a social context. *International Journal of Academic Research in Progressive Education and Development*, *11*(2), 419–428. https://doi.org/10.6007/IJARPED/v11-i2/12938

Piaget, J. (1954). *The construction of reality in the child*. Basic Books.

Plowright, D. (2011). *Using mixed methods: Frameworks for an integrated methodology*. Sage Publications.

Price, C. & Price-Mohr, R. (2018). Stories children write while coding: A cross-disciplinary approach for the primary classroom. *Cambridge Journal of Education*, *48*(6), 735-747. https://doi.org/10.1080/0305764X.2017.1418834

Prince, M. (2004). Does active learning work?: A review of the research. *Journal of Engineering Education*, *93*(3), 223-231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x

Puerta, L. G. (2024). Exploring if gamification experiences make an impact on pre-service teachers' perceptions of future gamification use: A case report. *Societies*, *14*, 11. https://doi.org/10.3390/soc14010011

Ray, S., Samaddar, R. & Sikdar, D. P. (2023). Exploration of prospective teachers' attitude towards teaching. *Global Journal of Arts Humanity and Social Sciences*, *3*(11), 1319-1324.

Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., Millner, A., Rosenbaum, E., Silver, J. S., Silverman, B. & Kafai, Y. B. (2009). Scratch: Programming for all. *Communications of the ACM*, *52*(11), 60-67. https://doi.org/10.1145/1592761.1592779

Resnick, M. & Silverman, B. (2005). Some reflections on designing construction kits for kids. In *Proceedings of the 2005 Conference on Interaction Design and Children* (pp. 117-122).

Rissanen, I., Laine, S., Puusepp, I., Kuusisto, E. & Tirri, K. (2021). Implementing and evaluating growth mindset pedagogy: A study of Finnish elementary school teachers. *Frontiers in Education*, *6*, 753698. https://doi.org/10.3389/feduc.2021.753698

Rose, S., Habgood, J. & Jay, T. (2018). Pirate plunder: Game-based computational thinking using scratch blocks. In *Proceedings of the 12th European Conference on Games Based Learning* (pp. 556-564). Academic Conferences and Publishing International. http://shura.shu.ac.uk/21715/

Rowley, J. (2014). Designing and using research questionnaires. *Management Research Review*, *37*(3), 308-330. https://doi.org/10.1108/MRR-02-2013-0027

Sandelin, M. (2022). The effects of questionnaire length on response rate, non-response bias, and data quality. SOM Institute. Retrieved from https://www.gu.se/sites/default/files/2022-11/2022-1%20Effects%20of%20questionnaire%20length%20%28Sandelin%202022%29%20v2_1.pdf

Sandoval-Medina, C., Arévalo-Mercado, C. A., Muñoz-Andrade, E. L., & Muñoz-Arteaga, J. (2024). Self-explanation effect of cognitive load theory in teaching basic programming. *Journal of Information Systems Education, 35*(3), 303–312. https://doi.org/10.62273/GMIV1698

Schmidt, S. M. & Ralph, D. L. (2016). The flipped classroom: A twist on teaching. *Contemporary Issues in Education Research*, *9*(1), 1-6. https://doi.org/10.19030/cier.v9i1.9544

Schneiderman, B. (1983). Direct manipulation: A step beyond programming languages. *Computer*, *16*(8), 57-69. https://doi.org/10.1109/MC.1983.1654471

Schoenborn, P., & Rees, T. (2013). *A Module Designed with Chaos and Complexity in Mind*. Innovation in Teaching and Learning in Information and Computer Sciences, 12(1), 14–26.

Sekhon, M., Cartwright, M. & Francis, J. J. (2017). Acceptability of healthcare interventions: An overview of reviews and development of a theoretical framework. *BMC Health Services Research*, *17*, 88. https://doi.org/10.1186/s12913-017-2031-8

Seliger, H. W. & Shohamy, E. (1989). *Second language research methods*. Oxford University Press.

Sengupta, P., Kinnebrew, J. S., Basu, S., Biswas, G. & Clark, D. (2013). Integrating computational thinking with K-12 science education using agent-based computation: A theoretical framework. *Education and Information Technologies*, *18*, 351-380. https://doi.org/10.1007/s10639-012-9240-x

Sentance, S. & Waite, J. (2017). PRIMM: Exploring pedagogical approaches for teaching text-based programming in school. In *WiPSCE '17: Proceedings of the 12th Workshop on Primary and Seconday Computing Education* (pp. 113-114). Association for Computing Machinery. https://dl.acm.org/doi/pdf/10.1145/3137065.3137084

Sentance, S., Waite, J. & Kallia, M. (2019a). Teaching computer programming with PRIMM: A sociocultural perspective. *Computer Science Education*, *29*(2-3), 136-176. https://doi.org/10.1080/08993408.2019.1608781

Sentance, S., Waite, J. & Kallia, M. (2019b). Teachers' experiences of using PRIMM to teach programming in school. In *SIGCSE '19: Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (pp. 476-482). Association for Computing Machinery. https://doi.org/10.1145/3287324.3287477

Serin, H. & Bozdağ, F. (2020). Relationship between teachers' attitudes towards technology use in education and autonomy behaviors. *The Turkish Online Journal of Educational Technology*, *19*(3), 60-69.

Shah, R. K. (2021). Conceptualizing and defining pedagogy. *IOSR Journal of Research & Method in Education*, *11*(1), 6-29. DOI: 10.9790/7388-1101020629

Shayo, E. H., Kivuyo, S., Seeley, J., Bukenya, D., Karoli, P., Mfinanga, S. G., Jaffar, S., & Van Hout, M.-C. (2022). The acceptability of integrated healthcare services for HIV and non-communicable diseases: Experiences from patients and healthcare workers in Tanzania. *BMC Health Services Research, 22*, 655. https://doi.org/10.1186/s12913-022-08065-4

Shih, Y. & Fang, K. (2004). The use of a decomposed theory of planned behavior to study Internal banking in Taiwan. *Internet Research*, *14*(3), 213-223. https://doi.org/10.1108/10662240410542643

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, *78*(1), 153-189. https://doi.org/10.3102/0034654307313795

Sreenindhi S, K. & Tay, C. H. (2017). Styles of learning based on the research of Fernald, Keller, Orton, Gillingham, Stillman, Montessori and Neil D Fleming. *International Journal for Innovative Research in Multidisciplinary Field*, *3*(4). 17-25.

Srikant, S. & Aggarwal, V. (2017). A framework for automated grading of programming assignments. In *Proceedings of the ACM SIGCSE Technical Symposium on Computer Science Education* (pp. 415-420).

Sweller, J., Ayres, P. & Kalyuga, S. (2011). *Cognitive load theory*. Springer Science & Business Media.

Tan, W., Samsudin, M. A., Ismail, M. E., Ahmad, N. J. & Talib, C. A. (2021). Exploring the effectiveness of STEAM integrated approach via Scratch on computational thinking. *EURASIA Journal of Mathematics, Science and Technology Education*, *17*(12), em2049. https://doi.org/10.29333/ejmste/11403

Taylor, S. & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research*, *6*(2), 144-176. https://doi.org/10.1287/isre.6.2.144

Tengler, K., Kastner-Hauler, O., Sabitzer, B., & Lavicza, Z. (2022). The effect of robotics-based storytelling activities on primary school students' computational thinking. *Education Sciences, 12*, Article 10. https://doi.org/10.3390/educsci12010010

Tichapondwa, S. M. (2013). *Preparing your dissertation at a distance: A research guide*. Virtual University for the Small States of the Commonwealth. https://dl.icdst.org/pdfs/files3/03ef9a5eda253443be12604adb361fcb.pdf

Tzenios, N. (2022). Learner-centered teaching. *International Research Journal of Modernization in Engineering Technology and Science*, *4*(12), 916-919. https://doi.org/10.56726/IRJMETS32262

UNESCO. (2003). Information and communication technologies in teacher education: A planning guide. *Technology, Pedagogy and Education*, *12*(3), 447–450. https://doi.org/10.1080/14759399800200232

Ungerer, L. M. (2016). Digital curation as a core competency in current learning and literacy: A higher education perspective. *International Review of Research in Open and Distributed Learning*, *17*(5), 1-27.

Vahldick, A., Farah, P. R., Marcelino, M. J. & Mendes, A. J. (2020). A blocks-based serious game to support introductory computer programming in undergraduate education. *Computers in Human Behavior Reports*, *2*, 100037. https://doi.org/10.1016/j.chbr.2020.100037

Van der Waldt, G. (2020). Constructing conceptual frameworks in social science research. *The Journal for Transdisciplinary Research in Southern Africa*, *16*(1), a758. https://doi.org/10.4102/td.v16i1.758

Vandeyar, T. & Adegoke, O. O. (2024). Teachers' ICT in pedagogy: A case for mentoring and mirrored practice. *Education and Information Technologies*, *29*, 18985-19004. https://doi.org/10.1007/s10639-024-12603-4

Van Esch, J. & De Jong, T. (2020). Learning to code in a parallel world: Enhancing event-driven programming in Scratch with new parallel constructs. *Educational Technology and Society*, *23*(3), 162-175.

Venkatesh, V. & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, *39*(2), 273-315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V. & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, G. B. & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425-478. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J. Y. L. & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, *36*(1), 157-178.

Virlan, A. Y. (2022). The role of error correction in teaching and learning of English from the cognitive load perspective: A case study. *Journal of English Teaching*, *8*(2), 195-208. https://doi.org/10.2307/41410412

Vom Brocke, J., Hevner, A. & Maedche, A. (2020) Introduction to design science research. In J. vom Brocke, A. Hevner & A. Maedche (Eds.), *Design Science Research: Cases* (pp. 1-13). Springer, Cham. https://doi.org/10.1007/978-3-030-46781-4_1

Gillern, V., & Robert, S. (2017). *Young children, computer coding, and story creation: An examination of first- and second-grade children's multimodal stories and literacy practices when engaged with a multimedia coding application* [Doctoral thesis, Iowa State University]. Iowa State University Digital Repository. https://lib.dr.iastate.edu/etd/15448?utm_source=lib.dr.iastate.edu%2Fetd%2F15448&utm_medium=PDF&utm_campaign=PDFCoverPages

Vujoševič-Janičić, M. & Tošić, D. (2008). The role of programming paradigms in the first programming courses. *The Teaching of Mathematics*, *11*(2), 63-83. http://elib.mi.sanu.ac.rs/files/journals/tm/21/tm1122.pdf

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wahab, S. A., Rose, R. C. & Osman, S. I. W. (2012). Defining the concepts of technology and technology transfer: A literature analysis. *Canadian Centre of Science and Research*, *5*(1), 61-71. https://doi.org/10.5539/ibr.v5n1p61

Waite, J. L., Curzon, P., Marsh, W., Sentance, S. & Hadwen-Bennett, A. (2018). Abstraction in action: K-5 teachers' uses of levels of abstraction, particularly the design level, in teaching programming. *International Journal of Computer Science Education in Schools*, *2*(1). https://doi.org/10.21585/ijcses.v2i1.23

Webb, N. M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology*, *79*(1), 1-28. https://doi.org/10.1348/000709908x380772

Weinberg, S. L. & Abramowitz, S. K. (2008). *Statistics using SPSS: An integrative approach* (2nd ed.). Cambridge University Press.

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33-35. https://doi.org/10.1145/1118178.1118215

Winslow, L. E. (1996). Programming pedagogy: A psychological overview. *ACM SIGCSE Bulletin*, *28*(3), 17-22. https://doi.org/10.1145/234867.234872

Wray, S. (2010). How pair programming really works. *IEEE Software*, *27*(1), 50-55. https://doi.org/10.1109/MS.2009.199

Wright, G. B. (2011). Student-centered learning in higher education. *International Journal of Teaching and Learning in Postsecondary Education*, *23*(1), 92-97.

Wu, I. & Chen, J. (2005). An extension of trust and TAM model with TPB in the initial adoption of online tax: An empirical study. *International Journal of Human-Computer Studies*, *62*(6), 784-808. https://doi.org/10.1016/j.ijhcs.2005.03.003

Xie, B., Loksa, D., Nelson, G. L., Davidson, M. J., Dong, D., Kwik, H., Tan, A. H., Hwa, L., Li, M. & Ko, A. J. (2019). A theory of instruction for introductory programming skills. *Computer Science Education*, *29*(2-3), 205-253. https://doi.org/10.1080/08993408.2019.1565235

Xu, Z., Ritzhaupt, A. D., Tian, F. & Umapathy, K. (2019) Block-based versus text-based programming environments on novice student learning outcomes: A meta-analysis study. *Computer Science Education*, *29*(2-3), 177-204, https://doi.org/10.1080/08993408.2019.1565233

Yilmaz, R., Sezgin, A., Kurnaz, S. & Arslan, Y. Z. (2019). Object-oriented programming in computer science. In M. Khosrow-Pour, M. (Ed.), *Encyclopedia of Information Science and Technology*, (pp. 7470-7480). IGI Global. https://doi.org/10.4018/978-1-5225-2255-3.ch650

Zainuddin, Z. & Halili, H. (2016). Flipped classroom research and trends from different fields of study. *International Review of Research in Open and Distributed Learning*, *17*(3), 313-340. https://doi.org/10.19173/irrodl.v17i3.2274

Zamir, S. & Ali, H. (2023). Prospective teachers' perceptions, reliance, and barriers to ICT integration in mathematics learning. *Journal of Education and Educational Development*, *10*(1), 7-25. https://doi.org/10.22555/joeed.v10i1.757

APPENDICES
APPENDIX A – PIRATE BRICK GAME

STEP 3: PENGUIN MOVEMENT

- Select the penguin sprite.
- In the "Events" category, drag the "when green flag clicked" block to the scripting area.
- Use "forever" loop to continuously check for arrow key inputs.
- Inside the loop, use "if-then" statements to check which arrow key is pressed (left, or right).
- Depending on the arrow key pressed, use "change x by [ ]" block to move the penguin left or right.

STEP 4: FALLING PIRATE BRICKS

- Add four sprites for falling pirate bricks or any other objects that you want to make fall.
- Use the "go to x: [ ] y: [ ]" block to position the falling pirate bricks at the top of the stage.

STEP 6: COLLISION DETECTION

- Select the penguin sprite.
- Drag a "when green flag pressed" block.
- Drag "forever" block into scripting area.
- In the "forever" block, use "if-then" block to check if the is penguin is touching a brick.
- Inside the "if-then" block, use "if touching [ ]" blocks to detect collisions between the penguin character and any pirate brick.
- If the penguin character touches a pirate brick, display a "Game Over" message and stop the game.
- Drag a "stop" block to end the game.

STEP 7: TEST AND REFINE

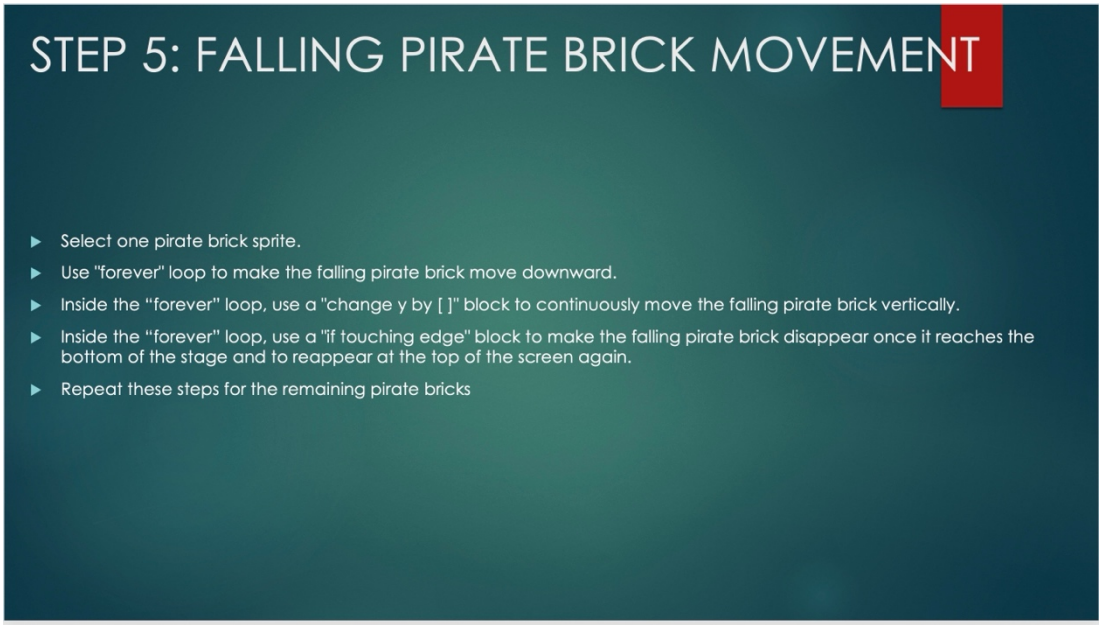
- Click the green flag to test your game and ensure the penguin character and falling bricks work correctly.
- Refine the game by adjusting movement speeds, adding more falling bricks, and enhancing the visuals.
- Add sound effects for collisions and scoring using "play sound [ ] until done" blocks.

STEP 2: ADD PENGUIN CHARACTER

- Add a sprite penguin for the player's character.
- Optional: Edit the costume to create the appearance of the penguin.
- Use the "go to x: [ ] y: [ ]" block to position the penguin at the bottom center of the stage.

PIRATE BRICK ACT METHODOLOGY

- CONVESATION & CORRECTION
  - Read the instructions for creating the PirateBrick Game, in your group discuss what the game is supposed to do based on the instructions.
  - In your group compare these instructions to the Scratch game, pointing out mistakes in the game.
  - In your group correct the Scratch game so then that the game works as expected.


STEP 5: FALLING PIRATE BRICK MOVEMENT
Select one pirate brick sprite.
Use "forever" loop to make the falling pirate brick move downward.
Inside the "forever" loop, use a "change y by [ ]" block to continuously move the falling pirate brick vertically.
Inside the "forever" loop, use a "if touching edge" block to make the falling pirate brick disappear once it reaches the bottom of the stage and to reappear at the top of the screen again.
Repeat these steps for the remaining pirate bricks


END OF PIRATE BRICK GAME

APPENDIX B – TRAFFIC DODGE GAME

STEP 2: ADD SPRITES

- Add a sprite for the player's car.
- Add two sprites for the buses.
- Add a sprite for a rock.
- Optional: Edit the costumes to create the appearance of the car, buses, and rock.

STEP 3: POSITION THE STARTING SPRITE POSITIONS

- Click on the car sprite to program the car sprite.
- Drag the "when green flag clicked" block into the scripting area.
- Use a "go to x[] y []" block to position the player's car on the left-center edge of the stage, therefore ensuring that the car is always in the same position when the game starts.

- Click on the bus1 sprite to program the bus sprite.
- Drag the "when green flag clicked" block into the scripting area.
- Use a "go to x[] y []" block to position the bus1 sprite at the bottom lane. This will place bus1 in this position every time the game is first run.
- Repeat these steps for the bus2 sprite.

- Click on the rock sprite to program it.
- Drag the "when green flag clicked" block into the scripting area.
- Use a "go to x[] y []" block to position the rock sprite at the right-centre of the lane. This will place the rock in this position every time the game is first run.

STEP 4: CAR MOVEMENT

- Drag the "when green flag clicked" block to the scripting area.
- Use a "forever" loop to allow the player's car to repeatedly move up and down using the arrow keys (up and down arrow keys).
- Inside the "forever" block use an "if-then" block to check which key is pressed (up or down).
- Inside of the "if-then" block use use an "if key [ ] pressed" block to change the car's y-position accordingly.

STEP 5: BUS AND ROCK MOVEMENT

- Click on the bus1 sprite.
- Drag "when green flag clicked" block into the scripting area.
- Use "forever" loop to make the bus1 move from right to left.
- Inside the loop, use "change x by [ ]" blocks to move the bus horizontally.
- Repeat these steps for the bus2 sprite.

- Click on the rock sprite.
- Drag "when green flag clicked" block into the scripting area.
- Use "forever" loop to repeatedly make the rock move.
- Inside the "forever" loop, use a "change x by [ ]" block to move the rock horizontally from right to left.

STEP 6: COLLISION DETECTION

- Click on the car sprite.
- Drag a "when green flag clicked" block.
- Use a "forever" loop to repeatedly keep checking whether the car is touching the yellow line.
- Inside the "forever" loop, use "if touching color [ ]" blocks to detect if the car touches the yellow line on the sides of the road.
- If the car touches the yellow line, use a "say message" block to display a "Traffic Infringement" message.
- Use a "stop all" to end the game.

- Drag a "when green flag clicked" block.
- Use a "forever" loop to repeatedly keep checking whether the car is touching the yellow line.
- Inside the "forever" loop use "if touching [ ]" blocks to detect if the car touches one of the buses or the rock.
- If the car touches any of these objects, use a "say message" block to display a "Crash" message.
- Use a "stop all" block to end the game.

STEP 7: TEST AND REFINE

- Click the green flag to test your game and ensure that the car movement, collision detection, and game over conditions work correctly.
- Refine the game by adjusting movement speeds, adding more obstacles, and enhancing the visuals.


ACT METHODOLOGY
CONVESATION & CORRECTION
Read the instructions for creating the TrafficDodge Game, in your group discuss what the game is supposed to do based on the instructions.
In your group compare these instructions to the Scratch game, pointing out mistakes in the game.
In your group correct the Scratch game so then that the game works as expected.
END OF TRAFFIC DODGE GAME

APPENDIX C – BLACK NIGHT GAME

STEP 2: ADD SPRITES

- Add a bird sprite for your player character.
- Add an egg sprite.
- Add 4 bat sprites.
- Optional: Edit the costumes of the bird, egg and 4 bat sprites to create their appearance.

STEP 3: POSITION THE ELEMENTS

- For each of the following, drag "when green flag clicked" to place each sprite at its starting point.
- Use "go to x: [ ] y: [ ]" blocks to position the bird at the starting point of the city (i.e left-most side of the city).
- Use "go to x: [ ] y: [ ]" blocks to position the egg at the end of the city (i.e the right-most side of the city).
- Use "go to x: [ ] y: [ ]" blocks to position the bat sprites at different places along the top of the stage.

STEP 4: BIRD MOVEMENT

- Select the bird sprite.
- In the "Events" category, drag the "when green flag clicked" block to the scripting area.
- Use "forever" loop to continuously check for arrow key inputs.
- Inside the "forever" loop, use "if-then" statements to check which arrow key is pressed (up, down, left, or right).
- Inside the "if-then" statements, use the "when [] key pressed" blocks to check which key is pressed.
- Depending on the arrow key pressed, use "change x by [ ]" or "change y by [ ]" block to move the bird in the corresponding direction.

STEP 5: BAT MOVEMENT

- Use "forever" loops to make the monster sprites move around the stage.
- Inside the loops, use "change y by [ ]" blocks to move the monsters horizontally.
- Use "if touching edge" blocks to make the monsters glide to a random position in the stage when they reach the edge of the screen.

- Select one of the bat sprites.
- In the "Events" category, drag the "when green flag clicked" block to the scripting area.
- Drag "forever" loop into the scripting area.
- Inside the "forever" loop use the "change y [] by" block to drop the move the bat down.
- Use the "if touching edge" block, glide the bat to a random position within the stage.
- Repeat these instructions for the other three bats, placing them at different positions at the top of the stage.

STEP 6: COLLISION DETECTION

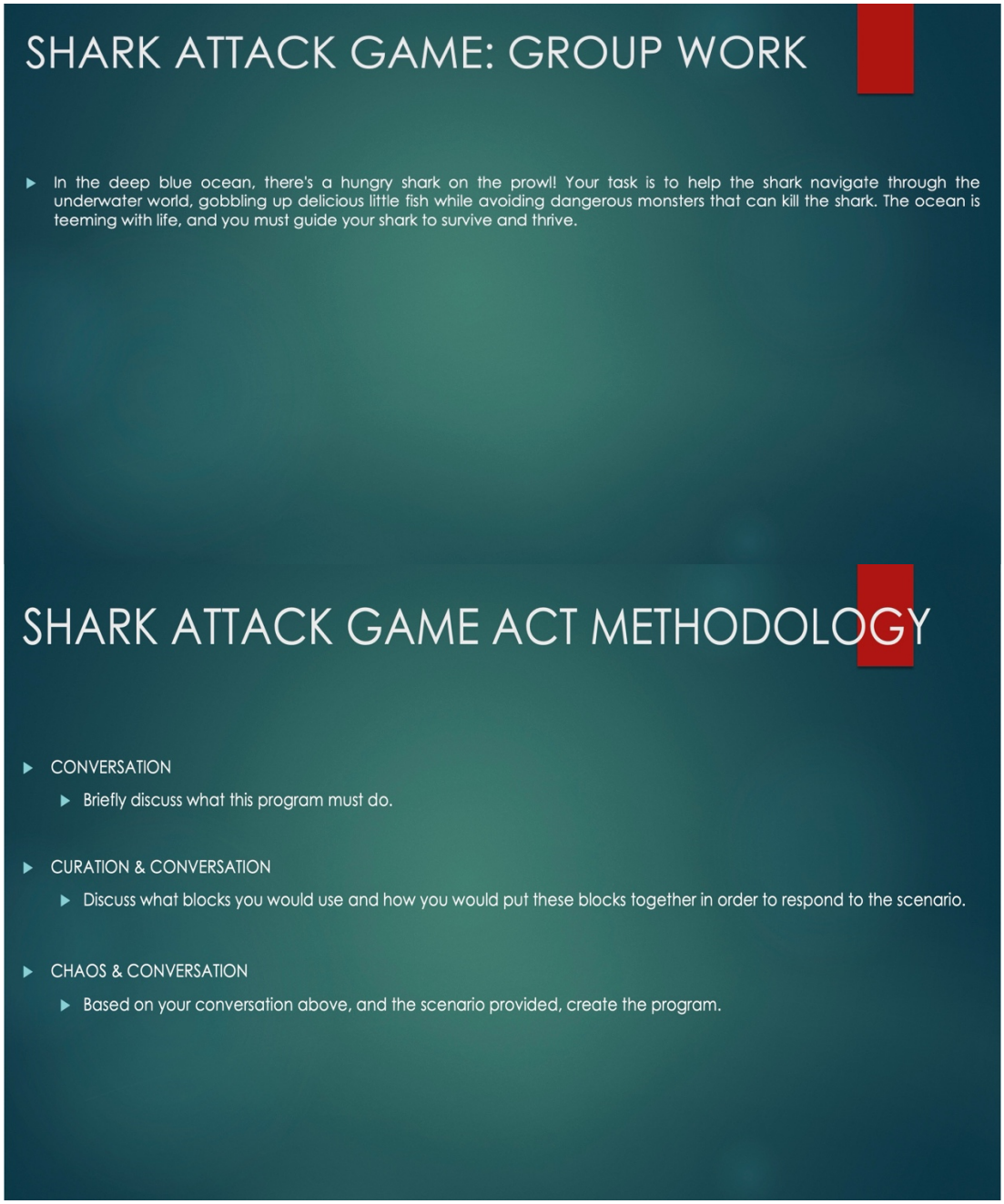
- Drag a "when green flag clicked" block into the scripting area.
- Use a forever block to repeatedly keep checking if the bird is touching any of the monsters.
- Use "if touching [ ]" blocks to detect when the bird touches a monster.
- If the bird touches a monster, display a "Game Over" message and stop the game.

STEP 7: WINNING THE GAME

- Drag a "when green flag clicked" block into the scripting area.
- Use a forever block to repeatedly keep checking if the bird has reached/ is touching the egg.
- Use "if touching [ ]" block to detect when the bird reaches the egg.
- If the bird reaches the egg, display a "You Win!" message and stop the game.


STEP 8: TEST AND REFINE
Click the green flag to test your game and ensure the bird, monsters, loosing and winning conditions work correctly.
Refine the game by adjusting movement speeds, adding more monsters, and enhancing the visuals.
Add sound effects for collision and winning conditions using "play sound [ ] until done" blocks.
BLACK NIGHT ACT METHODOLOGY
CURATION & C ON
For each of steps 3 to 7, state what blocks you will use and discuss how you will use those blocks to create the Black Night game.
CREATION & CONVERSATION
Based on your conversation above, with your group members follow the instructions provided in this guide to create the Black Night game.
END OF BLACK NIGHT GAME

APPENDIX D – SHARK ATTACK GAME




END OF SHARK ATTACK GAME

APPENDIX E – QUESTIONNAIRE

	Experience Factors					
	Effectiveness: The extent to which the intervention is perceived as having achieved its purpose.	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1	The intervention improved my ability to understand coding concepts quickly.					
2	The intervention improved my ability to understand Scratch code.					
3	The intervention improved my ability to solve problems.					
4	The intervention improved my ability to quickly interpret problems based on a scenario.					
5	The intervention improved my ability to convert designs to Scratch code.					
	Burden: The perceived amount of effort that was required to participate in the intervention.	**No effort at all**	**A little effort**	**No opinion**	**A lot of effort**	**Huge effort**
6	How much effort did it take to learn Scratch coding when taught using the intervention?					
7	How much effort did it take to learn how to design solutions using different design tools when taught using the intervention?					
8	How much effort did it take to learn to interpret flow of program based on design tools when taught using the intervention?					
9	How much effort did it take to understand coding concepts when taught using the intervention?					
10	How much effort did it take to understand problem scenarios when taught using the intervention?					

	Affection: How the participant felt (based on enjoyment) about the intervention.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
11	You enjoyed being taught how to design solutions when taught using the intervention.					
12	You enjoyed being taught problem solving when taught using the intervention,					
13	You enjoyed being taught coding concepts using the intervention.					
14	You enjoyed being taught using the intervention.					
	Trust Factors					
	Coherence: The extent to which the participant understood the intervention and how it works towards their activity.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
15	It was clear to me how the intervention was used to teach me coding.					
16	It was clear to me how the intervention was used to teach me how to solve problems.					
17	It was clear to me how the intervention was used to teach me solution design using design tool.					
18	It was clear to me how the intervention was used to teach me how to use different programming concepts and constructs.					
19	It was clear to me how the intervention was used to teach me how to interpret program flow based on design tools.					
	Reliability: the extent to which the participant deems the intervention as reliable and trustworthy.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
20	The intervention was helpful when learning to code.					

21	The intervention was appropriate for learning complex jargon					
22	The intervention was trustable for learning program flow based on design tools					
23	The intervention yielded the same good results when used repeatedly.					
	People Factors					
	Social Influence: the extent to which the views of any lay-person such as a fellow student, an acquaintance, or any other person that may have knowledge of an intervention affected a student's views about an intervention.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
24	I like the intervention because my peers have positive views about the intervention.					
25	I like the intervention because my peers enjoyed being taught using the intervention.					
26	I like the intervention because my peers were helpful when I was taught coding using the intervention.					
27	I like the intervention because my peers were always excited about attending coding classes.					
28	I like the intervention because I saw good results of it on my peers.					
	Facilitator Influence: extent to which the participant liked the intervention as influenced by knowledgeable experts of the intervention, such as their lecturer or tutor.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
29	I like the intervention because my lecturer has positive views about the intervention.					
30	I like the intervention because my lecturer likes the intervention.					
31	I like the intervention because my lecturer was					

	helpful when I was taught coding using the intervention.					
32	I like the intervention because my lecturer enjoyed his teaching when using the intervention.					
	Anticipated Factors					
	Effectiveness: The extent to which the intervention is perceived being able to achieved its purpose.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
33	The intervention would improve my ability to teach coding concepts quickly.					
34	The intervention would improve my ability to teach how to simplify complex jargon.					
35	The intervention would improve my ability to teach how to describe Scratch code.					
36	The intervention would improve my ability to teach how to quickly solve problems based on a scenario.					
37	The intervention would improve my ability to teach how to convert designs to Scratch code.					
	Burden: The perceived amount of effort that is required to participate in the intervention.	**No effort at all**	**A little effort**	**No opinion**	**A lot of effort**	**Huge effort**
38	How much effort will it take to teach Scratch coding when teaching using the intervention?					
39	How much effort will it take to teach how to design solutions using different design tools when teaching using the intervention?					
40	How much effort will it take to teach students how to interpret flow of programs based on design tools when teaching using the intervention?					
41	How much effort will it take to teach students					

	coding concepts when teaching using the intervention?					
42	How much effort will it take to teach students how to decipher problem scenarios when teaching using the intervention?					
	Affection: How an individual expects to feel (based on enjoyment) about the intervention.	**Strongly dislike**	**Dislike**	**No opinion**	**Like**	**Strongly like**
43	Will you like or dislike teaching coding using the intervention?					
44	Will you like or dislike teaching how to design solutions when using design tools using the intervention?					
45	Will you like or dislike teaching problem solving using the intervention?					
46	Will you like or dislike teaching coding concepts using the intervention?					
47	Will you like or dislike teaching using the intervention?					
	Self-Efficacy: the extent to which the participant believes they will be able to perform at the expected levels.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
48	I think I will be able to teach coding when using this intervention.					
49	I think I will be able to describe programming concepts and constructs when teaching using this strategy.					
50	I think I will introduce students well to problem solving using this intervention					
51	I think I will teach students well how to interpret designs and turn them into code when using this intervention					
52	I think I will teach students well how to decipher problem scenarios and turn it into					

	a design solution when using this intervention					
	Trust Factors					
	Coherence: The extent to which the participant thinks they will understand the intervention and how they will use it.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
53	It is clear to me how the intervention will assist me to teach.					
54	It is clear to me how the intervention will assist me to teach how to solve problems.					
55	It is clear to me how the intervention will assist me to teach solution design using design tools.					
56	It is clear to me how the intervention will assist me to teach how to use different coding concepts and constructs.					
57	It is clear to me how the intervention will assist me to teach how to interpret program flow based on design tools.					
	Reliability: extent to which the participant thinks they will deem the intervention as reliable and trustworthy	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
58	The intervention will be helpful when I teach students how to code.					
59	The intervention will be appropriate when I teach problem solving.					
60	The intervention will be trustable when I teach coding concepts and constructs.					
61	The intervention will be reliable when I teach students how to convert designs to code.					
62	The intervention will repeatedly yield the same results when I use it.					
	People Factors					

	Social Influence: extent to which participant thinks they will like the intervention based on their students' views about the intervention.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
63	I will like the intervention if my students have positive views about it.					
64	I will like the intervention if my students enjoy being taught the intervention.					
65	I will like the intervention if my students are helpful to each other when I teach coding using the intervention.					
66	I will like the intervention if my students are always excited about being taught coding using the intervention.					
67	I will like the intervention if I see its good results on my students.					
	Facilitator Influence: extent to which participant thinks they will like the intervention based on the views of fellow teachers in the future.	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
68	I will like the intervention if other teachers have positive views about the intervention.					
69	I will like the intervention if other teachers like the intervention.					
70	I will like the intervention if other teachers are helpful when I teach coding using the intervention.					
71	I will like the intervention if other teachers seem to enjoy teaching using the intervention.					
	Usage Behavior					
	Usage Behavior: the anticipated manner of use of the intervention by the participant	**Strongly disagree**	**Disagree**	**No opinion**	**Agree**	**Strongly Agree**

	when they are a teacher in the future.					
72	As a teacher in the future I would attend classes that use the intervention.					
73	As a teacher in the future I would conduct classes that use the intervention.					
74	As a teacher in the future I would not use the intervention at all, whether for my learning or teaching.					

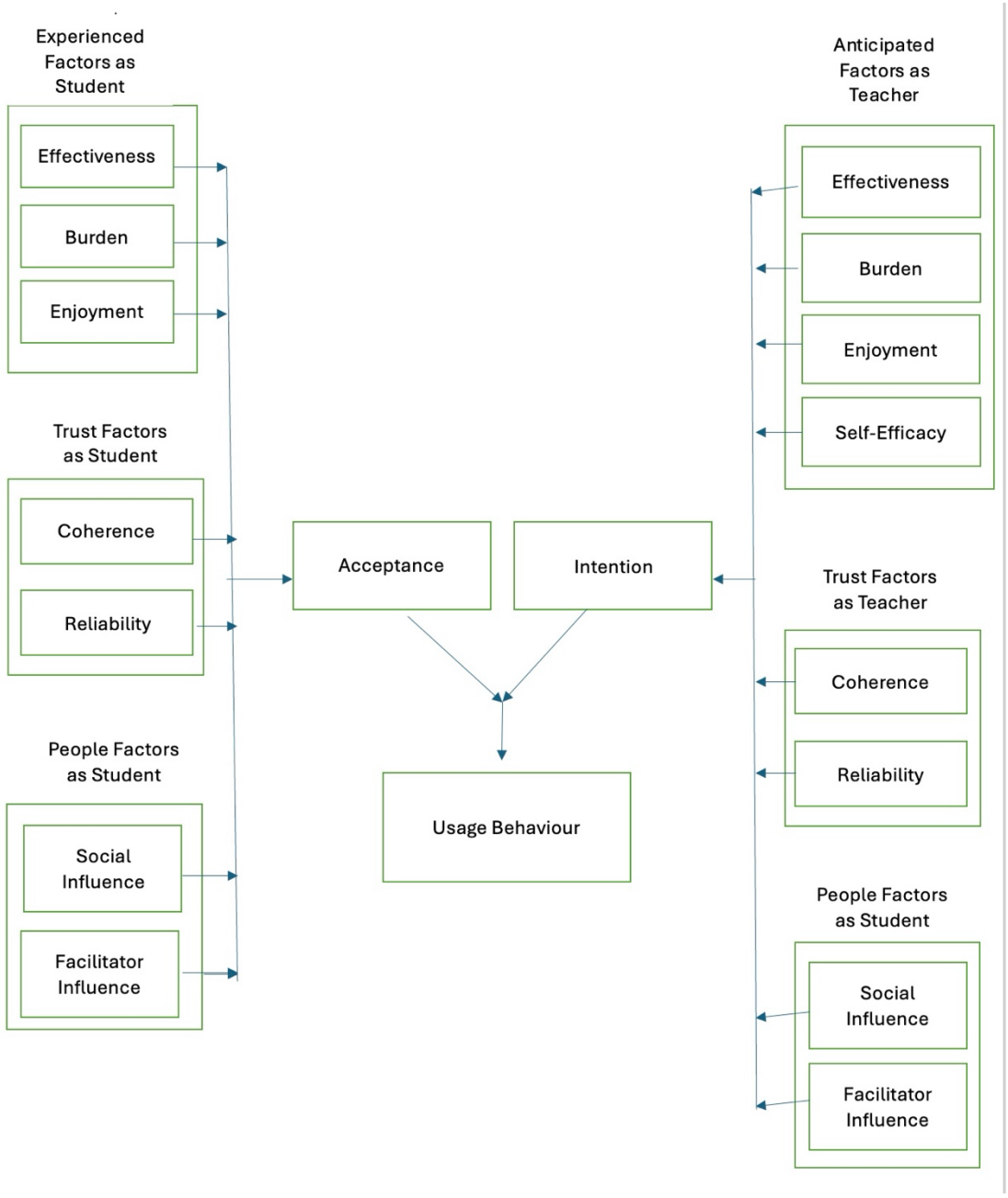
APPENDIX F – INTERVIEW SCHEDULE

Interview schedule to further be confirmed after quantitative data analysis.

Please provide the following information before commencing with interview
Gender:

1. In what way do you think the experience of being taught using the intervention affected the way you would use the intervention for your teaching in the future and why?
2. In what way do you think the experience of being taught using the intervention affected the way you would use the intervention for your learning purposes in the future and why?
3. In what way do you think your anticipated views of the intervention affected the way you would use the intervention for your teaching in the future and why?
4. In what way do you think your anticipated views of the intervention affected the way you would use the intervention for your learning in the future and why?
5. Which factor (Experience, Trust or People Factor) was most influential in affecting the way you would use the intervention in the future and why?
6. Which factor (Experience, Trust or People Factor) was least influential in affecting the way you would use the intervention in the future and why?
7. Further questions will be based on quantitative findings.

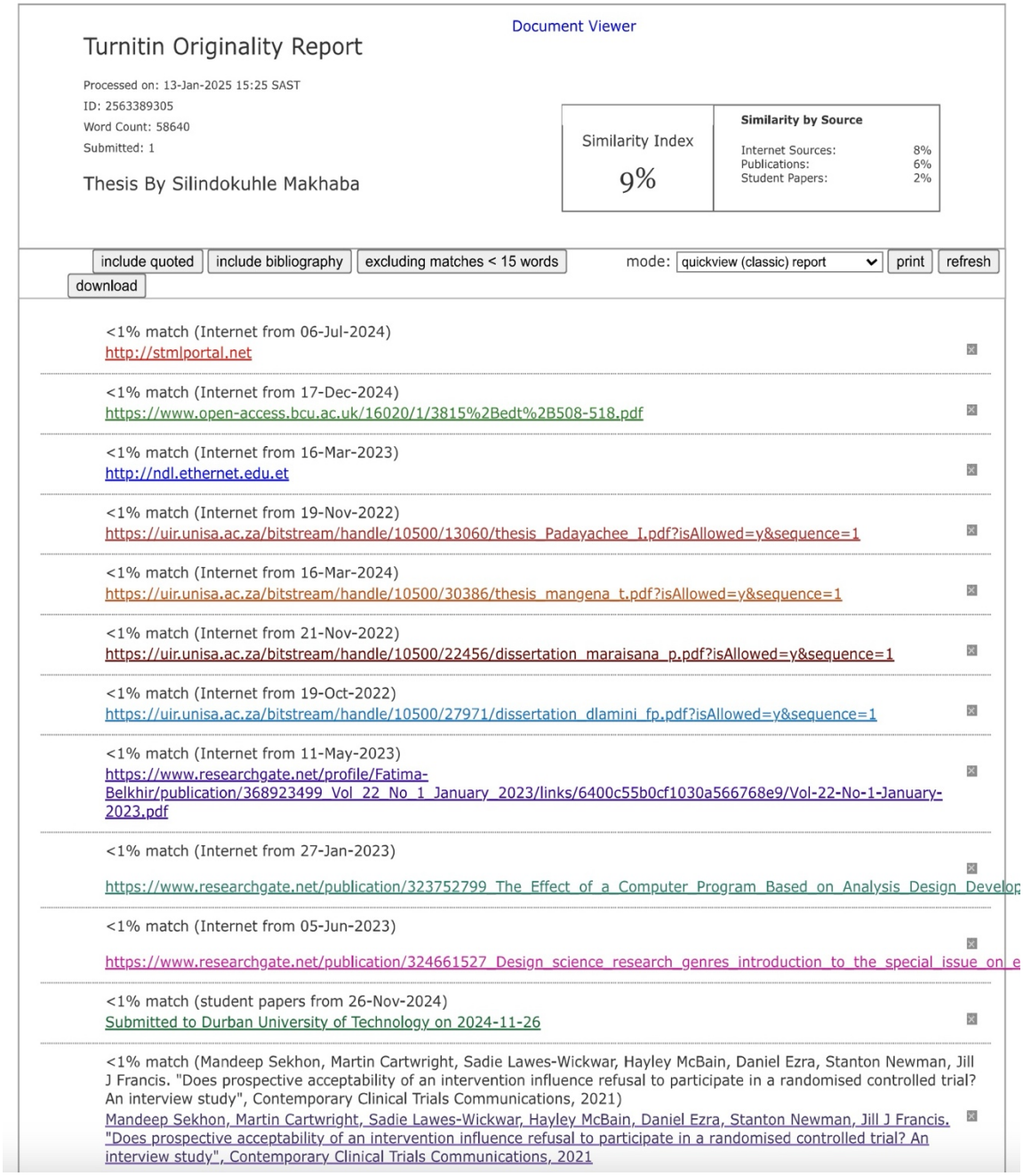
APPENDIX G – CONCEPTUAL FRAMEWORK



APPENDIX H – EFFECTS OF ACCEPTANCE AND INTENTION ON USAGE BEHAVIOR

Acceptability	Intention	Usage Behaviour
High	High	Use as a Deliverer or Use as a Receiver
High	Low	Use as a Receiver
Low	High	Use as a Deliverer
Low	Low	No Use

APPENDIX I – TURNITIN REPORT



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Submitted to Durban University of Technology on 2024-11-26

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Mandeep Sekhon, Martin Cartwright, Sadie Lawes-Wickwar, Hayley McBain, Daniel Ezra, Stanton Newman, Jill J Francis. "Does prospective acceptability of an intervention influence refusal to participate in a randomised controlled trial? An interview study", Contemporary Clinical Trials Communications, 2021

APPENDIX J – ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

23 January 2023

Silindokuhle Bright Makhaba (210504342)
School of Education
Edgewood Campus

Dear SB Makhaba,

Protocol reference number: HSSREC/00005075/2022
Project title: Students' perspectives on using an activated classroom teaching approach with computational thinking to introduce coding: A case study at a South African university
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 08 November 2022 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 23 January 2024.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/ms

Humanities and Social Sciences Research Ethics Committee
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Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville