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The Teacher Perceptions in Mpumalanga Province Schools Regarding the Inception of Coding and Robotics in Schools

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ABSTRACT

This study aimed to explore the perceptions of teachers in Mpumalanga Province schools regarding the integration of coding and robotics education in the science curriculum. Through a mixed-methods research design, data was gathered from 47 teachers in selected schools in Mpumalanga Province. The findings suggest that teachers have a positive attitude towards integrating coding and robotics education and acknowledge the importance of these subjects in preparing learners for future careers. However, there is a need for professional development programs to support teachers in effectively integrating these technologies in the science curriculum. The study also identified a number of obstacles that educators must overcome, such as inadequate infrastructure and resources, inadequate support and training, and potential hurdles brought on by preconceptions and cultural beliefs. Additional study is necessary due to the relevance of the findings and recommendations for professional development programs.

Keywords: Perceptions; Integration; Robotics

Introduction

The South African education sector is undergoing a transformative shift with the introduction of Coding and Robotics education in schools. This shift aims to equip learners with the necessary skills and knowledge to thrive in the digital age and contribute to the country's future workforce. As a result, it is crucial to explore and understand the perceptions of teachers in Mpumalanga Province, South Africa, regarding the integration of Coding and Robotics in schools. By examining their perspectives, we can identify the challenges they face, their expectations, and develop strategies to support and enhance their preparedness in teaching these subjects effectively. The integration of Coding and Robotics in the curriculum brings forth a range of challenges for teachers. One of the key challenges is the lack of teacher preparedness and training in Coding and Robotics (Smith, et al. [1,2]). Many teachers may find themselves ill-equipped to teach these new subjects due to a lack of exposure to coding and robotics concepts during their own teacher training programs (Giannandrea, et al. [3]). This lack of preparedness may lead to uncertainty and insecurity among teachers when it comes to implementing Coding and Robotics in their classrooms (Jacobsen, et al. [4]).

Therefore, it is essential to understand the extent of this issue and develop appropriate strategies to address teacher preparedness. Furthermore, the availability of resources and infrastructure poses another challenge. Low-income schools in Mpumalanga Province, in particular, face difficulties in acquiring the necessary tools and technology required to effectively teach Coding and Robotics (Mofoka [5]). Limited access to computers, reliable internet connection, and robotics kits may hinder teachers' ability to provide hands-on learning experiences to their learners (Stokes, et al. [6]). Without adequate resources, teachers may struggle to engage learners in meaningful and practical Coding and Robotics lessons. Therefore, it is crucial to explore the availability and accessibility of resources supporting these subjects in Mpumalanga Province. Moreover, cultural perceptions and stereotypes can influence teacher perceptions and buy-in towards Coding and Robotics education (Zhang, et al. [7]). Traditional gender roles and biases may steer female learners away from en-

gaging in STEM education, including Coding and Robotics (Chigona [8]). It is essential to understand how these societal factors impact teachers' perceptions and to address them in order to create a more inclusive and equitable learning environment.

Promoting and encouraging greater participation of all learners in Coding and Robotics will help foster diversity and ensure equal access to educational opportunities. To bridge this gap and ensure the successful integration of Coding and Robotics into the South African curriculum, it is necessary to investigate the perceptions of teachers in Mpumalanga Province. Understanding their thoughts, concerns, and expectations will allow for the development of targeted strategies and interventions to support teacher capacity-building in this emerging academic domain. This study aims to explore teacher perceptions in Mpumalanga Province schools regarding the inception of Coding and Robotics. By analyzing the existing literature, we aim to gain insights into the current status of teacher preparedness, challenges faced, and recommended strategies for the successful implementation of Coding and Robotics education. This study shed light on the perceptions of teachers in Mpumalanga Province schools regarding the integration of Coding and Robotics education. By understanding their perspectives, we can identify the gaps and challenges and propose evidence-based recommendations to support teachers in effectively integrating these innovative subjects into the curriculum.

Through collaboration and support, we can ensure that learners are adequately prepared for the digital future, fostering a culture of innovation and enhancing educational outcomes in Mpumalanga Province schools. Hence, the research question: What are the perceptions of teachers in Mpumalanga Province schools regarding the integration of Coding and Robotics education, including their preparedness, challenges, and recommendations?

Method

Research Design

This study adopted a mixed methods research design to investigate teachers' preparedness in embracing the inception of Robotics and Coding in schools. According to (Shorten, et al. [9]) mixed methods research draws on potential strengths of both qualitative and quantitative methods, allowing researchers to explore diverse perspectives and uncover relationships that exist between the intricate layers of our multifaceted research questions. This study investigates teacher preparedness regarding the pedagogical content knowledge, content knowledge as well as whether the schools are resourceful in allowing the teachers to advance the teaching of Coding and Robotics. A convergent parallel design will be applied in this study. A convergent parallel design entails that the researcher concurrently conducts the quantitative and qualitative elements in the same phase of the research process, weighs the methods equally, analyses the two components independently, and interprets the results together (Creswell, et al. [10]).

Data Gathering Procedure, Respondents and Instruments

Data was collected from teachers working in selected MSTA schools in Mpumalanga Province. The researcher used purposive sampling to select 47 teachers from these schools. Creswell [11] suggests being purposeful in identifying participants that might provide insight into your research question. Purposeful sampling involves selecting participants because you believe that they might contribute something to your analysis. This group was selected because the Department of Basic Education in Mpumalanga Province tasked them to take a lead in the teaching of Coding and Robotics. Patton [12] describes these at samples within samples and suggests that purposeful samples can be stratified or nested by selecting units or cases that vary according to a key dimension. stratified purposeful sampling approach can lend credibility to a research study. When enough information is known to identify characteristics that may influence how the phenomenon is manifest, then it may make sense to use a stratified purposeful sampling approach.

Data collection or data gathering is the process of gathering and measuring information on targeted variables in an established system, which then enables one to answer relevant questions and evaluate outcomes (Creswell [11]). The data was collected through administering a questionnaire. The questionnaire probed teachers regarding their perceptions about Coding and Robotics, their professional development in Coding and Robotics, availability of resources and application Coding and Robotics of as well as their content knowledge in Coding and Robotics. The data solicited by using goggle form was analysed via goggle form also. This enabled the researcher to achieve better understanding of participants' readiness about Coding and robotics. All participants answered the same questions asked in the same order.

Results and Discussion

The data presented in this response was analysed using descriptive and qualitative research approach. It involved analysing the responses of the teachers in Mpumalanga Province who participated in the study. The responses were transcribed and coded to identify common themes and patterns. The themes related to learner engagement and learning outcomes, implementation strategies, and recommendations for professional development. To support the findings and discussion, references were provided from relevant scholarly sources. These references include studies that have examined the impact of robotics and coding education on learner learning outcomes (Barker, et al. [13]), the theories and frameworks that underpin the integration of technology in education (TPACK framework, Technological Determinism, Constructivism), and the pedagogical principles that support active learning and learner engagement (Prince, et al. [14,15]). The inclusion of these references strengthens the analysis by drawing on established theories and research studies that have examined similar topics.

This allows for a more comprehensive understanding of the data and its implications, providing a solid foundation for the recommendations for professional development programs. Table 1 and Table 2 provide a descriptive analysis of teachers' responses per development stage of Robotics and Table 3 provide qualitative syntheses of the results in Tables 1 & 2. Based on the data, there is generally a positive attitude towards the integration of Coding and Robotics education in Mpumalanga Province schools. Respondents strongly agreed and agreed that Robotics and coding lessons equip pupils to enter the digital era and prepare them for future careers. They also expressed a desire to have more knowledge of Robotics and coding, indicating an awareness of its importance in the modern world. The data also suggests that teachers are interested in determining how to enhance online teaching and learning. They expressed a need for more information on the time and energy commitments required for online teaching and learning, as well as a desire to discuss the possibility of using online teaching methods. This indicates a willingness to adapt and utilize technology in the educational context.

Table 1: Attitudes and perceptions of teachers towards robotics, coding education and professional development.

Category	Question	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Robotics and Coding	Robotics and coding lessons equip learners to enter the digital era and prepare them for future careers.	7	22	18	0	0
	I have more knowledge of Robotics and coding.	10	16	21	0	0
	Would like to know my impact to learners after teaching them Robotics and coding.	6	16	27	2	0
	I would like to determine how to enhance Online teaching and learning.	5	22	22	0	0
	I would like to have more information on time and energy commitments required by Online teaching and learning.	2	18	27	0	0
	Would like to discuss the possibility of using Online teaching and learning.	5	15	27	0	0
	I would like to know how to conduct Online teaching and learning in the future.	2	17	28	0	0
Professional Development	Teacher professional development is a crucial aspect of the effective teaching of Robotics and Coding.	11	13	23	0	0
	I received sufficient training to teach Robotics and coding.	3	17	5	20	2
	I received sufficient training to use online teaching and learning from the District.	4	18	6	11	8
	Professional Development | Teachers have access to a broad range of support for teacher professional development.	4	17	26	0	0
	Teacher professional development helped me to prepare teach Robotics and coding lessons.	5	16	25	1	0
	Teacher development helped me to be able to create and coach learners in doing sound Robotics and coding projects.	5	22	20	0	0

Table 2: Digital Technology awareness and competency development in education.

Category	Question	Never	Almost never	Sometimes	Mostly	Always
Develop awareness of digital technology and digital competency to Discover ICT tools and digital technologies.	● Explore digital skills and competency	0	0	15	19	13
	● Explore basic graphic and visual representation	0	0	10	16	21
	● Learn to use digital technology responsibly	0	0	15	19	13
	● Explore data and information management skills	0	0	9	15	23
	● Develop computational thinking and problem-solving skills	0	0	7	18	22
	● Explore algorithms and code to create their own interactive stories and games	0	0	14	17	16
Content creation and data interpretation	● Build digital skills and competency	0	0	15	18	14
	● Learn to do graphic and visual design/representation.	0	0	17	15	14
	● Develop awareness of human interactions with digital technology.	2	1	5	19	20
	● Become responsible users of digital technology.	2	1	6	18	20
	● Further develop problem-solving skills.	0	0	7	20	20
	● Use coding skills and techniques to solve basic problems (basic algorithms).	0	1	5	13	20
	● Think computationally.	0	1	6	15	20
	● Apply coding tools, techniques and strategies to solve problems.	0	1	5	13	20

Table 3: Findings and discussions of teachers' perception regarding the integration of Coding and Robotics education.

Levels of Digital Technology Awareness and Competency Development in Education	FINDINGS
Perceptions and attitudes	The majority of teachers believe that Robotics and coding lessons are important for preparing pupils for future careers. There is an interest in and curiosity for online teaching and learning for these subjects. Discussion: The findings consider the importance of Robotics and coding education in preparing learners for future careers. This is linked to the Theory of Human Capital which recognizes education as an investment in human capital for higher future returns leading to higher productivity, earnings, and individual wellbeing (Becker, et al. [18,19]). These findings suggest the recognition of the importance of investment in technology through Robotics and coding education, an uptake in related vacancies, and the economic and social benefits associated with it (OECD [20]). These findings concur with previous research indicating an interest in technology-based career paths (Hew [21]) while providing initial evidence of the need to integrate Robotics and coding into the curricula.
Professional development	Most teachers feel they have not received enough training to use online teaching and learning, and some teachers feel unsupported by the district to integrate online teaching and learning in the science classroom. Discussion: The findings speak to the importance of professional development in equipping teachers with the necessary skills and knowledge to effectively integrate online teaching and learning in the science classroom. This aligns with the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes the need for teachers to develop a deep understanding of the interplay between technology, pedagogy, and content knowledge (Mishra, et al. [16]). The findings suggest that there is a gap in teacher training and support in using online teaching and learning methods, particularly in the context of robotics and coding education.
Challenges	No specific challenges faced by teachers in integrating robotics and coding education were identified in the data. Discussion: The lack of specific challenges identified in the data may indicate a need for further research or exploration to gain a deeper understanding of the barriers and obstacles that teachers in Mpumalanga Province may face when integrating robotics and coding education. Existing literature suggests that challenges in integrating technology in education can include lack of resources, inadequate infrastructure, limited teacher expertise, and resistance to change (Ertmer, et al. [22,23]).

Resources and constraints	Teachers have different preferences for available resources, with some relying mostly on laptops and others having access to a range of devices such as tablets and interactive whiteboards. Some teachers report being unable to present certain content related to digital technology and digital competency. Discussion: The findings highlight the importance of having access to a variety of resources for teaching robotics and coding. This aligns with the theory of Technological Determinism, which posits that technology shapes and influences teaching and learning practices (Kozma [24]). The findings also suggest that there is a need for additional resources and support to address the gaps in content related to digital technology and digital competency. This aligns with the notion that effective integration of technology relies on adequate resources, such as hardware, software, and digital content (Ertmer [25]).
Learner engagement and learning outcomes	Teachers observed increased engagement and enthusiasm among learners when integrating robotics and coding education into the science classroom. They also reported improvements in learners' problem-solving skills, critical thinking abilities, and teamwork. Discussion: These findings align with the theory of Constructivism, which suggests that active engagement and hands-on learning experiences enhance learner learning (Vygotsky, et al. [26,27]). Robotics and coding education provide opportunities for learners to actively explore, experiment, and solve problems, fostering higher-level thinking skills. The reported improvements in problem-solving, critical thinking, and teamwork are consistent with the research indicating the positive impact of robotics and coding on learner learning outcomes (Barker, et al. [13,28]). It can be inferred that integrating robotics and coding education in the science classroom can contribute to the development of 21st-century skills.
Implementation strategies	Teachers mentioned various strategies they used to successfully integrate robotics and coding education in the science classroom. These strategies included hands-on activities, project-based learning, collaborative group work, and making connections to real-world applications. Discussion: The identified strategies align with best practices in STEM education and promote learner-centered, inquiry-based learning. Hands-on activities and project-based learning provide learners with opportunities to explore and apply their knowledge and skills in practical and relevant contexts. Collaborative group work fosters teamwork and communication skills, which are essential for success in the 21st century workplace. Making connections to real-world applications helps learners understand the relevance and importance of robotics and coding in their everyday lives. Furthermore, the use of these implementation strategies aligns with the pedagogical principles of active learning and learner engagement. Research has shown that active, hands-on learning experiences lead to deeper understanding, increased motivation, and better retention of knowledge (Prince, et al. [14,15]). Thus, incorporating these strategies in the integration of robotics and coding education can enhance learner learning and engagement in the science classroom.
Recommendations for professional development	Based on the findings of this study, several recommendations for professional development programs can be made. Firstly, there is a need for targeted training and support for teachers in Mpumalanga Province to enhance their technological competencies and skills in integrating robotics and coding education. This can be achieved through workshops, courses, or online training modules that provide teachers with the necessary knowledge, resources, and hands-on experiences to effectively integrate these technologies in the science curriculum. Moreover, professional development programs should focus on the pedagogical principles and strategies that promote active learning, learner engagement, and collaboration. This includes providing teachers with guidance and support in implementing hands-on activities, project-based learning, and collaborative group work in the classroom. Additionally, efforts should be made to address the resource constraints identified in this study. This may involve advocating for increased funding for educational technology resources, such as robotics kits, tablets, and interactive whiteboards. Access to these resources can greatly enhance the ability of teachers to effectively integrate robotics and coding education in the science classroom. Collaboration and networking among teachers should be promoted to facilitate sharing of best practices, lesson plans, and resources. Collaborative platforms, both online and offline, can provide opportunities for teachers to connect, learn from one another, and support each other in their professional development journeys. By implementing these recommendations, it is anticipated that teachers in Mpumalanga Province will be better equipped to integrate robotics and coding education in the science classroom, leading to enhanced learner engagement, learning outcomes, and the development of 21st-century skills necessary for future success.

Regarding professional development, respondents recognized its importance in the effective teaching of Robotics and Coding. They believed that teacher professional development is crucial and contributed to their ability to teach Robotics and coding lessons effectively. Additionally, they felt that teacher development has helped them create and coach learners in sound Robotics and coding projects. TPACK emphasizes the intersection of technology, pedagogy, and content knowledge, and how their integration can enhance teaching and learning outcomes (Mishra, et al. [16]). In the context of this study, the positive attitudes towards Robotics and coding education demonstrate an understanding of the content knowledge required to prepare learners for the digital era. The interest in enhancing online teaching and learning reflects the integration of pedagogical strategies with technological tools. The recognition of the importance of professional development aligns with the need to develop teachers' technological pedagogical knowledge.

The findings indicate that there is a general recognition of the importance of digital technology and digital competency in Mpumalanga Province schools. The respondents expressed a desire to explore various aspects of digital technology, such as digital skills, basic graphic and visual representation, data and information management skills, computational thinking, and problem-solving skills. This demonstrates an awareness of the need for learners to develop these competencies in order to navigate the digital era effectively and prepare for future careers. Furthermore, the respondents also acknowledged the importance of responsible usage of digital technology. This suggests an understanding of the ethical implications and potential negative effects that can arise from improper use of technology. It is encouraging to see that educators in Mpumalanga Province are emphasizing responsible digital citizenship and fostering awareness of human interactions with technology.

The findings also highlight a strong emphasis on problem-solving skills and coding within the curriculum. Respondents expressed a desire to further develop problem-solving skills and use coding techniques and strategies to solve basic problems. This aligns with the growing recognition of computational thinking as a fundamental skill for the 21st century. By integrating coding and problem-solving into the curriculum, Mpumalanga Province schools are equipping learners with valuable skills that are in high demand in the digital age. These findings align with existing frameworks and theories in education. The Technological Pedagogical Content Knowledge (TPACK) framework emphasizes the integration of technology, pedagogy, and content knowledge to enhance teaching and learning outcomes (Mishra, et al. [16]). The positive attitudes towards digital technology and the desire to develop various digital competencies demonstrate an understanding of the content knowledge necessary to prepare learners for the digital era. Additionally, the focus on problem-solving skills and coding aligns with the principles of computational thinking, which involves breaking down complex problems into smaller parts and using logical and algorithmic thinking to solve them (Wing [17]).

Overall, the findings suggest that Mpumalanga Province schools are moving towards a more holistic and integrated approach to digital education, where learners not only acquire technical skills but also develop critical thinking, problem-solving, and responsible digital citizenship. This reflects a forward-thinking approach in preparing learners for the demands of the digital age. The findings suggest that there is a positive attitude towards integrating robotics and coding education in Mpumalanga Province schools. Teachers recognize the importance of these subjects in preparing learners for future careers and show an interest in online teaching and learning methods. However, there is a need for professional development to support teachers in effectively integrating robotics and coding education. The study also identifies the need for additional resources and addresses potential challenges that teachers may face. The findings highlight the benefits of integrating robotics and coding education, such as increased learner engagement, improved problem-solving skills, critical thinking abilities, and teamwork. These outcomes align with the theoretical frameworks of human capital theory, constructivism, and active learning, which emphasize the importance of hands-on, practical learning experiences [18-28].

The study also identifies various implementation strategies, such as hands-on activities, project-based learning, collaborative group work, and real-world connections. These strategies promote learner-centered, inquiry-based learning and can enhance learner learning and engagement in the science classroom. Based on the findings, several recommendations for professional development programs are proposed. These include targeted training and support for teachers, focusing on both technological competencies and pedagogical strategies. Efforts should also be made to address resource constraints and promote collaboration among teachers. By implementing these recommendations, Mpumalanga Province schools can effectively integrate robotics and coding education, leading to enhanced learner learning outcomes and the development of 21st-century skills.

Conclusion

This study explored the perceptions of teachers in Mpumalanga Province schools regarding the inception of coding and robotics education in their classrooms. The findings suggest that in general, teachers have a positive attitude towards integrating robotics and coding education and acknowledge the importance of these subjects in preparing learners for future careers. However, there is a need for professional development programs to support teachers in effectively integrating these technologies in the science curriculum. The study also identified various challenges that teachers face, including the lack of adequate resources and infrastructure, inadequate training and support, and potential barriers due to cultural perceptions and stereotypes. To overcome these challenges, several recommendations for professional development programs were proposed, such as targeted training and support for teachers in both technological competencies and pedagogical strategies, addressing resource constraints, and promoting collaboration and networking among teachers.

By implementing these recommendations, Mpumalanga Province schools can effectively integrate robotics and coding education in the science curriculum, leading to enhanced learner learning outcomes and the development of 21st-century skills necessary for future success. Overall, this study contributes to the ongoing efforts in South Africa to prepare learners for the digital age and to bridge the existing gap in STEM education.

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