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# SUCCESSES AND CHALLENGES IN TEACHING CODING AND ROBOTICS IN GRADE 7-9 (SENIOR PHASE) IN PILOT SCHOOLS: LIVED TEACHERS' EXPERIENCES

## *SUCESSOS E DESAFIOS NO ENSINO DE PROGRAMAÇÃO E ROBÓTICA NAS SÉRIES 7ª A 9ª (FASE SÉNIOR) EM ESCOLAS PILOTO: EXPERIÊNCIAS VIVIDAS PELOS PROFESSORES*

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**Abstract**
The incorporation of Coding and Robotics (C&R) into the Grades 7–9 (Senior Phase) curriculum in South Africa aimed to equip learners with essential skills required to thrive in the Fourth Industrial Revolution, including computational thinking, problem-solving, creativity, and collaboration. Although successes in implementing and teaching C&R had been reported, the initiative continued to face substantial obstacles. This study explored South African Senior Phase teachers' experiences in implementing and teaching the newly approved Curriculum and Assessment Policy Statement (CAPS) in pilot schools. Using a qualitative case study framed within the Technological Pedagogical Content Knowledge (TPACK) theory, embedded in the interpretivist paradigm, the study employed interviews, document analysis, and observations to generate and collect data from purposively selected Senior Phase C&R teachers. The data were then thematically analysed. The findings illuminated successes (changes in teacher attitudes, increased teacher engagement, and parental support), as well as constraints (staff capacity, knowledge and understanding of C&R, infrastructure, and institutional and administrative barriers) and enablers [coaching, Professional Learning Communities (PLCs), unplugged-to-plugged learning sequences, and the ethical use of generative AI]. These findings offered actionable recommendations for the successful and equitable implementation and teaching of C&R.

**Keywords:** Coding and Robotics (C&R). Senior Phase. Fourth Industrial Revolution (4IR). Computational Thinking. Digital Literacy. Sustainable Development Goals.

***Resumo***
*A incorporação da Programação e Robótica (C&R) ao currículo do 7º ao 9º ano (Fase Sênior) na África do Sul teve como objetivo dotar os alunos das competências essenciais necessárias para terem sucesso na Quarta Revolução Industrial, incluindo pensamento computacional, resolução de problemas, criatividade e colaboração. Embora tenham sido relatados casos de sucesso na implementação e no ensino de C&R, a iniciativa continuou a enfrentar obstáculos significativos. Este estudo explorou as experiências de professores da Fase Sênior da África do Sul na implementação e no ensino da recém-aprovada Declaração de Política Curricular e de Avaliação (CAPS) em escolas-piloto. Utilizando um estudo de caso qualitativo enquadrado na teoria do Conhecimento Tecnológico-Pedagógico-Conteúdo (TPACK), inserido no paradigma interpretativista, o estudo empregou entrevistas, análise de documentos e observações para gerar e coletar dados de professores de C&R da Fase Sênior selecionados propositadamente. Os dados foram então analisados tematicamente. Os resultados destacaram os sucessos (mudanças nas atitudes dos professores, maior engajamento dos professores e apoio dos pais), bem como as restrições (capacidade da equipe, conhecimento e compreensão de C&R, infraestrutura e barreiras institucionais e administrativas) e os facilitadores [coaching, Comunidades de Aprendizagem Profissional (PLCs), sequências de aprendizagem "unplugged-to-plugged" e o uso ético da IA generativa]. Essas conclusões ofereceram recomendações práticas para a implementação e o ensino bem-sucedidos e equitativos de C&R.*

***Palavras-chave:*** *Programação e Robótica (C&R). Ensino Médio. Quarta Revolução Industrial (4IR). Pensamento Computacional. Alfabetização Digital. Objetivos de Desenvolvimento Sustentável.*

## 1 INTRODUCTION AND BACKGROUND

Responding to the emerging global phenomenon of the Fourth Industrial Revolution (4IR), the Department of Basic Education (DBE) in South Africa, like many other countries, embarked on developing a C&R curriculum (DBE, 2025; Sehlako *et al*., 2023; Moloi & Mhlanga, 2021). This move signalled the state's commitment to ensuring that all learners, regardless of background, were equipped with computational thinking, problem-solving, and systems design skills. Subsequently, the first draft Curriculum and Assessment Policy Statement (CAPS) documents for Grades R–3, 4–6, and 7–9 were submitted to Umalusi for recommendations and appraisal on 7 October 2020 (DBE, 2024; Parliamentary Monitoring Group, 2024). While awaiting input from Umalusi, the quality assurance body, the DBE began a phased pilot project in selected schools across the country in 2021. Having complied with the requirements, the DBE approved and gazetted the Coding and Robotics CAPS on 7 June 2024 in Gazette No. 50767 (DBE, 2024; CAPS 123, 2023).

According to DBE (2021) and Geldenhuys and Fataar (2021), the 2021 phased pilot implementation focused on Grades R–3 (Foundation Phase) and Grade 7 (Senior Phase). The pilot programme was then extended to Grades 4–6 (Intermediate Phase) and Grade 8 (Senior Phase) in 2022, followed by Grade 9 in 2023. The full-scale implementation of the Senior Phase was planned as follows: Grade 7 in 2023, Grade 8 in 2024, and Grade 9 in 2025 (De Jager, 2023; DBE, 2021; Geldenhuys & Fataar, 2021). The pilot project revealed that although provinces had oriented and trained teachers, equipped classrooms, deployed hundreds of thousands of teacher- and learner-support materials and devices, and secured partnerships with several industries, implementation proved more complex than expected. Although teachers' experiences on the ground vary widely, scoping reviews highlight a range of challenges, including teacher unpreparedness and infrastructural gaps, insufficient resources, device obsolescence, limited maintenance support, and timetabling constraints, all of which remain significant hurdles. Several studies have examined C&R teachers’ experiences in the Foundation and Intermediate Phases, but few have explored a similar topic in the Senior Phase. Therefore, it became essential to gain a deeper understanding of Senior Phase C&R teachers' lived experiences, focusing on successes and challenges. The purpose of this paper was to explore the lived experiences of teachers in Grades 7–8 (Senior Phase) teaching C&R in pilot schools. Hence, the research question guiding the study was: What are teachers’ experiences of teaching Coding and Robotics in Grades 7–8 (Senior Phase) in pilot schools, particularly regarding successes and challenges? Framed by TPACK theory and embedded within an interpretivist paradigm, this qualitative study utilised individual interviews, document analysis, and observations to generate and collect data from Senior Phase C&R teachers.

In the South African context, schools are grouped into primary schools (for younger learners, typically 5–12-year-olds) and secondary schools (for older learners, typically 13–18-year-olds). Schools are further categorised into four phases: Foundation Phase (Grades R–3), 5–8-year-olds; Intermediate Phase (Grades 4–6), 9–11-year-olds; Senior Phase (Grades 7–9), 12–15-year-olds; and Further Education and Training (Grades 10–12), 16–18-year-olds. The Senior Phase comprises Grade 7 in primary schools and Grades 8 and 9 in secondary schools. The Senior Phase, among others, became a subject of interest because it was the last phase to experience the implementation of the pilot programme, particularly in Grades 8 and 9 in secondary schools.

## 2 LITERATURE REVIEW

### 2.1 Successes in the implementation and teaching of C&R

The introduction of C&R into the South African curriculum signalled a significant shift towards equipping learners with 21st-century competencies. Freese (2021) states that the initiative aims to enhance problem-solving, innovation, digital literacy, and computational thinking among learners nationwide. Since the commencement of the pilot programme in 2021, several successes have been documented and reported. Among these is the steady increase in the number of schools participating in the pilot programme, from the initial 1000 schools in 2021 to 1769 in 2023 (comprising 200 primary schools with Grades R–3, 1000 primary schools with Grade 7, and 569 secondary schools with Grades 8 and 9) (Geldenhuys & Fataar, 2021; Motshekga, 2023; CAPS 123, 2023), thereby enhancing the data pool on which analyses and decisions can be based. The primary beneficiaries of this increase are primary schools with Grade 7 and secondary schools with Grades 8 and 9. However, McNulty (2024) argues that, due to several constraints, fewer schools are currently participating in the programme.

According to Boz and Allexsaht-Snider (2021), C&R teachers' attitudes improved significantly during the pilot implementation. This improvement in teachers' attitudes may be attributed to increased nationwide awareness of C&R (Letsie, 2023). It is also possible that teachers' attitudes were influenced by recognising C&R's contribution to learners' metacognitive skills, sequential thinking, creativity, and their ability to consider multiple perspectives, skills necessary for the 21st century (Arsalan & Celik, 2022). According to the ICR Foundation (2025), pilot and teacher reports indicate that learners demonstrated enthusiasm for creative problem-solving, robotics tasks, and visual programming.

The literature also notes that provinces reported increases in their budgets, particularly for the procurement of C&R materials (Letsie, 2023). To facilitate effective subject implementation and support teachers' lesson planning, the DBE developed lesson plans and made them available to teachers (Letsie, 2023).

## 2.2 Challenges in the implementation and teaching of C&R

Scoping literature reviews indicate that, since the inception of the C&R pilot programme, teachers have been experiencing a range of challenges. According to DBE (2021) and Zivanayi and Malinga (2025), the rollout of the pilot programme outpaced the availability of fully trained and competent teachers to teach the subject with confidence, highlighting the challenge of teacher preparedness. Mishra and Koehler (2006) emphasise that effective teaching is based on teachers' competence in subject content and technological knowledge. The literature further indicates that teachers were caught off guard when the subject was introduced, particularly in the Senior Phase. Teachers in pilot schools reported experiencing systemic challenges related to infrastructure, equipment, maintenance, and connectivity (Zivanayi & Malinga, 2025). Several schools reportedly use outdated and limited computers in laboratories, reducing the likelihood of meaningful practical learning experiences (Freese, 2021; ICR Foundation, 2025). Reports also reveal that rural and township schools are the most affected, a dilemma that reinforces the status quo and perpetuates educational inequalities and social injustices.

Teachers are challenged by the fragile literacy and numeracy levels among senior phase learners, making it extremely difficult for learners to internalise abstract digital concepts such as programming (Kuo & Kuo, 2025; Wang *et al*, 2024; Zivanayi & Malinga, 2025). In addition, the ICR Foundation (2025) and Oxford University Press South Africa (2025) found that learners enter secondary schools with a wide range of prior knowledge of computers and the English language, making it extremely difficult for teachers to uniformly pace technical vocabulary and algorithmic concepts.

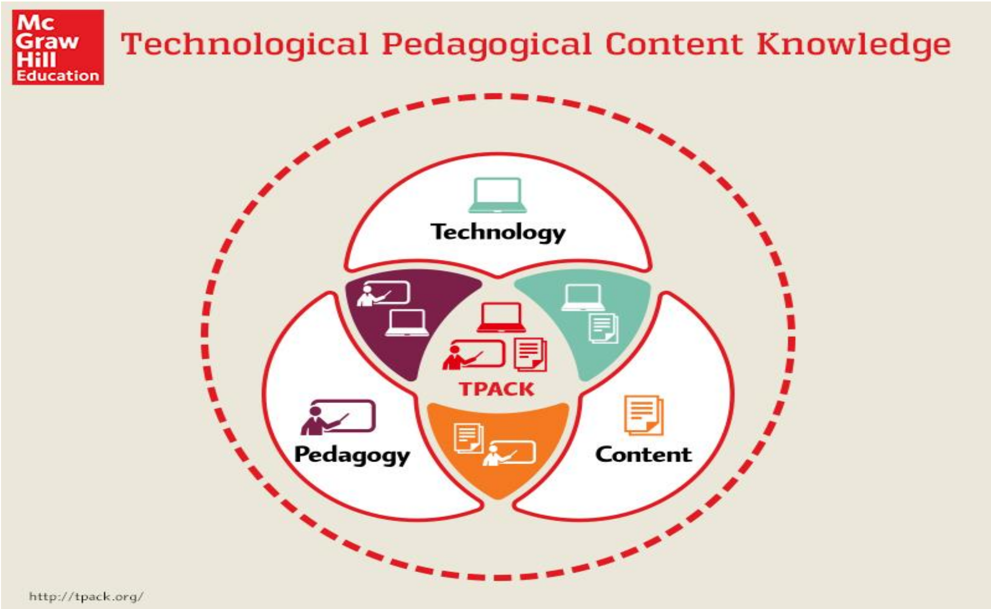
Assessing C&R activities (e.g., team artefacts, debugging logs, and iterative prototyping in the Senior Phase) requires standardised rubrics and moderation protocols, which are reportedly still maturing in most districts (DBE, 2024), thereby compromising standards, creating inconsistency, and causing uncertainty among teachers. The literature also notes that teachers are administratively burdened by the need to capture process-based evidence and manage version control for digital projects in areas with persistent connectivity challenges (ICR Foundation, 2025).

## 3 THEORETICAL FRAMEWORK

The study was framed by Mishra and Koehler's Technological, Pedagogical, and Content Knowledge (TPACK) framework. TPACK highlights the meaningful interplay between teachers' content knowledge, pedagogy, and digital tools (Mishra & Koehler, 2006). According to Mishra and Koehler (2006), Phillips *et al*. (2025), and Schmidt *et al*. (2009), TPACK emphasises that teachers should be competent in three basic knowledge domains: subject content, pedagogy, and technologies aligned with the subject of their specialisation. In the context of C&R teaching, TPACK emphasises that teachers should have a sound understanding of how to integrate C&R content with appropriate pedagogical approaches and teaching tools suitable for C&R instruction. These three knowledge domains are equally important for meaningful teaching that supports learners' retention and application. Figure 1 below presents Mishra and Koehler's TPACK theoretical framework.

**Figure 1**

*The three core elements of TPCK (McGraw-Hill Canada-Hill Canada, 2024)*




## 4 METHODOLOGY

This qualitative case study was framed by Mishra and Koehler's (2006) TPACK theoretical framework and embedded within the interpretivist paradigm. The qualitative case study design was well-suited to capturing Senior Phase C&R teachers' experiences across different school contexts. The purposive sample included six Grade 7–9 C&R teachers from schools across the Umlazi District, south of Durban. The sampled teachers were from schools located in affluent urban, informal, semi-rural, and rural areas. Participants and participating schools were given pseudonyms: P1 from School A, P2 and P3 from School B, P4 from School C, and P5 from School D. Data were generated and collected through individual semi-structured interviews, document analysis, and observation. The data were carefully analysed using Creswell's (2009) thematic analysis, informed deductively by TPACK theory.

## 5 FINDINGS AND DISCUSSION

The aim of piloting the C&R curriculum was to introduce it and evaluate its successes, challenges, and shortcomings (DBE, 2021; Lang, 2021). It was also important to explore the lived experiences of Senior Phase C&R teachers using scientific research methods. Through thematic data analysis, two themes emerged: Theme 1: Successes in the pedagogical implementation and teaching of C&R education, and Theme 2: Challenges encountered in the implementation and teaching of C&R in education. Sub-themes also emerged under each central theme.

### 5.1 Successes in the pedagogical implementation of coding and robotics in education

#### *5.1.1 Change in teacher attitudes*

Although participants acknowledged that they had limited knowledge and understanding of C&R, they generally began to appreciate the introduction of coding and robotics. P1 mentioned:

*I was advised to take coding and robotics courses to improve my employability at school. I had no choice but to give the subject a chance, and I realised that there is much I need to learn to be an effective coding and robotics teacher. I guess this would happen through workshops and continuous staff development programmes.*

Despite these challenges, participants still found hope in the implementation of the curriculum. P2 and P4 commented that '*the content guideline is very interesting and will definitely improve learners' problem-solving skills and prepare them for success in the 21st century.*' Boz and Allexsaht-Snider (2021) argue that teachers' perceptions of C&R have evolved from scepticism to acceptance, as evidenced in P2's response above. All participants in this study strongly agreed that the DBE, in collaboration with the Provincial Department of Education, should provide ongoing support and training to equip teachers teaching C&R.

*5.1.2 Learner engagement*

Learners are the primary beneficiaries of the pilot project, and their response is of utmost importance. The study found that Senior Phase learners are responding positively to the subject and, in many cases, exceeding teachers' expectations. P2 explained:

*Learners love the subject; they make exciting models, and, interestingly, they can explain them well. At times, they even came for coding and robotics during breaks; they really love it.*

The study's findings confirm those of Clevenger *et al*. (2022) and Zhang *et al*. (2020), which indicate that learners are enthusiastic about the subject. This positive response suggests that conditions are favourable for teachers to introduce the subject effectively. Learners' positive engagement may also be attributed to their enjoyment of hands-on activities, problem-solving, and opportunities to try something new. C&R provides an excellent opportunity for learners to explore these learning experiences.

*5.1.3 Engagement and support from parents*

Lemmer (2007) and Mncube (2009) observed that parental involvement has often proven challenging, especially in township and rural communities. Contrary to much of the literature, this study revealed that teachers were pleased with the level of parental involvement and support in the teaching of C&R in pilot schools. All participants (P1, P2, P3, P4, and P5) reported receiving strong parental support. P4 enthusiastically reported:

*We are receiving enormous support from parents. I believe they want their children to know about this new subject. We talk to parents through SGB. At the beginning of the year, we write letters to ask for their support. Sometimes, we send children to search for something online, and parents assist them with their data and phones.*

Expressing a similar experience in her school, P5 reported:

*Parents support us in various ways. They help their children with projects, crafting models, and searching for information at home. They even come to see when their children present their models. I think, for some reason, parents love this subject.*

The unanimous enthusiasm expressed by participants (P1–P5) indicates a remarkably positive, perhaps surprising, level of parental involvement in implementing C&R programmes. P4 underscored that parents were contributing significantly by assisting learners in completing their tasks with essential resources, such as internet access and data services, and by actively engaging in subject-related matters. The ability to encourage parents to become involved in their children's education is an outstanding achievement, particularly in rural and township communities. According to Epstein (2011) and Jeynes (2016), parental involvement is achieved and sustained when it is welcomed and when parents recognise its value. However, initial studies indicate that parents were initially sceptical about the introduction of C&R, possibly because of uncertainty about the new skills it would bring to learners (Toh *et al*., 2016). Increased awareness appears to have worked in the subject's favour (Letsie, 2023). According to Prof Greyling, parents are more willing than ever before to assist their children, as they fear they may miss out while others progress (ASSAf, 2021).

## 5.2 Challenges encountered in the pedagogical implementation of coding and robotics education

### *5.2.1 Limited staff capacity and expertise*

The DBE (2024) emphasises that introducing a new curriculum requires careful planning, including extensive consultation with all relevant stakeholders. Curriculum aspects and expectations should be clearly addressed prior to implementation, followed by continuous monitoring. Teachers who will be at the forefront of curriculum implementation should ideally be selected based on their expertise or interest in the subject. However, P1, P3, and P5 reported that their involvement in teaching C&R was not based on expertise or interest in the subject. P1 explained:

*Actually, management informed me to attend the Coding and Robotics workshop. I was taken aback because I didn’t get any explanation for why I was chosen. I had no clue at all what Coding and Robotics were about. So, I did not volunteer or show any interest in teaching the subject.*

P5 informed:

*You will not believe how I got involved in this subject. I was told to attend the workshop. Before you know it, I was told to teach the subject because I attended the workshop. I tried to resist, but they convinced me.*

The study found that none of the participants had qualifications or expertise in teaching C&R when they were recruited to teach the subject. Among the participants, P4 disclosed that she '*had no formal qualification to teach this subject when I was recruited; I still do not have it.*' P5 also confessed, '*I do not have any qualification in this subject. I specialise in something else. Here I am now, teaching coding and robotics.*' The DBE announced that it would not employ specialised teachers in C&R, but that teachers would instead be identified within schools and trained to teach the subject (DBE, 2021; Lang, 2021). The directive to identify and reassign current staff members, often without considering their qualifications, interests, or preparedness to teach the subject, placed a significant burden on School Management Teams (SMTs). The study's findings reveal that most schools lacked the capacity, and many teachers lacked the expertise, to teach C&R, similar to the experiences reported by Foundation and Intermediate Phase teachers when the pilot was first introduced.

### *5.2.2 Knowledge and understanding of the curriculum, content, pedagogy and technical aspects of teaching C&R*

Most Senior Phase teachers' comprehension and familiarity with the C&R curriculum, including its content, pedagogy, and technological aspects, emerged as a challenge. Curriculum knowledge includes understanding the subject aims, learning outcomes, the skills embedded in C&R, and the content areas, including key concepts and terminology. Developing effective lesson plans largely depends on a comprehensive understanding of the curriculum and relevant subject content (Mishra & Koehler, 2006; Zhang & Tang, 2021). Despite research suggesting that effective and meaningful teaching emerges from a thorough knowledge and understanding of the subject curriculum, the study's findings reveal the opposite, as reflected in the participants' responses. P1 and P5 alluded to their challenges and shortcomings in understanding how coding and robotics connect with the broader curriculum. P1 stated:

*It is a major challenge for me because the concepts were unfamiliar and difficult to interpret for teaching and learning, since I am new to this subject and was asked to assist.*

P2 articulated, '*The theory tends to be more complex because there is a lot of it. There are too many complex concepts, more than the practical part*.' P4 mentioned, '*The subject is new and has many complex concepts, so it is challenging. I am not a specialist in this subject.*' P5 stated:

*It is challenging because I am not professionally trained in the subject. There are new concepts that need a clear explanation for learners. Moreover, I do not really understand them.*

In agreement with P4 and P5, the lack of knowledge and understanding of the C&R curriculum and content could be attributed to limited teacher training in pilot schools across the country. Participants' responses clearly indicate that they are unfamiliar with the subject's curriculum policy statement, its concepts, and its content. The C&R curriculum is outlined in the CAPS document and supplemented by other relevant documents, such as the Annual Teaching Plan (ATP) and lesson plans, to support teachers. The CAPS documents contain the subject curriculum, including the general aims, strategies, content, and assessments. However, the availability of these documents may be of limited value if teachers are not supported through continuous, hands-on workshops focused on their content and practical application.

Pedagogical knowledge and understanding include teachers' familiarity with and understanding of C&R methodologies, including approaches, strategies, lesson plan implementation, and assessment techniques. According to Neo-Mafa-Theledi (2024) and Seherrie and Mawela (2022), this knowledge is essential for teachers to deliver the curriculum effectively. McGraw-Hill Canada (2024) and Koehler and Mishra (2009) also emphasise the importance of pedagogical knowledge, noting that it entails teachers' ability to design and implement lesson plans using appropriately aligned teaching and assessment strategies. However, participants reported using any available teaching method, regardless of its alignment with the subject. P1 explained:

*I wouldn't say there is a particular strategy or method. I must explain concepts. So, I use storytelling, explaining, and demonstrating. I try to get to the learner's level as much as possible because they are not familiar with these abstract concepts, and we do* *not have many real objects. Ideally, they should see and do, but I cannot show them because we do not have resources.*

Echoing similar sentiments, P5 stated, '*I cannot say that I use a specific method because I have to explain; as I said earlier, these concepts are difficult. So, I have to explain repeatedly*.' The responses of both P1 and P5 reveal the persistent difficulty in utilising advanced strategies aligned with C&R, as well as the challenges posed by resource constraints. Although most participants remained reliant on traditional teaching approaches and strategies, a few demonstrated a gradual shift towards more contemporary strategies aligned with the subject, such as problem-solving. P2 reported:

*If they have to create models, I always start by explaining, then give instructions, and finally step back and let them work on their models. And most of the time, they struggle with the first attempts. So, I help them go back to the drawing board to see where they went wrong until they get it right. So, I would say I use a combination of methods.*

P2's response confirms the observations of Mashite and Dewa (2024) and Willemse (2023) that teachers have begun shifting from traditional to more contemporary teaching methods. Although the shift is not yet occurring at the expected scale, it offers hope for the future as the curriculum stabilises. However, traditional teaching methods still appear relevant for the current cohort of Senior Phase learners due to a foundational knowledge gap. The current cohort of learners in the Senior Phase did not begin studying C&R in Grade R; instead, they started in either the Intermediate or Senior Phase. Consequently, this knowledge gap requires teachers to use more traditional methods to explain basic concepts that should be phased.

Participants were asked whether they were aware of the DBE's lesson plans and whether they used them in their teaching. The findings revealed that all participants (P1, P2, P3, P4, and P5) were aware of the department's lesson plans; however, most found them too difficult to follow. P4 explained,

*The department provided us with draft lesson plans, as I mentioned earlier, and they are not easy to follow. To simplify things, I review the lesson plans and then try to simplify them as much as possible. So, I use DBE's lesson plans as a guide*.

The DBE's lesson plans have proven complicated for some teachers; as a result, some have chosen to select and teach only the content they understand. P4 shared similar sentiments to P5, indicating that the DBE's lesson plans were too complex and not aligned with their learners' level of understanding. Consequently, she decided to simplify the content and develop her own lesson plans, which she believed were more effective for learners.

All participants reported feeling inadequately equipped in this area. P2, who is from a better-resourced school (School B), was also challenged by her inability to utilise most of the available technology. P2 mentioned that '*We only had two to three theoretical workshops. There were not enough, and they did not include guidance on how to use the technology*.' This suggests that the workshops did not cover technology use in sufficient detail. Although participants reported that they were not adequately capacitated, all participants (P1, P2, P3, P4, and P5) indicated that they had basic knowledge of using computers, computer applications, and projectors in their classrooms, but admitted that their knowledge was limited. The study's findings confirm existing literature, indicating that C&R teachers were not adequately prepared when the pilot programme was implemented. This may suggest that many teachers in pilot schools lacked adequate curriculum knowledge. The Senior Phase, particularly Grades 8 and 9 teachers in secondary schools, was the last group to experience the implementation of C&R. Therefore, their experiences may differ from those of Foundation Phase teachers, who may have taught the subject for a longer period.

### *5.2.3 Inadequate infrastructure, equipment and limited access to teaching resources*

According to ASSAf (2021), DBE (2025), and Zivanayi and Malinga (2025), C&R requires a range of resources, including infrastructure (robotics laboratories and computers), equipment (computers, presentation projectors, and robotic kits), and materials such as textbooks, maintenance funds, and data. My observations of infrastructure, equipment, and teaching materials, together with participants' responses, revealed differing levels of availability across schools, with most experiencing severe shortages. P4 reported, '*We do not have robotic kits. We use applications and do basic things, such as handling the mouse.*' P5 explained:

*We do not have coding and robotics kits or any advanced applications. We download our own simple applications. We need advanced technology, such as*

*Cleavertouch boards, the latest projectors, and recorders. The computer lab is too small to fit in the entire class at once. So, they take turns, which takes up a lot of our time.*

P1 also explained:

*We do not have robotics kits, not even one. We do not have a Coding and Robotics lab or textbooks. Our computer lab is too small, with only a few working computers. Learners must take turns for practicals; it's time-consuming and tiring. Really, we have a challenge here.*

Responses from P1 and P5 reflect the challenges experienced by several C&R Senior Phase teachers in pilot schools. Many schools lack robotics kits, robotics laboratories, or learner textbooks. This highlights the reality that the DBE implemented the C&R curriculum while key resources were still limited. The policy documents clearly stipulate that each learner should have access to a textbook, workbook, or e-book for C&R to support content scaffolding and alignment with the CAPS document (DBE, 2021). Therefore, textbooks are necessary to maintain consistency and provide a standardised, structured learning pathway. According to DBE (2021), each learner must have access to a C&R textbook, workbook, or e-book. P1 alluded, '*If you look at the CAPS document, it lists all the items that are required for teaching coding and robotics; unfortunately, we do not have them*.' P5 complained, '*The least the learners should have are their textbooks, but there is nothing.'*

The effective teaching of C&R depends on the availability of appropriate infrastructure, equipment, and educational materials (ASSAf, 2021; DBE, 2025). The absence or shortage of these resources undermines the curriculum's purpose. On the other hand, P2, a teacher from School B, is among the more privileged teachers in pilot schools in the Umlazi township and disclosed, '*We have an abundance of robotic kits, both plugged and unplugged. We have not yet used some of them*.' P3, another teacher from School B, expanded:

*Through collaborations with the private sector, we have a well-resourced coding and robotics laboratory with laptops, an overhead projector, cellphones, and Wi-Fi. However, we are concerned about the safety of these items and the size of our coding and robotics laboratory.*

The situation at School B exemplifies the uneven allocation of educational resources among schools in similarly disadvantaged areas. Furthermore, it underscores the importance of collaboration with the private sector to improve education in the country.

*5.2.4 Institutional and administrative barriers to implementation*

Key institutional and administrative challenges include disjointed communication channels, inadequate teacher orientation, timetabling issues, overcrowded classes, and insufficient support from subject advisors. These challenges compromise both teacher readiness and curriculum cohesion (ASSAf, 2021; Tshidi & Dewa, 2024). Expressing frustration with disjointed communication, P2 mentioned that '*I was not happy about the way the subject was introduced, the information was scanty and unclear.*' P5 also complained, '*Most of the time, I do not know what is happening. I wish the department, particularly subject advisors, would improve communication and make themselves available for support.*' The concerns raised by P2 and P5 regarding the lack of adequate and clear information highlight deeper systemic challenges within the implementation of the pilot programme.

Among other barriers, the study found that C&R teaching time was not clearly articulated in the draft CAPS document, leading to confusion, conflicts among School Management Team (SMT) members, and dissatisfaction among teachers. P5 reported:

*One challenge is that the subject is not included on the teaching timetable. I have to sacrifice my marking and resting time to teach the children. This is not sustainable. Every day, I go home very exhausted.*

The lack of clarity in scheduling imposed significant pressure on teachers, as highlighted by P5, who had to conduct lessons outside of standard hours, thereby compromising time for rest and administrative duties. In practice, some form of adjustment may be necessary, either by increasing teaching hours or by reallocating time from other subjects to accommodate C&R.

Overcrowded classrooms are a common phenomenon in the South African education system, and C&R classes in pilot schools are not immune to this challenge. All participants reported difficulties associated with large class sizes. P1 reported, '*There are too many learners in the class; I find it very difficult to work with them, considering that this is a practical subject.'* P2 also stated, '*Our coding and robotics laboratories can only* *accommodate 20 learners at a time, whereas most classes have more than 40 to 50 learners.*' Overcrowded classrooms significantly limit opportunities for personalised attention and hands-on experiences, both of which are vital for the acquisition of technical skills (Moloi & Mhlanga, 2023). The accounts of P1 and P2 highlight how high learner–teacher ratios diminish the effectiveness of curriculum implementation. According to Zivanayi and Malinga (2025) and Spaull (2019), subjects that require practical engagement and specialised equipment should maintain smaller class sizes to ensure equitable participation and meaningful learning experiences.

SMTs provide immediate support to teachers within schools. Similarly, district and circuit managers, as well as subject advisors, provide support services to schools within their respective jurisdictions (DBE, 2020). Contrary to the literature, all participants (P1, P2, P3, P4, and P5) indicated that, to some extent, they were satisfied with the support provided by their SMTs but explicitly expressed dissatisfaction with the level and quality of support received from the department, particularly C&R subject advisors. P5 narrated, '*Subject advisors are not available to support us. When we contact them, they keep saying they will come, but nobody comes.'* Similarly, P4 explained:

*It is very stressful to call subject advisors. Usually, they are not available. One day I managed to reach one. He said he would link me to other schools in Durban. It has been over five months now, and I am still waiting.*

The teachers' frustrations regarding the support provided by subject advisors highlight a significant weakness in the implementation of the C&R curriculum in pilot schools. Moloi and Mhlanga (2023) warn that this situation poses a risk of increased teacher burnout, which could ultimately lead to a decline in the quality of education.

On the surface, Senior Phase C&R teachers' experiences do not differ significantly from those of teachers in the Foundation and Intermediate Phases. However, observations from this study suggest that Senior Phase teachers face additional challenges because the current cohort of learners has a knowledge gap, while the content, activities, and assessments are pitched at a higher level compared to those of the Foundation and Intermediate Phases. As a result, Senior Phase teachers must navigate these demands with limited knowledge, resources, and support.

## 6 RECOMMENDATIONS

The study recommends that:

- The DBE should roll out additional C&R awareness campaigns to further improve the attitudes and engagement of teachers, learners, and parents through the use of various communication platforms.
- The DBE should also shift from a once-off workshop approach to a coaching-centred model enriched by the TPACK framework, where teachers are continuously and practically trained in the curriculum, content, pedagogy, and the use of appropriate technological tools.
- The DBE should sustain the pilot programme for at least three more years while ringfencing additional funds for the required resources and materials. It should also formalise the unplugged-to-plugged learning sequence and promote the use of low-cost robotic kits and hybrid, offline-capable platforms.
- District managers should devise monitoring strategies to track the support programmes of subject advisors, while subject advisors should provide ongoing support to teachers, identify local mentors, and establish peer learning networks.

## 7 CONCLUSION

The introduction of C&R signifies the state's commitment to equipping its youth with 21st-century skills and contributing towards the achievement of Sustainable Development Goal 4 (Quality Education). The DBE has laid the foundation for this initiative. Although some progress has been reported and documented, the execution of the plan and the implementation of the subject still require significant attention, particularly regarding teacher preparedness, resource availability, administrative coordination, and teacher support.

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