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Improving Classroom Mathematics Instruction: Exploring Instructional Challenges in Junior Secondary Schools in Botswana

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Abstract: *This study explores the instructional challenges faced by junior secondary school teachers when teaching algebraic equations, focusing on the prevalence of teacher-centered methods. Rooted in the Knowledge Quartet Model, the research utilizes an Interpretivist approach and a qualitative case study design across two selected secondary schools. Two mathematics teachers were purposefully sampled for observations, semi-structured interviews, and document analysis. Atlas. ti Version 8.0 software aided data analysis, which was then subjected to thematic analysis. The findings revealed significant challenges, including large class sizes and syllabus congestion hindering interactive learning and comprehensive understanding of algebraic concepts. Poorly prepared lesson plans led to missed opportunities for addressing students' misconceptions. To address these issues, the study recommends collaborative efforts among teachers, encouraging reflection on teaching practices and effective strategies for teaching algebraic equations. Furthermore, it suggests organised workshops for policy makers and curriculum designers to enhance curriculum implementation and promote active learning in classrooms.*

Keywords: *Instructional Challenges, Teacher-Centered Methods, Knowledge Quartet Model, Algebraic Equations, Collaborative Teaching Strategies*

1. BACKGROUND

Mathematics education is a crucial component of preparing learners for critical thinking and problem-solving, essential skills for success in various domains. The global perception of algebra, however, is often clouded by myths perpetuated by educators, such as its inherent beauty and direct applicability in various professions (Demme, 2014). This perception overlooks the diverse ways in which critical thinking skills are developed, extending beyond algebraic contexts. Additionally, the practical application of algebra in certain professions is often underestimated (Torpey, 2012, 2013). Understanding algebraic equations is fundamental to investigating instructional challenges in teaching algebra. Algebraic equations involve solving unknown phenomena through the organization and representation of variables, requiring the application of mathematical statements and properties of equality and real numbers (Dilley et al., 1990; Zegarell, 2017). Historical roots tie algebraic equations to everyday problem-solving, emphasizing their relevance in disciplines like science, finance, and economics (Boyer & Merzbach, 2011).

Given the persistent and formidable challenges educators face in teaching algebraic equations, as evidenced by the extensive research conducted by Kilpatrick &Izsack (2008), Ko & Karadag (2013), Pappano (2012), Schoenfeld (2007), and Shah (2012), there is a compelling need for further investigation into the instructional landscape of algebra education. The existing body of research consistently underscores the substantial hurdles teachers encounter in delivering algebraic content effectively, hindering students' smooth transition from basic arithmetic to more intricate algebraic concepts. The prevalent reliance on teacher-centered methods and the absence of hands-on activities emerges as critical contributors to these challenges, demanding a closer examination of alternative instructional approaches. Moreover, the evident constraints in teachers' Content Knowledge (CK) and Pedagogical Content Knowledge (PCK), as highlighted by Black (2008) and Naseer (2016), accentuate the urgency of in-depth research to uncover targeted solutions. By delving into these instructional challenges, research can provide valuable insights and recommendations that have the potential to reshape algebra education, ensuring a more seamless and effective learning experience for students. Aligned with the identified hurdles in effectively delivering algebraic content, the primary focus of this research is to address the following inquiry: What precise instructional challenges do teachers confront when imparting knowledge of algebraic equations at the junior secondary school level? Consequently, the primary objective of this study is to discern and outline the specific instructional challenges faced by mathematics teachers in the junior secondary school setting when teaching algebraic equations. Through a comprehensive examination of these challenges, this research aims to contribute nuanced insights and targeted recommendations to enhance the overall instructional strategies employed in teaching algebra at the junior secondary school level.

2. LITERATURE REVIEW

Instructional challenges in global algebra education reflect a range of perspectives, showcasing diverse goals set by educators and curricula worldwide. The dichotomy emphasized by Thorpe (1989) and Schoenfeld (2007) illustrates varied instructional objectives globally. Real-world applications of algebra, exemplified in scenarios like sharing sweets, present a pedagogical challenge, necessitating the effective alignment of abstract concepts with tangible situations. Challenges persist in fostering a robust understanding of algebraic structures, prompting continuous exploration of pedagogical strategies as noted by Booth (1988), Knuth et al. (2005), and Tahir (2012). Flanders (1987) envisions algebra as a preparation ground for navigating derivatives in physics and engineering, emphasizing the interconnectedness of mathematical education across disciplines.

Global variations in instructional practices are evident in studies such as Leung et al.'s (2014) comparison of algebra teaching in Confucian Heritage Cultures (CHC) and other countries, revealing differences in emphasis on conceptual understanding and procedural fluency. Studies in New Zealand, Sweden, and China contribute to understanding diverse challenges, while research in Korea challenges assumptions about teacher-directed instruction hindering deep understanding (Park & Leung, 2006). Andrews and Sayers' (2012) comparative study in European countries emphasizes the transition from concrete to abstract thinking, using concrete models to deepen learners' understanding of abstract concepts.

Insights from studies in South Africa and Botswana highlight gaps in mathematics teachers' content knowledge and pedagogical content knowledge, emphasizing struggles with the equal sign's relational aspect and higher-level problem-solving. Guerriero (2014) and Ball et al. (2008) underscore the importance of pedagogical knowledge in creating effective learning environments. Additionally, research by Black (2008), Ivey (2003), and Naseer (2016) collectively emphasizes the critical role of teachers' content knowledge and instructional strategies in addressing challenges, advocating for continuous professional development. Technology's role in algebra education, explored by Hegedus et al. (2015) and Ko and Koradag (2013), provides insights into the positive impact of tools like SimCalc software and GeoGebra dynamic worksheets on students' learning experiences and outcomes. The integration of educational technology aligns with the current study's focus on understanding factors influencing learners' experiences and outcomes in algebra education.

3. CONCEPTUAL FRAMEWORK

The study's conceptual framework delves into historical models addressing Pedagogical Content Knowledge (PCK) and instructional practices. Described by Jabareen (2009) as an interconnected network providing a holistic understanding, a conceptual framework encompasses ontological, epistemological, and methodological assumptions (Guba and Lincoln, 1994). Various PCK models, starting with Shulman's (1986) influential model, aimed to overcome the content-pedagogy dichotomy. Ball et al. (2008) proposed a refined model, distinguishing between Common Content Knowledge (CCK) and Specialized Content Knowledge (SSK). Boesdorfer and Lorsbach (2014) utilized Magnusson et al.'s (1999) model to study teachers' orientation towards science. Technology integration is explored through Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) model, offering insights into the synergy of technology, pedagogy, and content. In South Africa, Mavhunga and Rollnick (2011) developed Topic Specific Pedagogical Content Knowledge (TSPCK), emphasizing components like learners' prior knowledge and conceptual teaching strategies.

This study adopts the Knowledge Quartet framework (Rowland & Turner, 2008) to scrutinize teachers' practices in teaching algebraic equations. Comprising four dimensions—Foundation, Transformation, Connection, and Contingency—the Knowledge Quartet delves into teachers' theoretical background and beliefs, converting content knowledge into effective pedagogical forms, ensuring coherence in lesson planning, and addressing adaptability to unforeseen events. It provides a lens for understanding teachers' PCK, subject matter knowledge, and understanding of students. However, limitations include its exclusive focus on classroom practices, neglecting efforts during lesson planning and preparation.

4. Methodology

The research methodology employed for investigating instructional challenges in teaching algebraic equations adopts a comprehensive approach, grounded in the interpretive paradigm within the qualitative research framework. Emphasizing social constructions, shared meanings, and classroom instructional practices, the study utilizes a case study research design aligned with Stake's qualitative and interpretivist approach. The qualitative research methodology, guided by Creswell (2007), facilitates an in-depth exploration of teachers' pedagogical practices, particularly focusing on instructional challenges within their natural settings. To enhance reliability and internal validity, the study employs multiple data collection methods, including semi-structured interviews, non-participant observations, and document analysis. Purposive sampling is utilized, selecting two government junior secondary schools in Gaborone, Botswana, based on common scheming to ensure comparable teaching practices. The study, conducted in the South-East Education Region, involves 21 junior secondary schools, with participants comprising mathematics teachers from two Gaborone West cluster schools. A smaller sample size allows for in-depth analysis, and sampling procedures involve homogeneous selection criteria, such as qualifications in mathematics education and a minimum of five years of teaching experience.

Data collection techniques include non-participant observation, semi-structured one-on-one interviews, and document analysis, capturing the depth and nuances of teachers' pedagogical practices. The non-participant observation guide, comprising 45 items, focuses on various aspects of classroom organization, instruction, teaching practices, and reflective teaching practices. The semi-structured interview guide, with 17 items, explores teachers' content expertise, instructional techniques, and teacher-learner interactions. Document analysis involves evaluating printed and electronic materials, such as scheme books, lesson plan booklets, learners' exercise books, and prescribed textbooks. The data collection occurs in three stages: non-participant lesson observations, semi-structured interviews, and document analysis. Thematic analysis, guided by Gibson and Brown (2009), systematically organizes raw data from lesson observations, ensuring data triangulation for validity through multiple sources.

Ensuring trustworthiness, the study employs data triangulation to address credibility, transferability, dependability, and confirmability (Guba, 1981; Lincoln & Guba, 1985; Shenton, 2004; Gunawan, 2015). Ethical considerations are diligently adhered to, with obtained ethical clearance, secured informed consent, and maintained confidentiality. Data analysis involves a structured approach using ATLAS ti. Version 8.0, coding and categorizing the dataset for systematic and efficient analysis. The reduction of data follows a qualitative analysis process, endorsed by Creswell and others, focusing on relevant data to derive manageable themes.

5. Discussion of Results Analysis

The analysis of instructional challenges in teaching algebraic equations reveals several significant issues that impact the effectiveness of teaching and learning in this context. One notable challenge is the issue of large class sizes, ranging from 42 to 48 learners per class, which hampers the implementation of group work (see Figure 1 below).

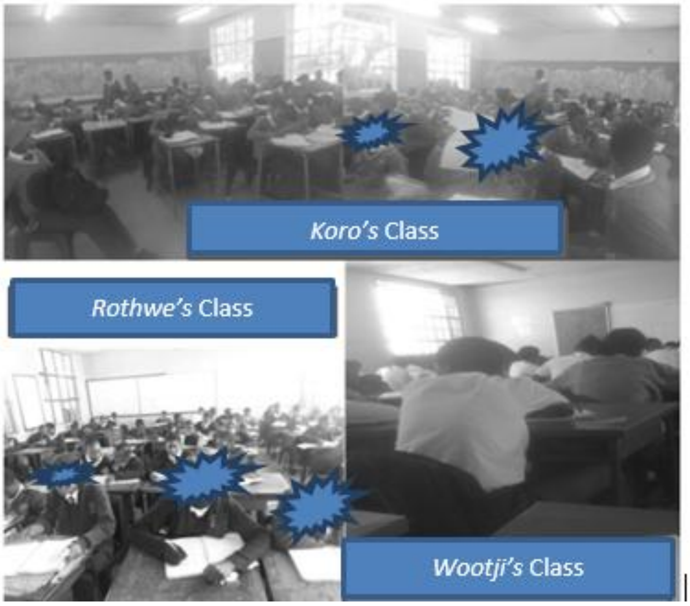


Figure 1. *Overcrowded classrooms*

In Figure 1, the outcomes depict the consequences of large class sizes, leading to certain learners displaying a lack of concentration, engaging in activities such as playing, folding their arms with their heads on desks, or perching on desktops. To understand the challenges arising from overcrowded classes, interviews with teachers, specifically Koro and Rothwe, were conducted. Koro's insights during the interview shed light on the impact of overcrowding on teaching and learning, particularly in the context of algebraic equations. When questioned about the effects of overcrowding, Koro highlighted the impracticality of traditional methods like marking student work. He emphasized that the large population compelled them to conduct marking during class time, limiting their ability to extend work beyond the stipulated hours. This practice significantly affected syllabus coverage, forcing a reduction in group work and an emphasis on individualized tasks to address time constraints. Koro pointed out the challenge of attending to each student individually due to overwhelming class sizes, particularly impacting weaker students. Additionally, he expressed skepticism about the effectiveness of group work, noting that students tended to become unruly and disruptive when grouped due to overcrowding. The shortage of textbooks further complicated matters, making it challenging for teachers to facilitate effective group work.

This finding aligns with existing literature on class size impact, suggesting that larger classes can hinder effective group activities (Hanushek & Rivkin, 2006). The study indicates that teachers, faced with the constraint of large classes, tended to prioritize teacher-centered methods over collaborative group work. This reluctance contradicts the potential benefits that collaborative learning can offer, such as improved understanding through peer interactions (Johnson & Johnson, 2014). The study raises concerns about the impact of class size on instructional strategies and the quality of learning experiences for students. Moreover, the study underscores the challenge of limited individual attention due to compromised marking of learners' work. Koro's interview highlighted the inadequacy of teaching resources, particularly textbooks distributed among learners at a ratio of one textbook to three learners. This insufficiency was pervasive across all observed lessons. The analysis of the interview data emphasized the impact of large class sizes on instructional practices, compromising individual attention and failing to address diverse learner needs adequately. Additionally, Koro acknowledged that the challenge of large class sizes led to significant classroom management issues, with class control becoming a considerable hurdle.

A notable consequence of large class sizes was the lack of thorough checking of learners' work, as evidenced by the presence of unmarked books for a substantial number of students. Even when marking occurred, it was often limited, raising concerns about the overall quality of teaching and learners' work due to the constraints imposed by large class sizes. The issues related to marking and individual attention are illustrated in Figure 2, displaying both marked and unmarked work from Koro's learners (see Figure 2).

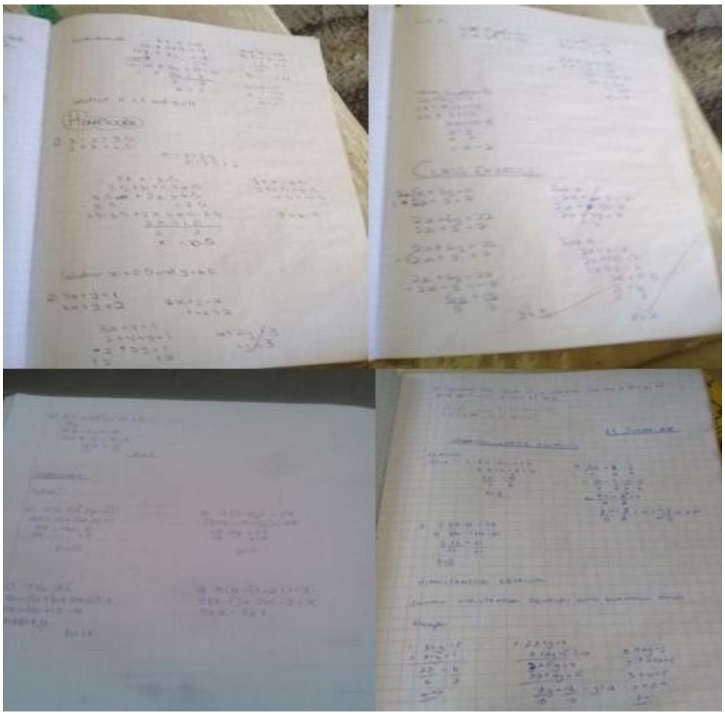


Figure 21. *Koro's marked and unmarked learners' work*

Upon closer inspection of Figure 2, discrepancies in Koro's marking practices become evident, as three sampled books were left unmarked. Even when marking was evident, it frequently involved a single tick without accompanying comments, casting doubt on the effectiveness of the provided feedback. The observed pattern of marking, predominantly occurring during class work, underscores the difficulties imposed by large class sizes. Similarly, in Figure 3 below, Rothwe, another teacher contending with an overwhelming class size, is depicted moving around the class to assess individual learners' work following the completion of the board demonstration of solved algebraic equations.

Figure 3. *Rothwe assisting individual learners.*

The instructional challenges stemming from large class sizes were clearly observed in Rothwe's teaching practices, as illustrated in Figure 3 above. The chalk-and-talk approach dominated the board, exemplifying a teacher-centered instructional method. Rothwe's interaction with groups was constrained, notably focusing on one group struggling with comprehension. The prolonged attention to this group suggested a potential disadvantage for the rest of the class.

During an interview, Rothwe elucidated his instructional choices, expressing a reluctance towards group work due to perceived time constraints and disruptions associated with large class sizes. Despite acknowledging the limitations of auditory instruction for all learners, Rothwe justified his preference for teacher-directed methods by emphasizing efficiency in syllabus coverage. He defended his instructional strategy, centered on demonstration and question-and-answer techniques, contending that it did not negatively impact syllabus coverage. Rothwe's disinclination to incorporate collaborative learning during regular class time was rooted in concerns about time constraints and the challenge of assessing its effectiveness. Consequently, his approach focused on memorization to prepare learners for examinations, revealing a trade-off between efficient syllabus coverage and the limitations imposed by large class sizes on adopting more interactive teaching methods.

The teachers' attribution of these limitations to the abstract nature of the subject and their lack of exposure to practical aspects during training underscores the necessity for targeted professional development for teachers. Existing literature emphasizes the significance of teachers' content knowledge and pedagogical content knowledge (Ball, Thames, & Phelps, 2008), and inadequate exposure may contribute to ineffective instructional practices. This aligns with literature suggesting that teachers' preparation significantly influences their instructional decisions (Grossman, Smagorinsky, & Valencia, 1999). The study's revelation that teachers did not reflect on learners' mistakes and misconceptions raises concerns about potential perpetuation of errors, hindering the development of a solid foundation in algebraic concepts.

Furthermore, the study highlights syllabus congestion as a challenge to effective teaching and learning. The bulky syllabus, coupled with a lack of strategies to address learners' prior knowledge, underscores the need for curriculum reform and instructional strategies considering diverse learner backgrounds. This aligns with literature on curriculum challenges and the importance of aligning curricular goals with effective teaching practices (Cohen, Raudenbush, & Ball, 2003). The study's identification of limited use of higher-order questioning techniques and the reluctance to encourage collaborative engagement adds to the discourse on fostering critical thinking and meaningful classroom discourse (Chin, Brown, & Bruce, 2002; Mercer & Littleton, 2007). Teachers' concerns about syllabus coverage affecting their control over classroom discussions highlight potential tensions between curriculum demands and the promotion of higher-order thinking skills.

In summary, the study illuminates various instructional challenges, including class size constraints, limited individual attention and syllabus congestion. These challenges underscore the importance of addressing not only classroom practices, but also broader issues related to teacher preparation, curriculum design, and professional development. The findings present an opportunity for educational stakeholders to consider targeted interventions to enhance the quality of algebraic instruction and promote effective learning outcomes.

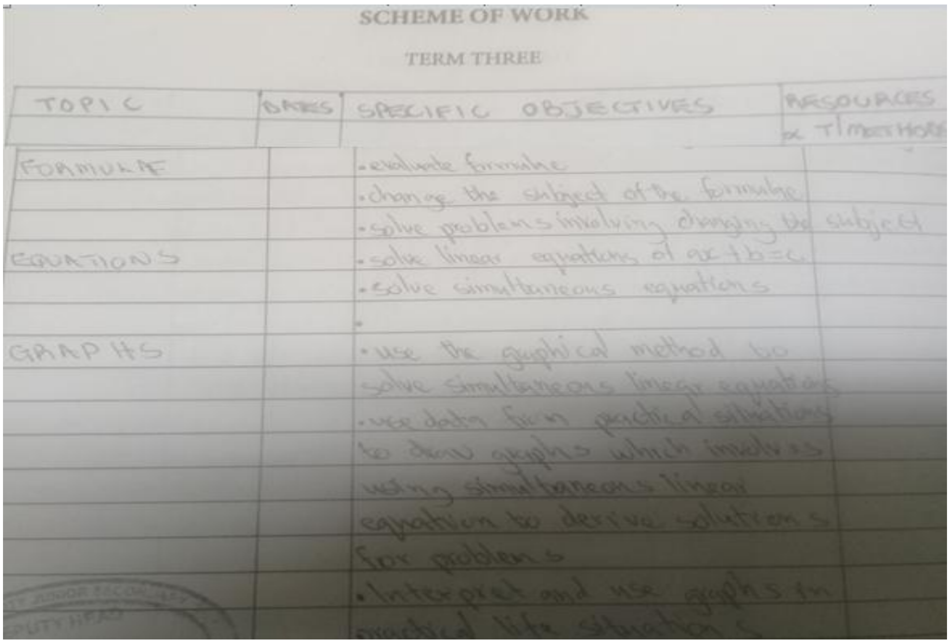
Syllabus congestion, as elucidated by Rothwe, Wooitji, and Sindi, underscores the formidable challenges arising from an extensive and overloaded mathematics syllabus in secondary education. Both document analysis and interviews exposed teachers' perceptions of the syllabus as excessively bulky, attributed to redundant content carried over from the previous primary education level. This perception has given rise to an examination-centric approach, with teachers concentrating on strategies directly impacting exam questions, resulting in a prevalence of drill and practice methods while sidelining the use of models and concrete materials.

Sindi articulated the difficulty of completing the syllabus within a single academic year due to its congestion, urging curriculum authorities to address the issue by eliminating repetitive content. Criticizing traditional teaching styles, she advocated for technology integration, emphasizing the inadequacy of talk-and-chalk methods, which she believed disengaged technologically advanced learners. However, Sindi lamented the lack of access to computers in schools and stressed the necessity for teacher training on technology integration.

In contrast, Wootji acknowledged her learners' interest in computers but resisted their pressure, emphasizing that concepts taught through computers are not examinable. She admitted to a lack of empowerment in using technology effectively, citing a scarcity of workshops on technology integration. Wootji's teaching approach aligned with an examination-oriented focus, prioritizing examinable content over potentially beneficial technological methods. Rothwe, too, acknowledged syllabus congestion and advocated for a strategy involving demonstration and practice. He dismissed group work as time-consuming and discouraged the integration of technology, citing limitations in computer laboratory capacity and the non-examinable nature of technology-related concepts. Rothwe's teaching approach appeared heavily examination-driven, concentrating on methods facilitating memorization for exams while sidelining strategies promoting conceptual understanding.

These collective accounts illuminate a prevalent examination-oriented mindset among teachers, driven by the challenges posed by syllabus congestion. While some teachers recognize the potential benefits of technology integration and alternative teaching methods, practical constraints and the prioritization of examinable content hinder their adoption. The narratives underscore the need for teacher empowerment through workshops on technology integration and a reconsideration of examination-focused teaching practices.

An examination of Rothwe's instructional materials, including the scheme of work, record of work, and lesson plans, exposed notable shortcomings. Figure 4 depicts an incomplete scheme of work, lacking information in the dates and resources or teaching aids sections, with topics not broken down into subtopics, hindering a detailed outline of content depth. The record of work, illustrated in Figure 5, was scant, lacking informative and comprehensive details about successes, failures, and suggestions for improvement or enrichment.

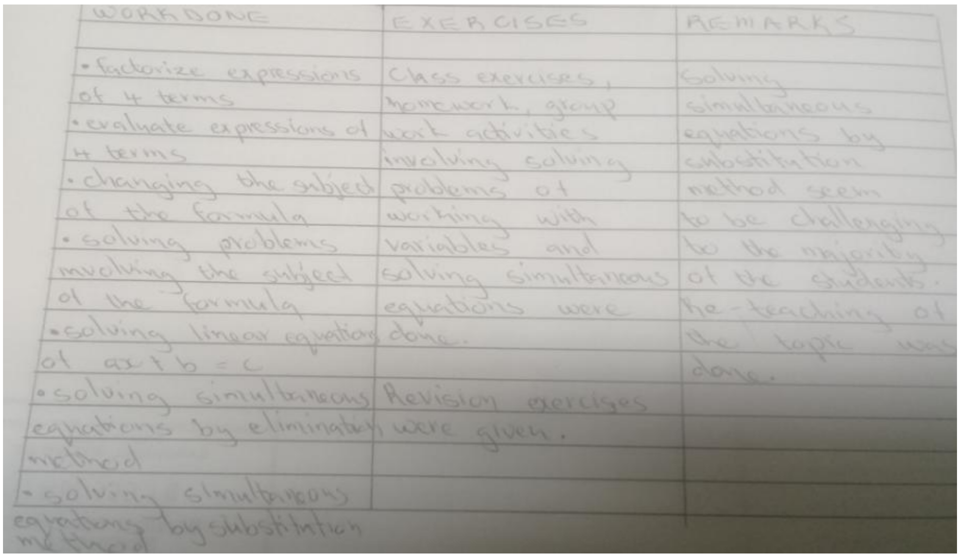


SCHEME OF WORK

TERM THREE

TOPIC	DATES	SPECIFIC OBJECTIVES	RESOURCES & T/METHODS
FORMULAE		• evaluate formulae	
		• change the subject of the formulae	
		• solve problems involving changing the subject	
EQUATIONS		• solve linear equations of ax+b=c	
		• solve simultaneous equations	
GRAPHS		• use the graphical method to solve simultaneous linear equations	
		• use data from practical situations to draw graphs which involves using simultaneous linear equation to derive solutions for problems	
		• interpret and use graphs in practical life situations	

Figure 42. *Incomplete scheme of work by Rothwe*



WORK DONE	EXERCISES	REMARKS
• factorize expressions of 4 terms • evaluate expressions of 4 terms • changing the subject of the formula • solving problems involving the subject of the formula • solving linear equation of ax+b=c	Class exercises, homework, group work activities involving solving problems of working with variables and solving simultaneous equations were done.	Solving simultaneous equations by substitution method seem to be challenging to the majority of the students. Re-teaching of the topic was done.
• solving simultaneous equations by elimination method • solving simultaneous equations by substitution method	Revision exercises were given.	

Figure 53. *Scant record of work done by Rothwe*

Furthermore, the lesson plans for Rothwe and Wootji, shown in Figure 6, were not readily available during observations but were collected three weeks later. Rothwe's lesson plan lacked a rationale for teaching the topic, a deficiency also observed in other teachers' plans. Wootji attempted to provide a generic rationale, but its immediate relevance to learners was questionable.

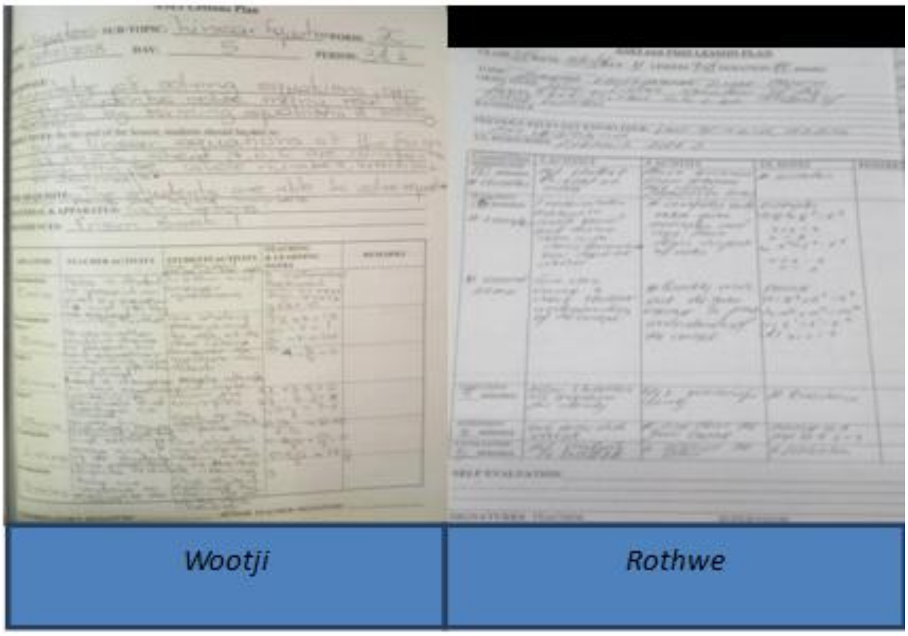


Figure 6. *A sample of the lesson plans for Rothwe and Wootj*

Interviews with Rothwe unveiled insights into teachers' perspectives on lesson plans, with Rothwe dismissing lesson planning as a mere policy and stating that they did not rely on it, primarily considering it for record-keeping purposes. He asserted that comprehensive planning was hindered by the limited space in the provided SMASE lesson plan booklet. Rothwe emphasized that the quality of teaching lies with the teacher rather than the lesson plan, pointing out that some colleagues produced consistent results without detailed plans, highlighting a general lack of reliance on lesson plans during classroom instruction, with teachers depending more on their experience (Smith, 2010). Rothwe's instructional materials, including the incomplete scheme of work, scant record of work, and lesson plans lacking detail, suggest significant challenges in instructional planning and documentation. The interviews with Rothwe underscore teachers' perspectives on lesson plans, emphasizing their limited utility for instructional guidance and a more prominent role in record-keeping, aligning with findings from previous research (Johnson, 2005; Smith, 2010).

The instructional challenge of addressing learners' misconceptions during the teaching of algebraic equations is notably highlighted. Document analysis and interviews with participating teachers, including Koro, Sindi, Rothwe, and Wootji, revealed that learners often displayed misconceptions, errors, mistakes, and howlers. Observations in Koro's class illustrated instances where learners exhibited misconceptions in solving equations. For example, Max treated an equation as having two variables, and Koro, in trying to correct this, displayed a similar misconception regarding the interpretation of the given equation. In another case, Hope misapplied rules, treating powers like ordinary multiplication. Koro failed to address Joy's question about an alternative solution method, contributing further to learners' confusion (Smith, 2010). This finding aligns with existing literature, suggesting that teachers' ability to address learners' misconceptions is a crucial aspect of effective teaching (Hiebert &Grouws, 2007; Smith, 2010). The study reveals challenges faced by teachers, such as Koro, in effectively identifying and correcting learners' misconceptions during algebraic equation instruction, emphasizing the need for targeted professional development to enhance teachers' pedagogical content knowledge (Shulman, 1986; Ball et al., 2008).

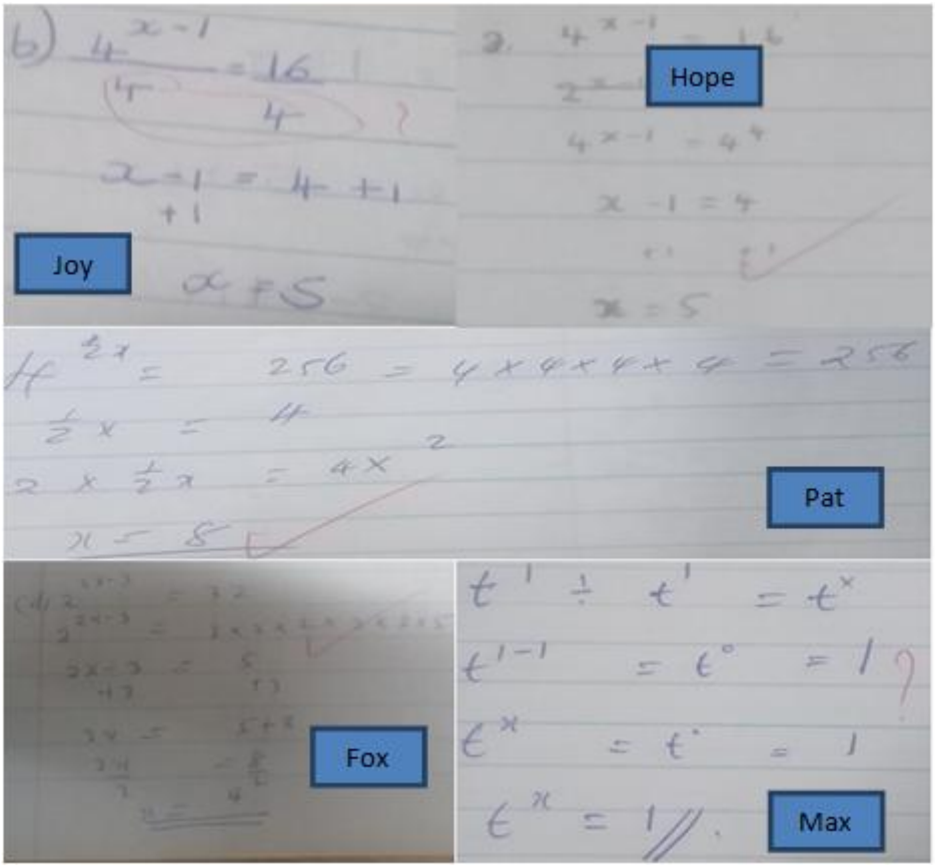


Figure 7. *Learners' varied misconceptions, errors and mistakes*

Sindi's class observations revealed that while she identified mistakes during group presentations, her approach to addressing misconceptions involved drilling learners with more examples (see figure 8 below). In an interview, Sindi emphasized the use of additional examples and drilling to help learners understand concepts and avoid repeating mistakes.

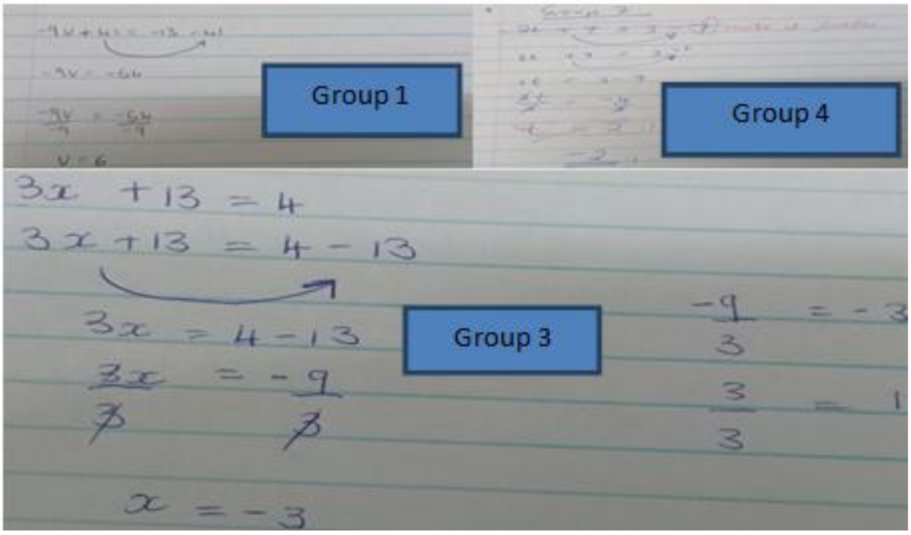


Figure 84. *Group work presentations in Sindi's class*

The findings underscore Sindi's utilization of diverse methods to address learners' misconceptions during algebraic instruction. In Figure 8, various groups in Sindi's class incorrectly combined the balance and transpose methods, prompting her to identify the mistake and intervene during the lesson. Sindi's proactive approach, evident in her reflective teaching, involved halting at Group 4 and instructing them to subtract -7 from the equation. Furthermore, she noted an error in omitting the negative sign when dividing -4 by two, and the learners rectified this mistake following her intervention. During an interview, Sindi detailed her strategies to ensure learners acquire conceptual understanding and prevent the recurrence of mistakes or misconceptions. She stressed the importance of providing additional examples to clarify misconceptions and concentrated on addressing challenges related to word problems through drilling. Sindi's approach includes incorporating extra questions on word problems across all streams, intending to enhance learners' retention for exams. However, the study suggests that Sindi's reliance on drilling learners may not be the most effective solution for dealing with misconceptions. While she identifies and corrects mistakes during class activities, her emphasis on repetitive exercises, particularly in word problems, raises questions about the depth of conceptual understanding achieved by the learners (Hiebert &Grouws, 2007; Smith, 2010).

In contrast, the study observed Rothwe, another teacher, demonstrating an incorrect representation of the balance method (See Figure 9). This observation aligns with existing literature, emphasizing the importance of teachers' content knowledge and pedagogical content knowledge in effectively addressing learners' misconceptions (Ball et al., 2008; Shulman, 1986). The study highlights the need for targeted professional development to enhance teachers' capacity to address and correct misconceptions during algebraic equation instruction.

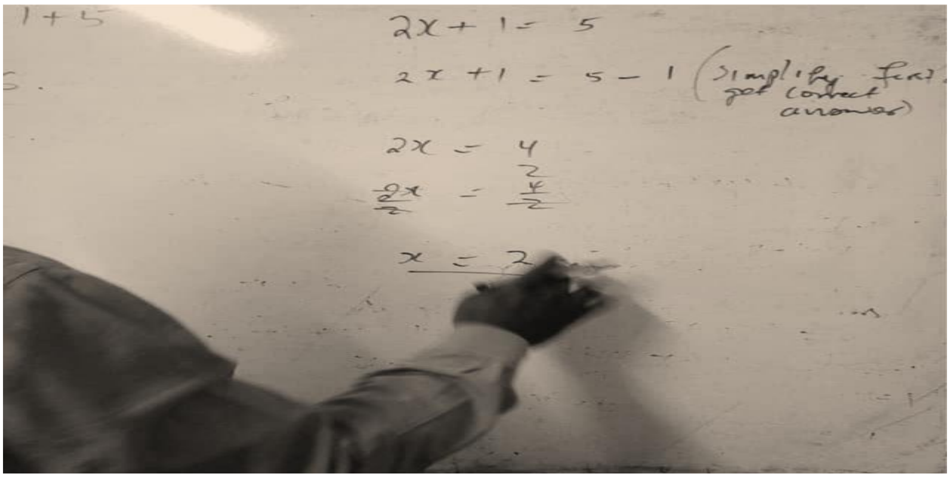


Figure 9. *Rothwe's solution*

The study brings attention to Rothwe's erroneous representation of the balance method in teaching algebraic equations. Figure 9 illustrates Rothwe working through a problem where he incorrectly distributed -1, resulting in an imbalance with +1 on one side of the equation and -1 on the other. This inconsistency was observed after several learners expressed confusion during Rothwe's demonstration. Rothwe's explanation of the solution demonstrated a lack of clarity and conceptual understanding. His statement, "Take one and put with five as they don't have variables, hence same sums +1 will be -1 as it goes to the other side," did not provide learners with a meaningful understanding of the algebraic principles involved. During the interview, Rothwe revealed his approach to addressing learners' mistakes, emphasizing the importance of emphasizing correct procedures and writing misconceptions on the board. However, he acknowledged a lack of experience in dealing with certain topics and suggested a need for yearly workshops and stronger collaboration among colleagues to address teaching challenges. The analysis of Rothwe's interview indicates that he relies on drill and practice as a solution to learners' misconceptions and lacks effective strategies to address the complexities of teaching algebraic concepts. His limited understanding of certain mathematical principles, such as the concept of the highest common factor, further contributes to challenges in providing accurate guidance to students. The study underscores the need for comprehensive professional development to enhance teachers' abilities to address learner misconceptions effectively. Wootji's class observation showed a learner, Bidi (see Figure 10), presenting a wrong solution to a word problem, displaying algebraic interpretation misconceptions. Wootji did not effectively interrogate Bidi's response and instead took over to demonstrate the correct solution. In an interview, Wootji attributed learners' lack of understanding to some slow learners and suggested that spending more time with them would be a waste (Black & Wiliam, 1998).

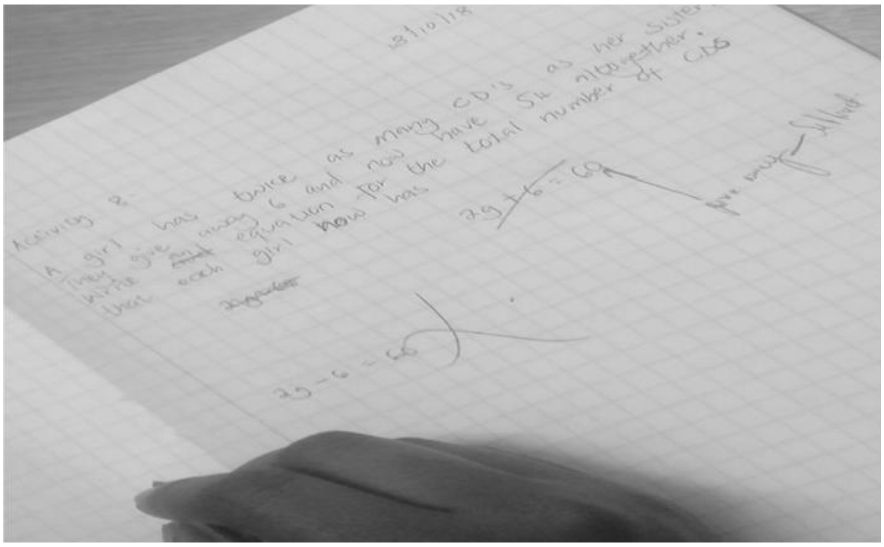


Figure 10. *Bidi's wrong answer*

Bidi's attempt at solving the algebraic word problem unveiled a misinterpretation of crucial statements, such as 'twice as many CDs (2g)' and 'give away six (-6) and remain with 54.' The ensuing misunderstandings prompted Bidi to formulate an erroneous equation, 2g - 6 = 60. This misstep underscored a failure to accurately translate the verbal problem into algebraic symbols, indicating a reliance on literal interpretation without considering the intended meaning. Bidi's deficiency in logical reasoning became apparent in her approach to equation setup, characterized by guesswork. Despite possessing all the pertinent details from Activity 8, she neglected to establish a coherent structure for translating the word problem into algebraic symbols. For instance, her initial equation, 2g + 6 = 60, incorrectly added six to 2g, resulting in an erroneous equation by elevating 54 to 60.

The analysis illuminates Wootji's missed opportunity to probe into Bidi's thought process and lay the groundwork for understanding. Instead of scrutinizing Bidi's response, Wootji, as depicted in Figure 9, assumed control, and presented the solution to the class. Unfortunately, this instructional approach lacked a clear definition for the variable 'y' used in the equation, and there was insufficient explanation provided to learners for the conceptualization of the given word problem. This oversight on Wootji's part impeded the opportunity to address Bidi's misconceptions and hindered the fostering of a deeper understanding of algebraic concepts among the students.

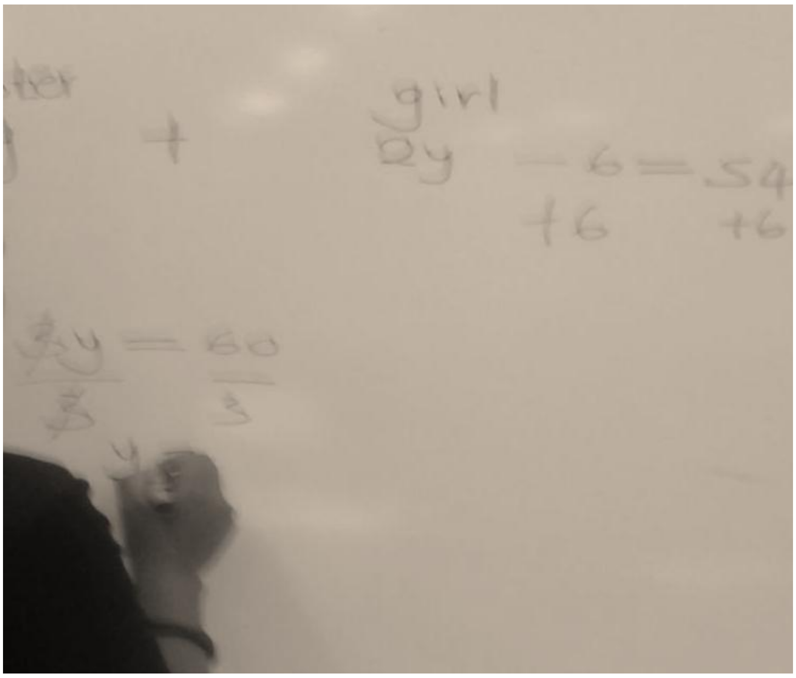


Figure 115. *Wootji demonstrating the solution on the chalkboard*

Wootji, after presenting an equation and receiving a negative response regarding understanding from the learners, attempted to clarify the concept using a similar problem, as depicted in Figure 10 below. This example aimed to assist students in grasping the presentation of the "twice as many" concept. However, despite these efforts, the demonstration was not convincing enough to aid Bidi, who had initially formulated the equation 2g - 6 = 60.

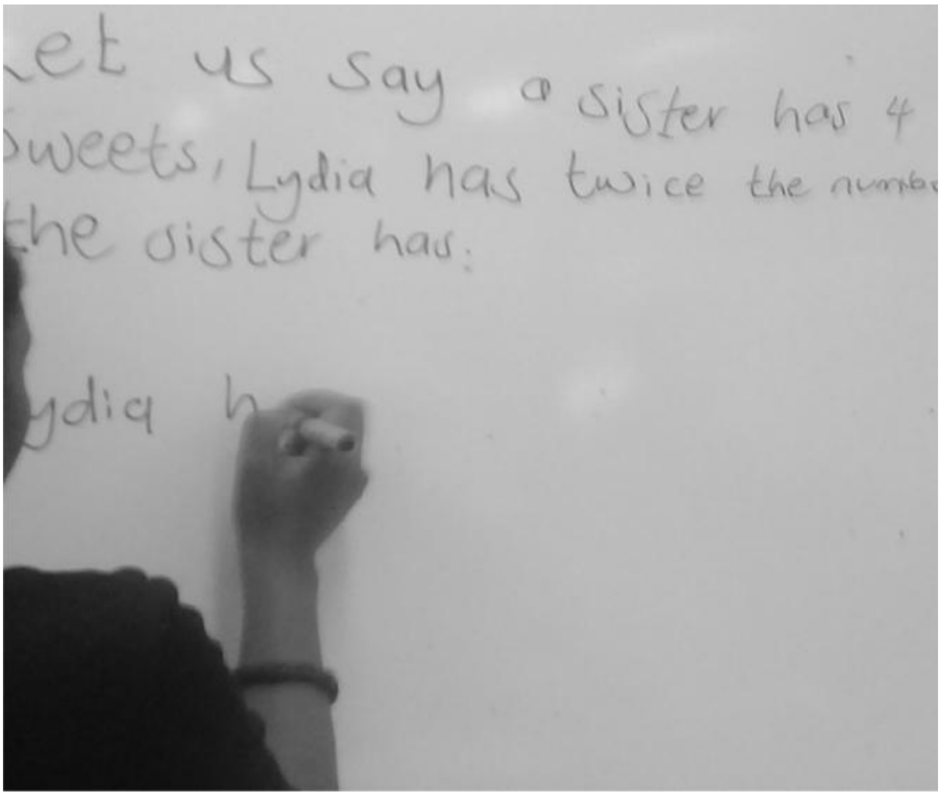


Figure 12. *Wootji demonstrating the idea using a similar problem.*

In interviews with Wootji, insights emerged regarding the challenges she encountered in addressing learners' misconceptions, errors, and mistakes. When questioned about the observed difficulties students faced in solving word problems, Wootji attributed it to some students being slow learners and suggested that the problems might be more suited for high achievers. She expressed reluctance to invest more time in addressing the concerns of other students, deeming it a waste of time. The interview analysis indicated that Wootji lacked specific strategies to effectively deal with learners' mistakes or errors, both during and outside of class. The study underscores the need for teachers to develop effective strategies for identifying and addressing learners' misconceptions during algebraic instruction, highlighting the complexity of addressing individual learning needs in a classroom setting.

6. Summary, Conclusion and Recommendations

The primary objective of this study was to investigate the pedagogical practices of junior secondary school teachers in teaching algebraic equations, addressing a gap in existing research on this subject. The focus of the research was on discerning the instructional challenges encountered by teachers in this context, guided by the central research question: What instructional challenges do teachers face when teaching algebraic equations at the junior secondary school level? The key findings are summarized under distinct themes related to instructional challenges.

6.1. Class Size

One prominent challenge identified was the issue of class size. The study revealed that class sizes were notably large, ranging from 42 to 48 learners per class. This large enrollment, coupled with limited classroom space, impeded the effectiveness of group work. In specific instances, there were seven to 10 learners per group, and in one class, only four learners per group, but the confined classroom space presented challenges. The study highlighted that the substantial class sizes made teaching challenging and adversely impacted classroom control. Group work, instead of fostering collaborative efforts on algebraic equations, was primarily utilized for resource sharing and book marking. The dominance of high achievers in group activities and teachers frequently taking control marginalized opportunities for cooperative learning among low achievers.

Furthermore, the study found that the constraints imposed by large class sizes posed a barrier to implementing learner-centered, activity-based learning, contradicting the goals outlined in Botswana's Educational and Training Sector Strategic Plan (ETSSP) for 2015-2020 (Botswana, 2015). The inadequate marking of learners' work further hindered reflective teaching, as mistakes and misconceptions went unaddressed in subsequent lessons. This discovery aligns with previous research, such as Mulryan-Kyne (2010), which suggests that large classes contribute to poor classroom management, emphasizing the effectiveness of active learning in enhancing learners' participation and reflection on mistakes.

The study proposes that active learning can be effective in enhancing learners' participation and enabling them to reflect on misconceptions and mistakes. However, the current research revealed a lack of opportunities for such active engagement and participation among learners in large classes. This contrasts with other studies, such as Lloyd-Strovas (2015), which recommended that teachers should incorporate plans for actively engaging learners while managing large class sizes. The approach advocated by Lloyd-Strovas holds promise for enhancing meaningful learning and reducing disruptive behaviors in the classroom, as suggested by Mulryan-Kyne (2010).

6.2. Syllabus Congestion

The findings unveiled a notably extensive mathematics syllabus, prompting a teaching approach oriented toward examinations. Teachers, under the pressure of examination demands, predominantly adopted a drill and practice method, sidelining activity-based learning that incorporated models and concrete materials for solving equations. Interviews disclosed that one teacher discouraged the use of group work and collaborative learning, citing their time-consuming nature and potential impact on syllabus coverage. The prevailing examination-driven focus led teachers to favor strategies directly related to exam questions, with drill and practice being the preferred method due to its perceived relevance, while activity-based learning was dismissed for its perceived misalignment with examination requirements.

Further analysis exposed a deficiency in effective lesson planning, exacerbating syllabus congestion. Teaching materials were not adequately planned for, and records of work done did not consider addressing learner misconceptions in future lessons. Poor lesson planning, characterized by simplistic statements like "give class work" and "learner do work," indicated a preference for the drill and practice approach. Despite literature emphasizing the positive impact of well-thought-out lesson plans on teacher competence(Boikhutso, 2010; Ghanaguru et.al., 2017; Kizlik, 2008; O’Donnell & Taylor, 2007; Donnell, Taylor & Flores, 2006), the observed teachers, influenced by years of experience, did not consistently bring lesson plans to class, treating them more as a policy-enforced record than a tool for instructional improvement. This lack of adherence to lesson planning was identified as a contributing factor to timely syllabus coverage, aligning with findings by Ghanaguru et. al., who reported discrepancies between written plans and actual classroom instruction.

The study suggests the importance of encouraging teachers to strive for quality instruction through well-researched, reflective lesson plans. Additionally, teachers' challenges with materials and representations negatively affected syllabus coverage, with instances of teachers deviating from curricular requirements, causing student confusion. The analysis of lesson plans indicated a lack of structure in the progression of algebraic equation concepts, and teachers failed to utilize suggested textbook materials for guiding active learning through models and hands-on activities. The study further noted a lack of anticipation of complexity in lesson planning, with lessons failing to address possible learner misconceptions or propose intervention strategies.

Some teachers did not connect word problems to real-life contexts, failing to demonstrate the application of algebraic concepts. The teachers' weak contingency knowledge was evident in the absence of planning for resource unavailability in lesson plans, dismissing engaging activities as time-consuming and likely to affect syllabus coverage. Despite acknowledging the importance of technology and teaching aids, teachers did not plan for improvisation, indicating a lack of contingency plans for addressing shortages in tools and resources for effective algebraic equations teaching.

6.3. Conclusion

In summary, the study illuminates significant challenges in teaching algebraic equations at the junior secondary school level, encompassing class size issues, syllabus congestion, algebraic misconceptions, and language use deficiencies. The recommendations span various domains, emphasizing the need for a comprehensive approach involving practice, professional development, research, and collaboration among curriculum developers and educators to improve the learning environment for students (Mulryan-Kyne, 2010; Ghanaguru et.al., 2017; Tanisli& Kose, 2013; Altun, 2006; Buforn et. al., 2020). This aligns with previous studies that advocate for a holistic strategy to address challenges in mathematics education.Addressing these challenges is pivotal for cultivating a more effective and engaging learning environment for students.

Following an exhaustive analysis of gathered data, literature study, and classroom observations, the study proposes several recommendations to enhance mathematics instruction considering the identified challenges.To overcome the challenge of large class sizes impeding effective teaching, teachers are encouraged to explore alternative strategies such as flexible grouping or peer teaching. The promotion of learner-centered, activity-based learning strategies should align with Botswana's ETSSP goals, emphasizing meaningful engagement and cooperative learning. Advocating for the inclusion of contingency plans in teaching practices is crucial for addressing unforeseen challenges during instruction.

Further research is recommended to explore innovative methods for managing large classes that enhance student engagement and participation. Studies should investigate the impact of balanced syllabus coverage on student performance and conceptual understanding, offering evidence-based insights for instructional practices. Additionally, research efforts should focus on effective strategies for addressing algebraic misconceptions and promoting learner independence in problem-solving. The study contributes to the body of knowledge by highlighting challenges in teaching algebraic equations at the junior secondary school level. It underscores the importance of active learning strategies, the impact of syllabus congestion, and the need for anticipatory approaches in lesson planning. The findings provide valuable insights for educators, researchers, and policymakers seeking to enhance mathematics education.Collaborative efforts among curriculum developers and educators are crucial for revising the mathematics syllabus. The revision should ensure alignment with both examination requirements and active learning approaches, fostering a balanced educational environment. Emphasis should be placed on effective lesson planning as a tool for improving classroom instruction, incorporating anticipatory strategies for complexity, learner misconceptions, and intervention into curriculum materials.

Teachers should receive training on effective syllabus coverage, striking a balance between examination requirements and active learning. Workshops should equip teachers with strategies for addressing misconceptions, promoting learner independence, and using proficient algebraic language. Continuous professional development opportunities should include sessions on integrating technology into teaching practices, ensuring educators are adept at utilizing modern tools for enhanced instruction.

Lastly, the study recommends a multifaceted approach involving improvements in classroom practices, research initiatives, contributions to the body of knowledge, collaboration among curriculum developers, and continuous professional development for teachers and educators. These recommendations aim to address the identified challenges and contribute to the enhancement of mathematics education at the junior secondary school level.

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