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Examining the Methods Used by Math Teachers in the Zambezi Region of Namibia to Address Algebra Problems Faced by Grade Twelve Learners

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Abstract

The purpose of this study was to investigate and establish the Mathematics teachers' teaching strategies that were used in addressing Grade 12 learners' challenges in Algebra in Katima Mulilo Circuit in Zambezi Region of Namibia. In order to guide the study, the following main question was used: What strategies do teachers use in teaching Algebra in Katima Mulilo Circuit in Zambezi Region? This descriptive qualitative design used convenient sampling technique to select three Mathematics teachers from a population of twelve, to elicit the strategies that teachers used in solving problems in Algebra. Observations, document analysis and interviews were used to generate data with teachers. Data generated from instruments was analyzed and classified. Hence, the similarities emerged with the strategies that were identified, thereafter align to social constructivism learning theory used as a lens. Some revelations were that, causes of challenges with Grade 12 learners in solving algebraic problems are lack of solving skills, inappropriate use of the learning strategies by learners and negative attitudes towards Algebra. The other finding was that, teachers used the strategies like visualizing a problem, step by step procedure, identifying key words, guessing and checking, and choosing an operation. Some of the recommendations point to the teachers to use the teaching strategies for solving algebraic problems and teaching strategies to make Grade 12 learners understand Algebra. Lastly, these teaching strategies should be used by applying the Concrete-Representational and Abstract Approach (CRA), where concrete materials are used in teaching Algebra to Grade 12 learners.

Keywords

Teaching Strategy, Habits of Mind, Algebra and CRA

1. Introduction

Seeking various strategies to assist learners improve the learning of Algebra and develop mathematical practices is a primary goal for all Algebra teachers (Zbiek & Larson, 2015), and also exposing various teaching strategies that help to mitigate learners' challenges in Algebra is vital. Algebra is one of the foundational components of mathematical understanding and competence, but unfortunately, it comes as a challenge for many learners for decades. The researchers concur with Yaro, Arshad & Salleh (2015) in believing that, the challenge in teaching nowadays is to teach learners of various capabilities and differing rates of learning success. Thus, the challenges that learners may have in Algebra include lack of knowledge and skills in algebraic problem solving strategies (Sikukumwa, 2017) and their poor attitude towards Algebra (Keierleber, 2015). Despite that, ineffective teaching leads to poor problem solving in Algebra by learners and eventually poor performance in Mathematics. This is evident in Namibia especially in Zambezi Region. In order to curb challenges in Algebra, schools globally intervene by tasking learners to do Algebra as early as lower primary. Algebra as a syllabus topic was formally introduced in Namibia in 2016 in Grade 7, but concepts of Algebra start at primary, i.e. ? + 4 = 7.

The Grade 12 learners showed the challenges in solving problems in Algebra as discussed by Sikukumwa (2017), that learners have little knowledge and skills in solving problems in Algebra. The change from Arithmetic to Algebra is particularly difficult, and improvements in Algebra teaching are greatly needed (Star & Johnson, 2009). In support of what is stated above, the challenges in Algebra encountered by Grade 12 Ordinary Level learners are also supported by an analysis of Algebra performance from 2013 to 2017 Namibian Senior Secondary Certificate Ordinary level (NSSCO) Mathematics final examination by the Directorate of National Examination and Assessment (DNEA). **Table 1**, below shows the examiners' comments on learners' performance as challenges in Algebra.

According to the below table (**Table 1**), questions on Algebra were been poorly answered and that was alarming. In addition, the researchers concur with Chow (2011) in believing that "the challenge in education today is to effectively teach learners to learn mathematical terms with understanding and developing positive attitudes towards mathematics learning" (p. 4). The Grade 12 learners were challenged with the mathematical terms and have a negative attitude towards Algebra. Therefore, effective teaching strategies are required to resolve the situation. This means the Grade 12 NSSCO learners are mostly lacking the right habits of mind, which assist in solving problems in Algebra. However, data from

Table 1. Document analysis of the DNEA examiners' report.

YEAR/ PAPER	QUESTION AND REPORT COMMENT
2013/3	5 (a) Learners could not write down the equation, and (b) many learners had no idea on how to solve a factored out quadratic equation.
2014/3	7 (b) (iv) Poorly answered 8 (c). Surprisingly, this part was fairly answered (changing the subject of the formula).
2015/3	10 (b)-(d) Poorly answered, most learners couldn't substitute correctly, change the subject of the formula, and could not factorize
2016/3	8 The question of algebra seemed very challenging to many learners. Learners struggled to collect like terms
2017	4 (b)-(c) Poorly answered 4 (b) learners could not substitute properly and make N the subject of the formula; 4 (c) Learners could not remove the brackets correctly.

the National Assessment of Educational Progress [NAEP] indicates that many Grade 12 learners can only solve the simple and routine Algebra tasks (Star & Johnson, 2009). This is also evident in Zambezi Region especially in Katima Mulilo Circuit.

In order to guide the study, the following main question was used: What strategies do teachers use in teaching Algebra in Katima Mulilo Circuit in Zambezi Region?

The findings of the study will be significant to teachers, learners and the stakeholders in education. These educational stakeholders are learners, school administrators, teachers, parents, local business leaders, community members, state representatives (for example, councilors), school board members (Yaro, Arshad, & Salleh, 2015). The outcome of the study will inform education stakeholders about learners' challenges in Algebra, in order for them to help in the education of their children. When learners perform well in school, there is assurance of community development. The school management and the senior education officers may use the findings of the study in workshops, to train and support teachers on effective teaching strategies in Algebra, to mitigate learners' challenges in learning Algebra.

2. Theoretical Framework and Literature Review

2.1. Theoretical Framework

Vygotsky's Socio-Constructivist Theory (SCT) informs the theoretical framework, individual knowledge is constructed through social interaction with others, rather than being received (Vygotsky, 1978). The assumption is that knowledge does not exist in a book, but rather it is constructed by the learner in the process of interacting with other learners. The theory examines the knowledge and understanding of the world that are been jointly developed by individual

learners. However, making sense of other peers and construct knowledge on a social level allows the learners to relate themselves to circumstances. The focus of social constructivist theory is the role played by social interaction in creating knowledge. Vygotsky believes that learning could not be separated from the social context. Vygotsky (1978) argues that all cognitive functions are been ignited as products of social interactions. This means constructivist theory largely influences the way in which people learn. The most important learning method according to constructivism is problem solving (Yaro, Arshad, & Salleh, 2015). Yaro, Arshad, & Salleh (2015) maintains that effective constructivist provides real life problems that learners must deal with and problems are solved well through social cognition rather than solving the problems alone. The teacher's main task in this model of learning is to translate the learning content into the format suited to the learners' state of understanding.

The study, therefore, focused on the concept of Zone of Proximal Development (ZPD). The ZPD is been defined as the gap between the time that the child may be able to solve a problem with the help of a teacher, and the time that the child can solve the same problem alone (Vygotsky, 1978). However, since the study concentrated on teachers, the focus of the study based on the potential developmental level. At that level, learners solved problems without the help of a teacher in other topics, which were prerequisites to Algebra, but in Algebra and at a stage where they were been challenged, the teacher had to come in and help. The teachers' strategies as the required habits of mind were been used in teaching Algebra to help the learners to solve algebraic problems. The teachers mostly facilitated the development of habits of mind as strategies to solve problems in Algebra. For example, visualizing the equation $2x + 1 = 7$ (In words: the number is doubled and 1 added to give 7). In that way, learners understand the given equation and work out the problem using solving skills in Algebra. Lastly, Vygotsky (1978) believes that teaching strategies using social constructivism as a lens include teaching in the context that has personal meaning to learners. Therefore, teachers used different categories of strategies in teaching learners how to solve problems in Algebra.

2.2. Literature Review

Algebra is a branch of Mathematics that deals with symbolic notations and the rules for manipulating the symbols (Coolman, 2015). These operations and symbols were been written in Latin and Greek, as quantities without fixed values and are called variables in basic Algebra. In olden days, Algebra went through an extensive development by Islamic scholars at their Golden Age. This was inherited later by the Babylonians who did Algebra with procedural methods, solving by transforming a problem into standard form and working out the solution. For example, solving $3(x - 3) = -6$. Firstly, the brackets are removed to set it in standard form as $3x - 9 = -6$ gives $3x = 3$, finally $x = 1$. Now in modern times, a move from applying procedural methods were used first, in doing operations to

each side of the equation. Nowadays, there are invented methods to deal with Algebra, if one engages with habits of mind. For instance, if one engages in visualization, he might interact with one of the two strands namely; mental visualization or analogy visualization (Cuoco et al., 1996). For example, if one decides to interact or use analogy visualization using a geometrical model, the Pythagoras Theorem can be visualized, area of the square on hypotenuse side is equal to the sum of area of squares on adjacent and opposite sides. In simple terms, the theorem entails that, the area of a square on the longest side is equal to the sum of the areas of squares placed on the other two sides, the adjacent and the opposite sides. This theorem can only be defined with an Algebraic expression as $c^2 = a^2 + b^2$. Moreover, the algebraic operations and symbolism were seen in Geometry first, and it was argued that Algebra should be demonstrated by using Geometry for learners to understand the concepts (Katz & Barton, 2007). The invented methods which require one to use habits of minds proceeded from Algebra's historical stages of development, which involved; "rhetorical, the syncopated and symbolic" stages (Katz & Barton, 2007). We are now on the symbolic stage as outlined above and the meaning of Algebra was taken from the symbolic stage, where algebra is defined as the representation of numbers by using symbols and letters. The variables used are x and y variables. The other four conceptual stages followed as stated by Katz and Barton (2007); are geometric stage, static-equation solving stage, dynamic function stage, and abstract stage (Katz & Barton, 2007). Algebra is being defined fully at the conceptual stage. In the Namibian curriculum, at the symbolic stage, Algebra is covered in the following topics; 1) Algebraic expressions, where pupils simplify, expand and factorize the expressions. For example, simplify $2x + 3y - 8x = 3y - 6x$. 2) Substitution of numbers into the expressions, such as find the value of $x^2 + 2$, if $x = -2$, $(-2)^2 + 2 = 6$. 3) Changing the subject of the formula, such as make z the subject in $y = 2 + z$, $z = y - 2$. 4) Equations, where learners solve equations (linear and quadratic). 5) Word problems, for example, "*The product of a number and* 2 *equals* 8. *What is the number*?" If a number is a, the equation will be $2 \times a = 8$, $2a = 8$ then $a = 4$. Sikukumwa (2017) argues that word problems are more challenging in Algebra than any other subtopic of what was been investigated. However, the researchers in this study believed that Algebra in general was a challenge to the learners, as discussed in the statement of the problem. In order to understand the learners' challenges, more literature in teaching Algebra is been discussed below.

A teaching strategy is a method used to help learners learn the desired subject content and be able to develop achievable goals in the future (Yaro, Arshad & Salleh, 2015). However, the researchers agree with Sikukumwa (2017) that learners should be able to act on the operational stage in order to solve the problem by using the strategies, and decide on what to do and how to do it. Cuoco et al. (1996) believed that visualizing problems, guessing, and pattern sniffing, experimenting, describing, inventing and conjecturing were important habits of mind as strategies useful for solving problems in Algebra. According to Cuoco et

al. (1996), habits of mind are "mental skills that allow learners to develop a repertoire of general heuristics and method that can be applied in many different situations" (p. 378). In this study, habits of mind meant two aspects; 1) *The skills as the dispositions teachers develop in learners in their teaching strategies for addressing Grade* 12 *learners' challenges in Algebra*. This translates to the skills that need to be developed in learners through a research experience. 2) *The teaching strategies used in Algebra in order to solve algebraic problems*. For example, visualization is a skill and a strategy used to solve problems like, x + 3 = 7. A learner visualizes in making a mental picture of what the problem is in trying to solve it. Visualization is aided by using concrete materials like counters. A problem can be described, as Maria has seven counters; she separates three counters from the seven. What has remained? It can also be in word (story) form. For example, *a number that can be added with three*, *the result is seven*. *What is that number*? However, a curriculum organized around the habits of mind tries to close the gap between what the users and makers of Mathematics do and what they say. It develops learners to have the ability to be creators, inventors, visualizers, conjectures, pattern sniffers and experimenters; it lets them experience what goes on behind the study door before new results are polished and presented (Cuoco et al., 1996). The problem-solving strategies that seem to be common in Algebra, especially when dealing with problem-solving, involve visualization, organizing data, finding a pattern, solving a simpler analogous problem, working backwards, adopting a different point of view, intelligent guessing and testing, logical reasoning, and considering extreme cases (Posamentier & Krulik, 1998). Other researchers (Puteh, 2002; Sikukumwa, 2017), review the strategies similar to the ones outlined above as habits of mind, but these researchers called some of the habits of mind (describing, and visualizing a problem) as teaching strategies. Puteh (2002) emphasizes on strategies to change learners' attitudes in Algebra. In addition, "teachers use learner-centered approach and on the other hand, diagnostic teaching to determine appropriate supplementary or remedial strategies" (Yaro, Arshad, & Salleh, 2015: p. 23). However, the challenge is how to facilitate pattern sniffing, visualizing, describing, experimenting, inventing and conjecturing as suitable habits of mind. Furthermore, the innovative, approach of teaching focuses on problem solving with pictures and diagrams (Keierleber, 2015). This approach may be used in changing learners' attitude, with the other similar strategies, which are a combination of habits of mind. Lastly, in order to collect the data for the study, the methodology is been discussed next.

3. Methodology

The study used a descriptive qualitative research design in observing and describing everyday practices of specific events of Mathematics teachers' strategies in teaching Algebra (Allwright & Hanks, 2009; Lambert & Lambert, 2012). In addition, the descriptive research design was used to expose the existence and

the extent of Grade 12 learners' challenges in Algebra that triggered this study in order to get new educational teaching and learning ideas in Algebra problem solving (Sikukumwa, 2017). Furthermore, there is a difference between the two types of research methods, quantitative and qualitative research strategies. The qualitative research method is chosen in order to explore the issue at hand in more detail than when it is a quantitative research method (Setia, 2017). This study adopted qualitative study since more details were been needed, as it describes teachers' strategies for addressing Grade 12 learners' challenges in Algebra, at the selected three secondary schools in Zambezi Region. The phenomenon is been described and explained as the researchers naturally observed it.

For this study, the population of the study was the 12 secondary school mathematics teachers in Zambezi Region. The criteria for the inclusion in the study were: 1) Mathematics teachers who were currently working in secondary schools 2) Mathematics teachers who were currently teaching Algebra.

A sample is defined as a group of people taken from the large population for measurement (Mujere, 2016). However, three mathematics teachers were sampled from the population of 12 mathematics teachers teaching Mathematics in three sampled secondary schools in Katima Mulilo Circuit, Zambezi Region.

The interview schedule, observational schedule, audio-visual recorder and document analysis guide were the instruments used to collect data. Hence, the interview, observation, audio-visual and document analysis were methods used to generate the data. The researchers used the above-mentioned instruments for the reasons that are been discussed below as advantages. The interview schedule was used to answer the research question. The researchers used observational schedule as naturalistic observations in identifying the teaching strategies that teachers used to teach Algebra. The observation also helped to fill the gap in generating information, which did not come out with the interview. This was an advantage because, it gathered information about the physical environment and general behavior of the participants, the data generated is rich and detailed. The researchers as observers had no effect on the validity of the data. To capture the conversations, the audio-visual device was used. This instrument also filled the gap left by the observation schedule. The researchers found time to listen to the conversations again from the device and wrote down the information as to answer the research questions. On the other-hand, document analysis was used to establish Grade 12 learners' performance in given tests and examinations on Algebra. Document analysis was a qualitative research instrument that was used in interpreting the documents in order to give meaning to what was assessed; it included coding content into themes (Bowen, 2009). While documents like examination question papers and tests as well as examiners' reports were to be analyzed for the purpose of this study, analysis thereof helped to interpret the data.

4. Results and Discussions

4.1. Demographic Information of the Participants

The participants were three Mathematics teachers who were teaching Grade 12

Mathematics in Katima Mulilo Circuit in Zambezi Region. The researchers used convenience-sampling technique in order to sample out the three Mathematics teachers at the three secondary schools as shown in Table 2 below.

The table above shows that, the participants of the study were aged from 26 years to 37 years. The two male participates are in their 30s and started teaching in their 20s. One female participant is in her 20s and started teaching five years ago. From the ages of the participants, there has been a clear indication that they had the required experience in teaching and no one had started teaching at the age below 23 years. Two participants were male and one female. The two males had more experience in teaching Mathematics at Grade 12 than the one female who was only five years in the profession. All the three participants, the mathematics secondary school teachers at the three sampled schools indicated that they had teaching qualifications. That meant that these participants went through secondary and tertiary education successfully. Equally important, the information showed that these teachers were professionally qualified to teach the grades they were teaching at the sampled schools of the Katima Mulilo Circuit in Zambezi Region. These teaching qualifications ranged from the Advanced Certificate of Education to a degree in education specializing in Mathematics and Science Education. Two of the participants were married and one was single. The two were married males and one unmarried female. The young lady was engaged to get married. The participants were all mature and responsible, as they had shown during observations and interviews.

4.2. The Algebra Test Results and April Examination on Algebra Questions

Tables 3-5 below show the results of Algebra tests written by Grade 12 learners at schools 1, 2, 3 and the results of April examinations from a document analysis of questions on Algebra. The Mathematics teachers taught using the teaching strategies that were at their disposal and learners got results as given in the tables. The information on learners was collected in order for the researchers to have a better understanding of how good or poor these learners were, in using the strategies they were taught at solving algebraic problems.

Table 3 shows the results for School 1. Firstly, the results show that 70% of the learners taught at this school got below 50% in April examination in 2019, on Algebra questions and only 30% got above average. The learners who performed

Table 2. Demographic information of the participants.

School	Participant	Age	Gender	Professional Qualifications	Marital status
1	A	37	M	Diploma In Education	Married
2	B	28	F	BEd, BSc	Single
3	C	34	M	BETD, ACE	Married

Table 3. Algebra test and April exam results for school 1.

Learner	April exam marks [out of 9]	%	Algebra test marks [out of 39]	%	Sex
A1	2	22	11	28	M
B1	0	0	13	33	M
C1	6	67	0	0	M
D1	5	56	30	77	M
E1	4	44	21	54	M
F1	2	22	6	15	F
G1	3	33	9	23	F
H1	2	22	15	38	F
I1	2	22	8	21	F
J1	7	78	14	36	F

Table 4. Algebra test and April exam results for school 2.

Learner	April exam marks [out of 17]	%	Algebra test marks [out of 25]	%	Sex
A2	9	53	5	20	M
B2	10	59	10	40	M
C2	11	64	13	52	M
D2	14	82	16	64	M
E2	9	53	12	48	M
F2	10	59	14	56	F
G2	9	53	9	36	F
H2	11	64	10	40	F
I2	12	71	11	44	F
J2	10	59	9	36	F

above average were learners C1, D1 and J1 who got 67%, 56% and 78% respectively. The learners who performed better than others were two boys and one girl. Secondly, 80% of the learners got below average in the Algebra test and 20% got above average. These were learners D1 (77%) and learner E1 (54%) and these were all boys.

Table 4 above shows the results for School 2. Firstly, the results show that all the sampled learners taught at this school got above 50% in the April examination in 2019, on the Algebra questions that were out of 17. Whereas, 60% of these learners performed between 50% and 60% and were both boys (3) and girls (3), 40% achieved between 60% and 83%, 2 boys and 2 girls. Secondly, 70% of the learners got below average in the algebra test and 30% got above average. The learners who achieved better than others were learners C2 (52%), D2 (64%)

Table 5. Algebra test and April exam results for school 3.

Learner	April exam marks [out of 10]	%	Algebra test marks [out of 30]	%	Sex
AA	5	50	0	0	M
AB	4	40	5	17	M
AC	1	10	17	57	M
AD	3	20	8	27	M
AE	4	40	14	47	M
AF	2	20	15	30	F
AG	5	50	13	43	F
AH	1	10	21	70	F
AI	3	30	10	33	F
AJ	4	40	9	30	F

and learner F2 (56%). These learners were two boys and one girl.

Table 5 above show the results for School 3. Firstly, the results show that 80% of the learners taught at this school got below 50% in the April examination in 2019, on Algebra questions and 20% got above average. One girl and one boy achieved, on average. The learners who performed above average were learners AA (50%) and AG (50%). Secondly, 80% of the learners got below average in the algebra test and 20% got above average. These were learners' AC (57%) and learner AH (70%); one boy and one girl.

Conclusively, among the three schools, School 2 was the school that performed best in the April Mathematics examination. The results still show that fact. The document analysis on the April examination Algebra questions still shows that School 2 was the best when compared to Schools 1 and 3 in the April examination. At School 2, all the learners achieved above average in April examination on Algebra questions when compared to other schools. However, School 3 achieved the poorest in the April examination Algebra questions (31%) and School 1 in the Algebra test (35.4%). The average achievements of Schools 1, 2 and 3 were as follows:

When learners were solving the algebraic problems, the researchers observed that learners were unable to apply appropriate strategies to solve the problems. Many of the questions asked assessed the "*choose an operation*" teaching strategy. However, the teaching strategy, choose an operation, mentioned by Teacher A as a "*golden rule*".

Figure 1 and Figure 2 present the samples of the answer sheet given by learners in School 1 of this study:

Learner F1 in Figure 1 was the lowest achiever in this Algebra test written. The learner had difficulties with the appropriate use of the teaching strategies taught by Teacher A. The learner demonstrated poor habits of mind in Algebra see Table 6 below by only getting an achievement of 6 out of 39, which is 15%

Table 6. Average percentage (%) marks of April exam and algebra test summary.

School	April Examination Algebra Questions	Algebra Test
1	36.6%	32.5%
2	61.7%	43.6%
3	31%	35.4%

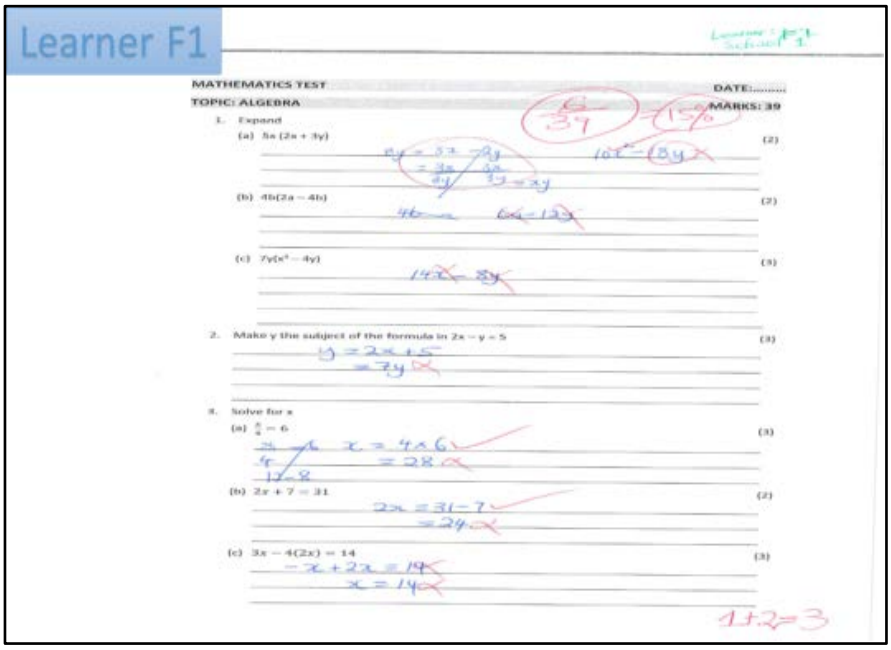

Figure 1. Learner F1's results in the algebra test at school 1.

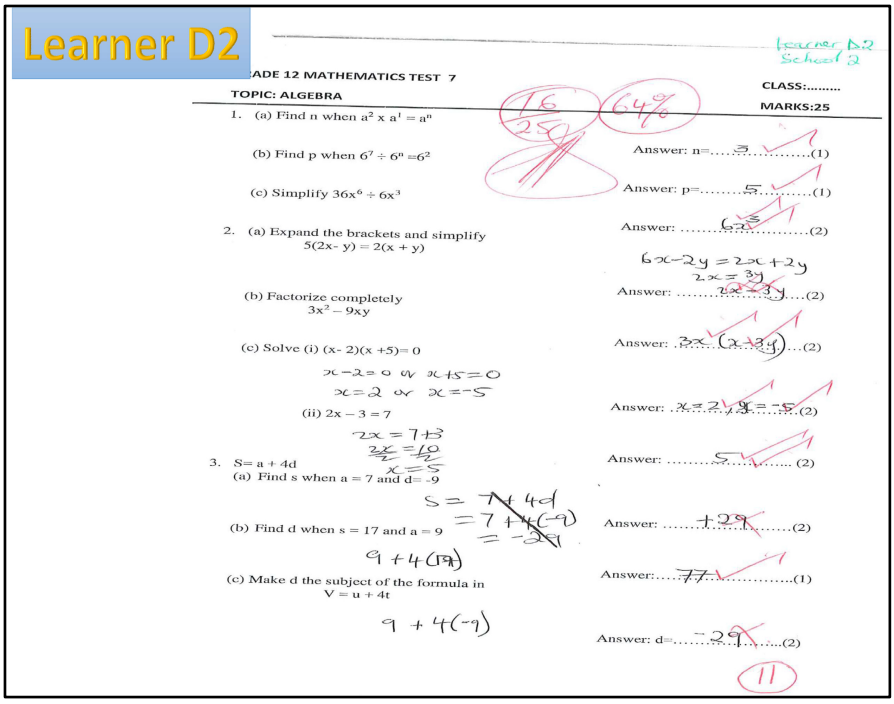

Figure 2. Learner D2's answer sheet of algebra test at school 2.

in the Algebra test.

Figure 1 shows Learner D1, the best achiever in this Algebra test written at School 1. The learner had minimal difficulties the teaching strategies taught by Teacher A. The learner demonstrated good habits of mind in Algebra, especially describing and visualization. Furthermore, the learner demonstrated his knowledge of the teaching strategies by getting 30 out of 39, which gives 77% achievement in the Algebra test.

Figure 1 and Figure 2, present samples of the test answer sheets for learners at Schools 2 of this study:

Learner D2 in Figure 2 was the best achiever at School 2 at the Algebra test by achieving 16 out of 25, which was 64%. The learner demonstrated reasonable habits of mind. The learner was able to *choose an operation*, *identify the key words*, do the *step-by-step procedure*, and *visualize the problems*. The learner had difficulty with questions 3 and 4 (b). In other words, the learner was able to apply most of the strategies in solving algebraic problems. Amongst the questions answered, word problems were a challenge to the learner hence he failed to apply the appropriate and suitable strategy in answering the questions. Learner D2 was supposed to decide on what operation to use in the word problem (addition, subtraction, division or multiplication). This is given in Figure 4 question 4 (b), which is about finding the perimeter of the rectangle with width $2x + 3$ and length $3x + 2$. The operation which was supposed to be chosen was the addition because perimeter is the distance around the shape, so it is given by $P = 2x + 3 + 3x + 2$, $P = 5x + 5$ written in terms of x.

Learner A2 in Figure 3 was the lowest achiever at School 2, by achieving 5 out of 25, which was 20% in the application of the strategies used to solve problems in Algebra teaching. The learner just answered questions 1 (a), 2 (c) and 4 (a) respectively. Therefore, the rest of the questions (80%) were a challenge. The questions answered correctly by the learner were where the teaching strategy "choose an operation" was been applied.

Figure 4 and Figure 5 present the samples of the answer sheets given by some of the learners at Schools 3 of the study, in the next pages:

Learner AC as shown in Figure 4 below was the best achiever (57%) in the Algebra test at School 3. At least the learner showed the minimal use of the strategies taught by the teacher. The learner was able to use strategies like *choose an operation* in most of the questions. For example, in question 3, which said, "the sum of the four consecutive numbers is 22. Find the numbers". In solving the word problem, the learner was supposed to choose the addition sign because of the word "*sum*". Then, underlining key words in the word problems (e.g. sum/four/consecutive), *visualizing the problem* (making a mental picture of the consecutive four numbers, step-by-step procedure and describing in order to solve problems in Algebra in questions 3, 4, 5 and 6 respectively. The result of learner AC is presented in comparison with the result for learner AA who could not answer any of the questions correctly (0%). The result of learner AA is given

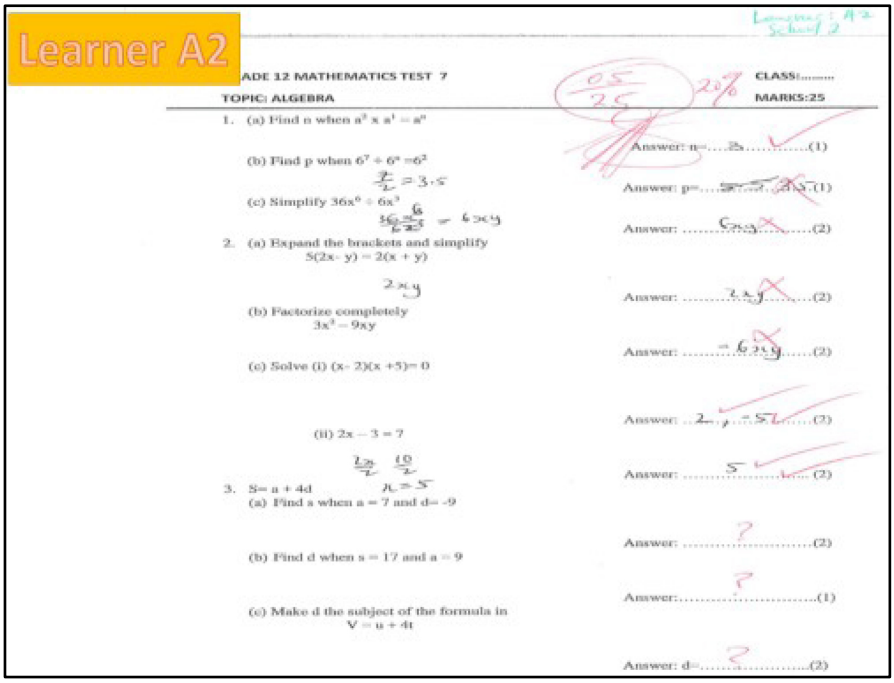

Figure 3. Learner A2's answer sheet of the algebra test at school 2.

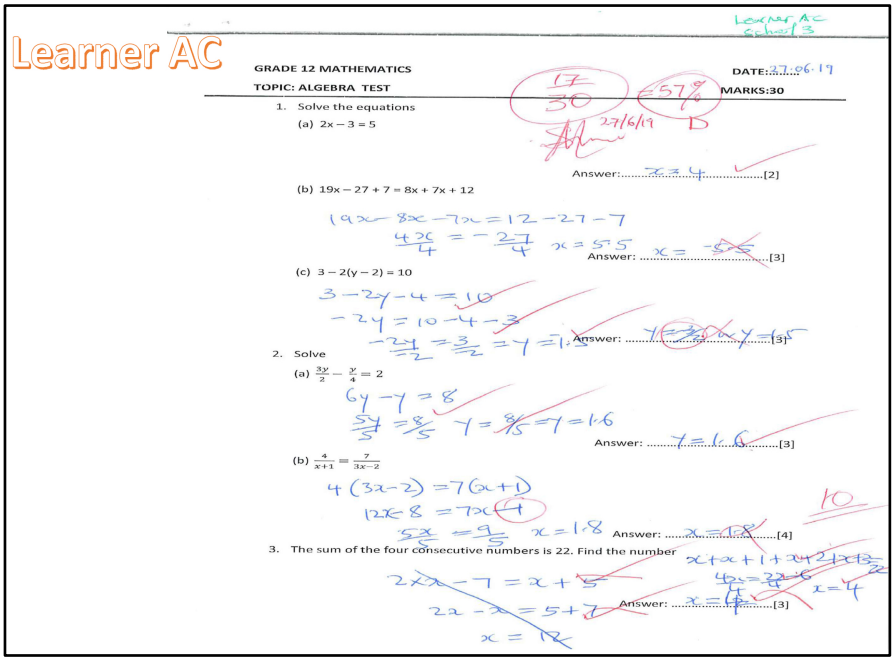

Figure 4. Learner AC's answer sheet in the algebra test at school 3.

below in **Figure 5**.

Learner AA as shown in **Figure 5** below was the lowest performer in the April examination in School 3 and he did not manage to answer even one question on Algebra, so he got a result of zero. The researchers observed that, amongst the teaching strategies used in solving algebraic problems, *choose operation* was been mostly used. If the learner had mastered this strategy, he could not get a

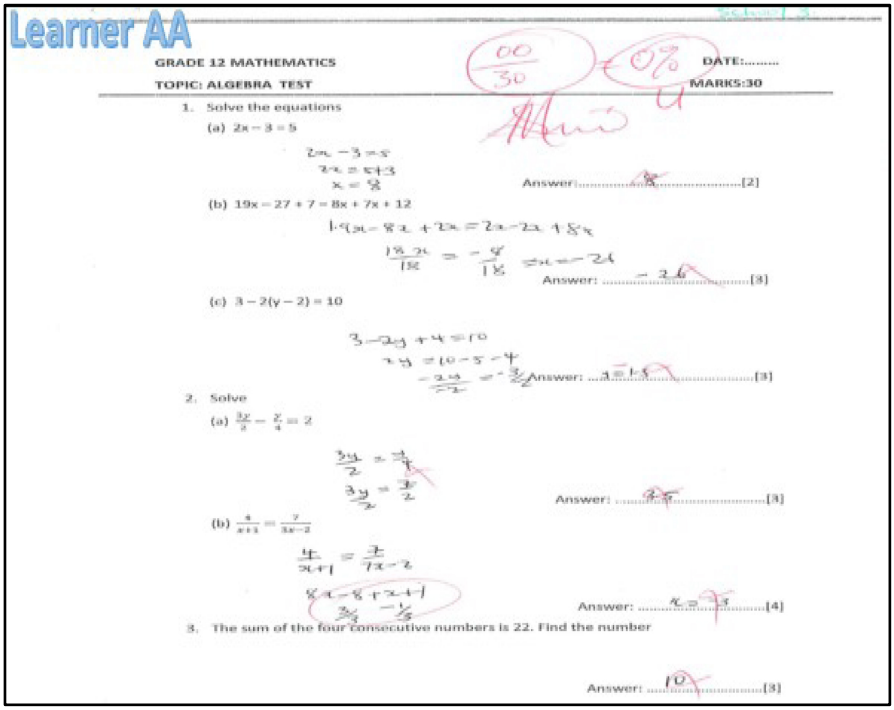

Figure 5. Learner AA's answer sheet in the algebra test written from school 3.

zero result. For example, in question 1, the problem given is to solve 2x − 3 = 5. The learner could have used *choose operation*, where the teacher mentioned that, the number changes the sign when it crosses over the equal sign. For example, when − 3 crosses it becomes + 3, so 3 adds to 5 to give 8 on the right, 2x = 8. x = 4. The question follows some steps the *step-by-step procedure* is used, then *guess and check* can be applied for the value of x.

5. Discussions

The study showed that the teachers at the three schools used some teaching strategies as reviewed in the literature of the research study. Teachers facilitated the teaching strategies involving the good habits of mind and this was observed in classes taught by Grade 12 Mathematics teachers. During the analysis of the learners' solutions to the algebraic problems in their April examination, and the tests, the researchers identified the teaching strategies as outlined in the study. Furthermore, during the class observations, the researchers observed seven emerging categories of teaching strategies used by teachers to teach Algebra, namely *identifying key words*, *choose an operation*, *re-reading the words*, *visualizing problems*, *guessing and checking*, *describing* (*step procedures*) *and looking for patterns*.

The teachers taught learners to identify key words before setting up the equations in word problems. At times, those teachers taught learners to use strategies of re-reading the words first and visualizing the questions and putting the questions in story form before they attempted to solve the problem. For example, the algebraic equations for the perimeter in **Figure 3** where visualization was ap-

plied. The perimeter will be 2 multiplied by a certain number and then added to 3. This sum is multiplied by 2 because there are two equal sides. Also, the word equation of the other remaining side is 3 multiplied by a certain number, then added to 2 and then multiplied by 2. The resultant perimeter will be the sum of the two word equations.

In paper 3, question 5 was on Algebra. The examiners said, "*This question on Algebra was fairly to moderately answered, as outlined by the examiners. Most candidates spoiled their answer for* **5(b)**, $7x^3 - 28xy$ to $-21x^3y$. *This showed that some candidates did not know that the answer comprised of* 2 *unlike terms*". The learners could not apply the strategies appropriately because they have a lacked of knowledge of the basics of Algebra as with like and unlike terms. The strategies, such as *choose an operation*, *visualization*, *step procedure and guessing-checking*, were to be used in answering the questions. When the strategy of "choosing an operation" is fully mastered, Mathematics learners should be able to solve many problems in Algebra successfully, especially problems with symbolic notations.

6. Conclusion

The findings of the study showed that teachers at the three sampled schools used some strategies in teaching Algebra to their Grade 12 learners, although these strategies were used inappropriately. During the observations, interviews and the document analysis of the April examination papers and Algebra tests, the researchers identified strategies used by Grade 12 learners to answer the questions in Algebra, which were the teaching strategies taught by teachers in Algebra. The strategies which emerged from the study that were used were: *choosing an operation*, *identifying key words*, *re-reading the words*, *visualizing problems*, *guessing and checking*, *step procedures*, *and looking for patterns*.

The researchers might have expected the result of the study, relatively because the Grade 12 learners were not given enough time to use all the strategies in the activities given in class. The April examination answers and the Algebra test showed that the learners focused on diverse standard procedures. Learners who used the strategies such as *choosing an operation*, *identifying key words*, *and visualizing problems* showed an understanding of critical aspects of the strategies as discussed above, namely that the same strategy could be used in different contexts or in the same context but in tasks with different characters (Sikukumwa, 2017). However, many Grade 12 learners showed in the analysis that they had a lack of knowledge of the strategies used to solve algebraic problems. This was expected, because the teachers in the sampled three schools were unable to identify and use all the teaching strategies too.

Recommendations

Finally, the study made some recommendations to the various stakeholders in the Ministry of Education. Mathematics teachers were recommended to give more algebraic problems to the Grade 12 learners to allow them to practise in order to

help the learners to become more efficient in solving problems using the strategies. The senior education officers were recommended to have workshops where they train teachers on teaching strategies of Algebra. On the other hand, further research was recommended to be done in all the phases of the school (primary, junior secondary, and senior secondary phases).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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