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Equipping South African Foundation Phase Pre-Service Teachers with Computational Thinking through Unplugged Coding

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ABSTRACT
The integration of computational thinking (CT) in South Africa's Foundation Phase curriculum is gaining momentum, particularly with the introduction of coding and robotics. However, full-scale implementation has been delayed by limited infrastructure, insufficient teacher training, and unequal access to resources. This article reports qualitative findings from the 2024 pilot phase of the Foundation Phase Unplugged Coding Project conducted at the Cape Peninsula University of Technology (CPUT). Guided by a Scholarship of Teaching and Learning (SoTL) approach, the study explores non-digital methods for developing CT and examines short-term shifts in pre-service teachers' knowledge, strategies, and confidence. Unplugged coding provides equitable, hands-on, and collaborative problem-solving experiences that are independent of digital devices, making them relevant to both well-resourced and under-resourced schools. Using service learning as a training model, the project aligns with national policy and investigates pre-service teachers' engagement in coursework, classroom implementation, and reflective practice. Reflective essays reveal how pre-service teacher participants implemented, understood, and adapted CT pedagogy across diverse South African classrooms, developing competence, problem-solving strategies, and CT literacy during teaching practicum. The study contributes empirical evidence to the emerging field of CT in early education and demonstrates the value of a SoTL approach for strengthening teacher education research.

Keywords: Computational Thinking, Foundation Phase, Pre-service Teacher Education, Service Learning

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1. INTRODUCTION

In an era of rapid technological advancement, education systems worldwide are under pressure to prepare learners for a digitally mediated society. Teachers must not only adapt to these shifts but also harness technology to enrich learning experiences (Geldenhuys & Fataar, 2021). Globally, the inclusion of coding and computational thinking (CT) in early education reflects a growing emphasis on cultivating twenty-first-century competencies such as creativity, collaboration, and problem-solving (van der Wal, 2021). In South Africa, the Department of Basic Education (DBE) has introduced coding and robotics within the Foundation Phase (Grades R–3), creating both opportunities and challenges for teacher education (Nkosi, 2023).

Despite policy progress, the large-scale rollout of coding and robotics has been hampered by financial constraints, policy delays, and competing curriculum priorities. In its reply to Parliamentary Question NW32, dated 6 February 2025, the DBE confirmed that full implementation was halted due to the high costs of teacher training, infrastructure, and maintenance, redirecting efforts toward strengthening literacy and numeracy (South Africa, Department of Basic Education, 2025). These pressures intersect with resource inequities and teacher-readiness concerns: many Foundation Phase educators remain untrained, work in overcrowded classrooms, and lack clarity on how to integrate CT meaningfully across subjects (Du Plessis & Letshwene, 2022; Simuja, 2024). This context highlights the Foundation Phase Unplugged Coding Project at the Cape Peninsula University of Technology (CPUT) as a strategically aligned and economically feasible initiative that directly responds to national needs for coding skills in early education.

The project supports national curriculum objectives, provincial teacher-development priorities, and institutional goals for initial teacher education. It explores ways of linking unplugged coding with Foundation Phase subjects through a combination of research, service learning, and reflective practice. By training pre-service teachers to teach CT through non-digital, hands-on activities before they enter the profession, the project offers a sustainable alternative to resource-intensive in-service training. Conducted in collaboration with the Western Cape Education Department (WCED), the initiative aligns with the province's strategic focus on equitable access to quality teaching and with the DBE's broader vision for inclusive, flexible curriculum innovation (Eden, Chisom & Adeniyi, 2024; South Africa. Department of Basic Education, 2024). Importantly, it addresses the lack of empirical research on the practical enactment of CT pedagogy in the Foundation Phase classrooms (South Africa, Department of Higher Education and Training, 2015; Hart, 2023).

Re-conceptualising Computational Thinking in Teacher Education

CT is increasingly recognised as a foundational cognitive skill, comparable to reading, writing, and arithmetic, essential for thriving in a technology-driven world (Zhang et al., 2024). It involves interrelated problem-solving processes such as abstraction, decomposition, pattern recognition, and algorithmic reasoning (Hu, Huang & Li, 2023). Integrating CT into the Foundation Phase deepens engagement with emerging technologies and strengthens transversal learning across science, technology, engineering, mathematics (STEM), literacy, and the arts (Lavigne et al., 2020).

Yet CT remains widely misinterpreted. Many teachers equate it solely with computer programming, overlooking its broader role as an interdisciplinary and collaborative approach to reasoning (Curran, Schulz & Hogan, 2019). When framed narrowly as a stand-alone subject, CT's relevance and accessibility are diminished (Geldenhuys & Fataar, 2021; Halberstadt et al., 2023; Tshidi & Dewa, 2024). Effective teacher preparation, therefore, requires re-imagining CT as a cross-curricular, inclusive pedagogy rather than a purely technical skill set. Pre-service teachers require both conceptual foundations and adaptable pedagogical strategies to effectively implement CT in diverse contexts (Romijn et al., 2021). Teacher competence in CT pedagogy is pivotal for successful classroom integration (Belmar, 2022).

The CPUT Foundation Phase Unplugged Coding Project embodies this re-imagining. It equips pre-service teachers to teach CT concepts through unplugged, hands-on, and collaborative learning activities using simple, low-cost materials. These low-tech methods, which are activities that do not rely on digital devices or computers, enable learners to explore sequencing, pattern recognition, and algorithmic reasoning (Brackmann et al., 2017; Zhang et al., 2024). Grounded in embodied cognition theory, the approach emphasizes the role of physical interaction in constructing knowledge (Vygotsky, 1978; Hu et al., 2023). Such tactile, play-based learning fosters creativity, engagement, and agency, allowing young learners to test and refine their own problem-solving strategies (Ragusa & Leung, 2023; Eden et al., 2024). For novice teachers, unplugged CT reduces dependence on digital tools, mitigates concerns about excessive screen time, and provides equitable access to CT learning in under-resourced schools. Its cross-curricular flexibility also supports integration with mathematics, languages, and life-skills teaching (Monteiro et al., 2021).

A Scholarship for Teaching and Learning Perspective

Applying a Scholarship of Teaching and Learning (SoTL) lens situates the project within systematic, evidence-informed inquiry into teaching and learning. SoTL emphasises reflective, research-based improvement of pedagogy and student learning (Eden et al., 2024; Liebenberg, 2024). The project's theoretical framing draws on three intersecting strands, namely, CT, service learning, and reflective practice. CT provides the disciplinary foundation; service learning connects pre-service teachers with authentic community-based classroom experience (Auten & Twigg, 2015; Romijn et al., 2021); and reflective practice cultivates professional growth and critical awareness (Geertsema, 2016). Through guided journaling and final reflective essays, pre-service teacher participants analyse how they implement and adapt CT pedagogy in diverse South African classrooms, thereby linking practical experience with theoretical understanding.

A SoTL-oriented approach to CT is particularly valuable in South Africa, where uneven infrastructure and limited digital access continue to constrain policy implementation (Nkosi, 2023; Aineamani, 2024). National initiatives, such as robotics competitions and coding boot camps, often fail to connect with formal teacher-education programs (Aineamani, 2024). Research-driven innovation within higher education institutions is therefore essential to bridge this policy–practice divide and to build evidence for scalable, context-responsive models of CT integration (La Fleur & Dlamini, 2022; Heyns, 2023; Langeveldt et al., 2023).

By positioning teaching as both the site and subject of scholarly inquiry, the Foundation Phase Unplugged Coding Project contributes to programme-level improvement and national discourse on curriculum renewal. It provides a practical model for embedding CT within initial teacher education, emphasizing reflective practice, service learning, and collaboration between higher education institutions and provincial departments. Ultimately, this study seeks to demonstrate how unplugged coding can build pre-service teachers' confidence and adaptability to teach CT effectively across the diverse realities of South African classrooms.

In the South African context, this work offers timely and practical relevance. Ongoing delays in the national roll-out of coding and robotics have created an urgent need for evidence-informed, low-cost approaches that can be embedded within pre-service teacher education. By demonstrating how unplugged CT pedagogy can be implemented without reliance on digital infrastructure, this study directly aligns with DBE priorities to strengthen foundational learning while addressing systemic resource inequalities. The findings also respond directly to provincial training needs within the Western Cape, where large-scale in-service training remains financially constrained. The project, therefore, offers a concrete and scalable model for integrating CT into existing B.Ed. Foundation Phase curricula, informing both higher-education programme design and provincial teacher development strategies. Its emphasis on simple, reusable, low-cost materials also offer a scalable approach suitable for under-resourced schools nationwide.

The research, therefore, addresses the following overarching purpose: to explore how unplugged, non-digital approaches to CT can support pre-service teachers' pedagogical development, reflective practice, and readiness to teach CT in the Foundation Phase. Building on this purpose, the study is guided by the following research questions: 1) How do pre-service teachers conceptualise computational thinking (CT) when introduced to unplugged, non-digital approaches? 2) How do pre-service teachers implement unplugged CT activities during their Foundation Phase teaching practicum? 3) What contextual factors (supports and barriers) shape the implementation of unplugged CT activities across well-resourced and under-resourced schools? 4) How does guided reflective practice influence pre-service teachers' pedagogical development in relation to CT? This study contributes empirical evidence on the value of a low-cost, SoTL-framed approach to initial teacher education, providing programmatic recommendations for scalable, context-responsive CT integration in early childhood education.

2. METHOD

Although the broader Foundation Phase Unplugged Coding Project uses a mixed-methods design, this article reports solely on the qualitative component of the 2024 pilot phase. The dataset analysed for this article consists exclusively of pre-service teachers' final reflective essays. The project forms part of the Foundation Phase Unplugged Coding Project at CPUT, a three-year initiative funded by the National Research Foundation (NRF) and implemented in collaboration with the WCED. Guided by a SoTL approach, the study investigated pre-service teachers' engagement with non-digital CT activities during their coursework and teaching-practice placements.

The reflective essays were analysed qualitatively; no quantitative analyses were conducted for the purpose of this article. Reflective essays provided insight into how participants planned, implemented, and adapted unplugged coding lessons in authentic classroom settings, as well as how they interpreted CT concepts within the Foundation Phase curriculum.

The pilot cohort comprised ninety-two third-year Bachelor of Education (B.Ed.) Foundation Phase pre-service teachers, all female, reflecting the typical gender composition of Foundation Phase programmes in South Africa. Most pre-service teacher participants were approximately twenty-one years old. They were enrolled in the Professional Practice module at CPUT and undertook the project as part of their assessed coursework. Their eight-week teaching practicum consisted of two four-week school placements. The first practicum cycle ran from April 8 to May 3, 2024, followed by the second cycle from July 15 to August 8, 2024. These placements took place across 143 schools in the Western Cape Province, encompassing both well-resourced and under-resourced contexts in urban and rural settings. Schools included a mix of public and independent institutions using Afrikaans or English as the medium of instruction. Placement selection occurred through consultation between students and the university to ensure exposure to varied classroom environments.

The project was embedded in the Professional Practice subject and implemented through structured training and guided field-based application. Prior to the teaching practicum, pre-service teacher participants attended two six-hour workshops, held on March 8, 2024, and March 15, 2024, facilitated by a specialist in unplugged coding pedagogy. These workshops introduced unplugged CT pedagogy through interactive demonstrations using simple, low-cost materials such as cards, blocks, ropes, coding mats, and floor grids. The sessions focused on developing core CT concepts, including sequencing, pattern recognition, and algorithmic reasoning, managing collaborative, play-based learning environments, and linking CT with existing curriculum subjects such as mathematics, language, and life skills. Following the workshops, pre-service teachers applied these concepts during their teaching practicum, designing and delivering lessons that linked unplugged CT activities to their regular teaching subjects. They also observed how in-service teachers approached or could approach similar non-digital methods for introducing concepts of CT. Throughout the teaching practicum, pre-service teacher participants completed structured observation forms that documented

instructional strategies, learner engagement, and classroom dynamics, serving as a basis for their reflective writing. Data for the broader project were collected from multiple instruments (surveys, observation sheets, journals, and reflective essays); however, only the reflective essays were used in this article's analysis. All data collected during the 2024 academic year were anonymised before storage in accordance with institutional research ethics guidelines.

Reflective essays were analysed thematically following Braun and Clarke's (2006) six-step framework: 1) familiarisation with the data; 2) generating initial codes; 3) searching for themes; 4) reviewing themes; 5) defining and naming themes; and 6) producing the final analytic report. This analytic approach captured recurring patterns in pre-service teachers' learning, pedagogical shifts, and classroom adaptations. Themes generated from the essays also informed iterative improvements to workshop content and practicum support for subsequent cohorts, consistent with the SoTL emphasis on research-informed pedagogical refinement.

Ethical approval was obtained from the university's research ethics committee. Participation was voluntary, and informed consent was secured from all pre-service teachers. School and learner identities were anonymized, and reflective data were used solely for research and program improvement purposes. Credibility was supported through systematic thematic analysis and clear documentation of training and practicum procedures. Transferability was strengthened through detailed contextual descriptions of the schools and training environment.

This qualitative design enabled an in-depth examination of pre-service teachers' experiences with unplugged CT pedagogy within authentic Foundation Phase contexts. The focus on reflective practice aligns with the SoTL principle that teaching and learning should be evidence-based and continuously improved through scholarly inquiry (Boyer, 1990; Geertsema, 2016).

3. RESULTS AND DISCUSSION

This section presents and discusses the key findings of the Foundation Phase Unplugged Coding Project, drawing on data from pre-service teachers' reflective essays. The analysis is organised around three themes: Navigating practical challenges, Pedagogical shifts and skills development, and Reflective practice and professional growth emerging from these reflections on unplugged coding. Each theme is illustrated with representative excerpts and discussed in relation to relevant literature on CT, Foundation Phase education, and teacher professional development.

Theme 1: Navigating practical challenges

Pre-service teachers faced several challenges during the implementation of unplugged coding activities, particularly concerning material resources and time constraints. Despite limited access to typical unplugged materials such as coding mats, blocks, and floor grids, many demonstrated creativity and adaptability in resource-constrained settings. Table 1 below summarises representative excerpts illustrating the adaptive strategies they employed.

Table 1. Adaptive strategies used by pre-service teachers in resource-constrained classrooms

Sub-theme	Pre-service teacher reflections
Lack of materials	"We didn't have equipment, so I drew a life-size coding maze on the ground with chalk. The learners loved it, and they still learnt the concepts."
Improvisation	"Instead of blocks, we used colored papers taped to the floor to teach sequencing."
Time constraints	"It was difficult fitting the unplugged activity into the schedule, but once I simplified the task, it worked well."
Tension with in-service teachers	"My mentor teacher was skeptical about using games, so I had to explain how it supports thinking skills."

These reflections highlight that the absence of ideal resources did not inhibit the development of CT skills. Instead, pre-service teachers exemplified CT dispositions such as problem-solving,

abstraction, and algorithmic thinking, illustrating the transfer of these concepts from content to pedagogy. Their improvisation with everyday classroom objects mirrors the adaptability promoted through unplugged approaches, aligning with studies that emphasise low-tech innovation in Foundation Phase classrooms (Brackmann et al., 2017; Geldenhuys & Fataar, 2021).

Time management also emerged as a significant concern, consistent with Halberstadt et al. (2023), who note that integrating new pedagogies requires deliberate planning and curriculum alignment within constrained timetables. Furthermore, the need to justify CT activities to sceptical in-service teachers emphasises the importance of a shared professional understanding of CT's educational value in Foundation Phase contexts. Within a SoTL framework, these challenges became opportunities for reflection and evidence-informed adaptation, revealing how pre-service teachers actively constructed professional knowledge through situated problem-solving.

In line with these reflections, Bers (2018) argues that unplugged, hands-on coding activities are particularly effective for supporting early CT development because they allow learners to externalise and test their reasoning through concrete manipulation. Similarly, Grover and Pea (2013) emphasise that competence in CT develops through conceptual engagement rather than reliance on digital tools. The adaptive strategies articulated by the pre-service teachers, including the improvisation of materials and the creation of floor-based coding mazes, reflect Bers's (2018) and Grover and Pea's (2013) findings that low-tech, embodied learning environments can foster essential cognitive processes, even in contexts with limited resources.

Theme 2: Pedagogical shifts and skills development

Participation in the Unplugged Coding Project supported noticeable pedagogical shifts among pre-service teachers. Initially uncertain about the nature of CT, many developed a deeper understanding of it as a means of fostering problem-solving, collaboration, and creativity rather than viewing it as purely technical content. Table 2 presents reflections that illustrate these shifts in understanding, lesson design, and the move toward more learner-centred, integrative teaching approaches.

Table 2. Shifts in understanding and teaching approaches among pre-service teachers

Sub-theme	Pre-service teacher reflections
Shift in understanding CT	"At first, I thought it was only games. Then I realised I was teaching problem-solving, patterns, and planning."
Learner-centred instruction	"Even the learners who usually stay quiet got involved. They had to work as a team and explain their thinking."
Integration across subjects	"We linked coding to maths patterns and even to story sequencing during language time."

This shift toward learner-centred instruction aligns with Vygotsky's (1978) sociocultural theory, in which knowledge is co-constructed through social interaction, and with Grover and Pea's (2013) conceptualisation of CT as an exploratory and collaborative process. Unplugged activities prompted pre-service teachers to design tasks that encouraged teamwork, reasoning, and creativity, strengthening pedagogical content knowledge (Kalelioglu et al., 2016).

Pre-service teachers also recognised the cross-curricular potential of CT. Their lessons frequently bridged mathematics, languages, and life-skills outcomes, demonstrating CT's integrative power within Foundation Phase learning (Mills et al., 2024). These findings suggest that unplugged coding can democratize access to computer science education by providing flexible, context-relevant ways of teaching fundamental cognitive skills. From a SoTL perspective, such pedagogical shifts exemplify how research-informed experimentation and guided reflection foster professional learning that is both evidence-based and transformative.

Furthermore, these pedagogical shifts resonate with Resnick's (2017) view that playful, exploratory learning environments enable learners to experiment, iterate, and express their thinking, which are conditions the pre-service teachers noted as emerging naturally through unplugged CT tasks. Moreover, the observed cross-curricular integration aligns with Mills et al. (2024), who conceptualise CT as an adaptable cognitive toolkit that supports learning across mathematics, languages, and life skills rather than functioning as a discrete subject. By designing collaborative, inquiry-driven activities, pre-service teachers enacted precisely the kinds of creative and problem-solving learning experiences promoted in current CT literature.

Theme 3: Reflective practice and professional growth

A major finding was the development of critical reflection skills among pre-service teachers. Engagement with reflective writing enabled pre-service teacher participants to move beyond description toward metacognitive evaluation of their practice, identifying areas for refinement and further professional growth. Table 3 highlights examples of critical reflection as pre-service teachers assessed their lessons, learner responses, and strategies for ongoing improvement.

Table 3. Evidence of critical reflection and professional growth in pre-service teachers' reflections

Sub-theme	Pre-service teacher reflections
Reflection on lesson planning	"I would do this lesson differently next time by scaffolding more. Some learners struggled with following the steps."
The learner needs awareness	"Next time I'll add more visual prompts because some learners needed extra support to follow the sequence."
Future adaptations	"In the future, I will design shorter activities with clear step-by-step instructions to keep young learners focused."

These reflections reveal an emerging capacity for professional judgement and adaptive decision-making, which are competencies regarded as hallmarks of effective teacher education (Healey, Flint & Harrington, 2016; Felten & Geertsema, 2023). Through reflective inquiry, pre-service teacher participants displayed increased autonomy and evidence of internalising a research-informed stance toward their teaching. Approximately two-thirds of pre-service teachers reported heightened confidence in lesson planning and learner-centred facilitation, while about half provided explicit examples of cross-curricular integration.

Such findings reinforce the transformative potential of structured unplugged coding interventions in developing reflective, adaptive, and contextually aware practitioners. Within the SoTL framework, reflective practice serves not only as a means of individual growth but also as a scholarly tool for program improvement. Insights from pre-service teacher participants' reflections are used to refine subsequent training cycles, closing the loop between inquiry and pedagogical enhancement (Boyer, 1990; Geertsema, 2016).

This growing reflective capacity echoes Bers' (2018) argument that CT education should cultivate not only cognitive processes but also dispositions such as perseverance, flexible thinking, and purposeful iteration. Likewise, Grover and Pea (2018) emphasize that CT pedagogy requires teachers to engage in continuous refinement based on learner feedback and contextual constraints, a process evident as pre-service teachers critique their lessons and identify strategies for improvement.

Taken together, the qualitative findings emphasize the perceived feasibility and educational value of integrating unplugged CT strategies into initial teacher education programs, particularly in resource-constrained environments. They emphasize the importance of experiential learning, guided reflection, and interdisciplinary integration in preparing pre-service teachers for the complexities of Foundation Phase teaching in a digitally evolving world.

LIMITATIONS OF THE STUDY

As pilot-phase findings from a larger SoTL study, drawn from a single-institution, single-year cohort of ninety-two third-year B.Ed. Foundation Phase pre-service teachers placed across 143 Western Cape schools over two four-week teaching practicum periods, the results reflect context-specific experiences rather than sector-wide outcomes. The cohort's demographic profile (all female) mirrors the typical gender distribution in Foundation Phase programmes; consequently, the study cannot explore potential gendered differences, and its findings speak most directly to similarly composed cohorts. The qualitative evidence relies primarily on self-reported reflections written in a course-linked context, complemented by brief observations and structured surveys, which may introduce social desirability and recall biases. Because implementation occurred within a short teaching practicum window, the findings provide short-term insights into the pedagogical growth of pre-service teachers. Variation in school contexts and mentor practices likely influenced how unplugged CT activities were enacted. These constraints mean that the results should be interpreted as indicative rather than generalisable. Future phases of the project will replicate the study with subsequent cohorts and teaching practicum cycles, analyse in-service teacher survey data alongside pre-service reflections, and expand institutional and regional coverage to test transferability.

4. CONCLUSION

This study shows that introducing computational thinking (CT) through unplugged, non-digital approaches effectively supports South African Foundation Phase pre-service teachers in developing both conceptual understanding and practical pedagogical skills.

a. The findings reveal that pre-service teachers initially held narrow conceptions of CT, often equating it with computers or coding tools, but shifted toward seeing CT as a cognitive, problem-solving, and cross-disciplinary practice when exposed to embodied, low-tech activities.
b. During their teaching practicum, the pre-service teachers were able to implement unplugged CT activities in developmentally appropriate ways, demonstrating growing confidence and creativity despite encountering real classroom challenges.
c. The study highlights that contextual conditions, including resource variability, school culture, material availability, and mentoring, strongly shaped their implementation. Pre-service teachers in under-resourced schools particularly relied on improvisation, collaboration, and adaptable low-cost materials to enact CT meaningfully.
d. Guided reflective practice played a central role in strengthening pedagogical judgment, professional identity, and the ability to translate theory into practice. Structured reflection helped teachers recognise misconceptions, refine instructional decisions, and align CT pedagogy with early childhood learning needs.

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REFERENCES

Aineamani, B. (2024, February). Is South African education ready to excel at coding and robotics? *Pearson South Africa.*

Akil, W. N. H. W. M., & Matore, M. E. (2023). Shocking truths about three factors that influenced computational thinking I wish I learned earlier! *International Journal of Academic Research in Progressive Education and Development*, 12(2), 1210–1224.

Auten, J. G., & Twigg, M. M. (2015). Teaching and learning SoTL: Preparing future faculty in a pedagogy course. *Teaching & Learning Inquiry: The ISSOTL Journal*, 3(1), 3–13.

Belmar, H. (2022). Review on the teaching of programming and computational thinking in the world. *Frontiers in Computer Science*, 4, 1–17.

Bers, M. U. (2018). *Coding as a playground: Programming and computational thinking in the early childhood classroom* (2nd ed.). Routledge.

Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate.* Carnegie Foundation for the Advancement of Teaching.

Brackmann, C. P., González, M. R., Robles, G., León, J. M., Casali, A., & Barone, D. (2017). Development of computational thinking skills through unplugged activities in primary school. *In proceedings of 12th workshop in primary and secondary computing education* (pp. 65–72). Association for Computing Machinery.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3(2), 77–101.

Curran, J. R., Schulz, K. A., & Hogan, A. (2019). *Coding and computational thinking: What is the evidence?* State of New South Wales Department of Education.

Du Plessis, E. C., & Letshwene, M. J. (2022). A reflection on identified challenges facing South African teachers. *The Independent Journal of Teaching and Learning,* 15(2), 69–91.

Eden, C. A., Chisom, O. N., & Adeniyi, I. S. (2024). Harnessing technology integration in education: Strategies for enhancing learning outcomes and equity. *World Journal of Advanced Engineering Technology and Sciences*, 11(2), 1–8.

Felten, P., & Geertsema, J. (2023). Recovering the heart of SoTL: Inquiring into teaching and learning 'as if the world mattered'. *Innovative Higher Education*, 48, 1095–1112.

Gansemer-Topf, A. M., Webb, A. S., Kensington-Miller, B., Maheux-Pelletier, G., Lewis, H., Luu, J., & Hofmann, A. K. (2021). Navigating the chaos: The value of SoTL during times of uncertainty. *Transformative Dialogues: Teaching and Learning Journal,* 14(2), 30–40.

Geertsema, J. (2016). Academic development, SoTL and educational research. *International Journal for Academic Development*, 21(2), 122–134.

Geldenhuys, C. J., & Fataar, A. (2021). Foundation phase teachers' experiences of teaching the subject, coding, in selected Western Cape schools. *South African Journal of Education*, 41(4), 1–9.

Grover, S., & Pea, R. (2013). Computational thinking in K–12: A review of the state of the field. *Educational Researcher*, 20(20), 1–6.

Grover, S., & Pea, R. (2018). Computational Thinking: A competency whose time has come. In S. Sentance, E. Barendsen, & C. Schulte (Eds.), *Computer Science Education: Perspectives on Teaching and Learning in School* (pp. 20-38). Bloomsbury Publishing.

Halberstadt, J., de Bronstein, A. A., Greyling, J., & Bissett, S. (2023). *Transforming entrepreneurship education: Interdisciplinary insights on innovative methods and formats.* Springer.

Hart, S. A. (2023). Identifying the factors impacting the uptake of educational technology in South African schools: A systematic review. *South African Journal of Education*, 43(1), 1–16.

Healey, M., Flint, A., & Harrington, K. (2016). Students as partners: Reflections on a conceptual model. *Teaching & Learning Inquiry,* 4(2), 8–20.

Heyns, J. (2023). *Development of a framework of factors essential to the optimal implementation of the coding and robotics subject in South African schools* [Unpublished master's thesis]. University of Stellenbosch.

Hu, W., Huang, R., & Li, J. (2023). Young children's experience in unplugged activities about computational thinking: From an embodied cognition perspective. *Early Childhood Education Journal,* 52, 769–782.

Kalelioglu, F., Gülbahar, Y., & Kukul, G. (2016). A framework for computational thinking based on a systematic research review. *Baltic J. Modern Computing*, 4(3), 583–596.

La Fleur, J., & Dlamini, R. (2022). Towards learner-centric pedagogies: Technology-enhanced teaching and learning in the 21st century classroom. *Journal of Education*, (18), 1–20.

Langeveldt, D. C., Pietersen, D., & van Wyk, A. (2023). South African legal framework to prepare pre-service teacher education programmes: A Freirean approach. *Research in Educational Policy and Management,* 5(3), 95–107.

Lavigne, H. J., Presser, A. L., & Rosenfeld, D. (2020). An exploratory approach for investigating the integration of computational thinking and mathematics for preschool children. *Journal of Digital Learning in Teacher Education*, 36(1), 63–77.

Liebenberg, I. (2024). Robotics and coding in South African schools: Are we ready to join the 4IR? *The Eduvation Network.*

Mills, K. A., Cope, J., Scholes, L., & Rowe, L. (2024). Coding and computational thinking across the curriculum: A review of educational outcomes. *Review of Educational Research*, *20*(1), 1–38.

Monteiro, A. F., Miranda-Pinto, M., & Osório, A. J. (2021). Coding as literacy in preschool: A case study. *Education Sciences*, 11(5), 1–15.

Nkosi, M. (2023, October 7). Empowering South African learners: The journey of teaching the coding and robotics curriculum. *IT News Africa*.

Petersen, Z. (2020). *Primary school teachers' experiences of professional development in teaching coding* [Unpublished master's thesis]. Cape Peninsula University of Technology.

Ragusa, G., & Leung, L. (2023). The impact of early robotics education on students' understanding of coding, robotics design, and interest in computing careers. *Sensors*, 23, 1–10.

Resnick, M. (2017). *Lifelong kindergarten: Cultivating creativity through projects, passion, peers, and play.* MIT Press.

Romijn, B. R., Slot, P. L., & Leseman, P. P. M. (2021). Increasing teachers' intercultural competences in teacher preparation programs and through professional development: A review. *Teaching and Teacher Education,* 98, 1–15.

Saleem, A., Kausar, H., & Deeba, F. (2021). Social constructivism: A new paradigm in teaching and learning environment. *Perennial Journal of History,* 11(11), 403–421.

Saxena, A., Lo, C. K., Hew, K. F., & Wong, G. K. W. (2019). Designing unplugged and plugged activities to cultivate computational thinking: An exploratory study in early childhood education. *Asia-Pacific Edu Res,* 29(1), 55–66.

Simuja, C. (2024). Exploration of foundation phase: Pre-service teachers' perspectives on their abilities to integrate technology in the classroom. In A. Chigona, H. Crompton, & N. Tunjera (Eds.), *Global perspectives on teaching with technology: Theories, case studies, and integration strategies* (pp. 110–126). Routledge.

South Africa. Department of Basic Education. (2025, February 6). Reply to parliamentary question NW32 01/2025. Status of the roll-out of coding and robotics as mandatory subjects for Grades 1 to 9. *Parliamentary Monitoring Group.*

South Africa. Department of Basic Education. (2024). *Curriculum and assessment policy statement: Foundation Phase Grades R – 3: Coding and Robotics.* Department of Basic Education.

South Africa. Department of Higher Education and Training. (2015). *Revised policy on the minimum requirements for teacher education qualifications.* Government Printers.

Tshidi, M., & Dewa, A. (2024). The promise and peril of Coding & Robotics education in South Africa: A scoping review of teacher preparation and generative artificial intelligence's potential for delivering equity. *Journal of Education*, (96), 141–164.

Van der Wal, E. H. (2021). *Development of 21st century thinking skills in early childhood learners through coding and robotics* [Unpublished master's thesis]. University of Pretoria.

Voon, X. P., Wong, S. L., Wong, L. H., Md. Khambari, M. N., & Syed-Abdullah, S. I. S. (2023). Developing pre-service teachers' computational thinking through experiential learning: Hybridisation of plugged and unplugged approaches. *Research and Practice in Technology Enhanced Learning*, 18(6), 1–27.

Vygotsky, L. S. (1978). *Mind and society: The development of higher mental processes*. Harvard University Press.

Zhang, Y., Liang, Y., Tian, X., & Yu, X. (2024). The effects of unplugged programming activities on K-9 students' computational thinking: Meta-analysis. *Education Tech Research Dev,* (72), 1331–1356.