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STUDENTS' MATHEMATICAL EXPERIENCES WHEN SOLVING PROBABILITY PROBLEMS IN GRADE 11 CLASSROOMS

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ABSTRACT
This paper reports on students' mathematical experiences in Tshwane West district when solving probability problems. There were 380 grade 11 mathematics students and their teachers who were studied. A purposive sampling process that prioritized the critical case sampling technique was used. The study targeted schools in the Tshwane West District in South Africa, with poor mathematical performance in grade 12 in the last three years before the study. The study was a combination research using a sequential explanatory design. Students' experiences in analysing, solving and communicating probability problems were studied. A diagnostic test was administered to gauge students' mathematical problem-solving performance, while subsequent semi-structured interviews and lesson observations sourced qualitative data. The findings show that students lacked procedural and conceptual knowledge to solve probability problems. Analysis of qualitative data highlighted instances of students' low interest towards the probability topic. These findings may carry important implications for educational stakeholders to develop effective instructional strategies to boost student problem-solving abilities.

Keywords: Probability problems; mathematical problem-solving; Venn diagrams; mutually exclusive events; dependent events.

INTRODUCTION
Perennial and vicious circles of observed students' low levels of mathematical performance in high schools is a major concern for educational stakeholders in South Africa. Trends in International Mathematics and Science Study (TIMSS, 2015) revealed that South Africa performed relatively poor in mathematics when compared to other participating countries (Visser, Juan &Feza, 2015). One area of mathematics that is problematic to students is the topic of probability (Elbehary, 2021; Pale, 2016).It seems that mathematics teachers struggle to inculcate mathematical skills and knowledge to students, especially in a topic of probability.Procedural and conceptual knowledge, reasoning and strategic competences are the main knowledge domains underpinning the mathematics curriculum (Kilpatrick, Swafford & Findell, 2001).

Some studies have highlighted students' misconceptions associated with learning the topic of probability in high school (for examples, see, Mutara, 2015; Paul & Hlanganipai, 2014).Other studies have reported on, (1) insufficiency of pedagogical content knowledge needed to promote meaningful learning of the topic of probability in mathematics classrooms (see, Brijlall, 2014); (2) ineffectiveness of classroom instruction to enhance students' comprehension of data handling (Adu & Gasa, 2014);

and, (3) the role and influence of language in learning aspects of probability (Paul & Hlanganipai, 2014). The discussion this paper are purposed to highlighting challenges embedded within classroom instruction that aim to advance productive teaching of probability in mathematics environments.

In South African, the topic of probability was firstly incorporated in the high school (FET) curriculum in 2006 (Makwakwa & Mogari, 2011). Prior to this infusion, the topic of probability was viewed as an additional and optional educational discourse to enrich students who were deemed to be mathematically capable (Mutodi & Ngirande, 2014). Mathematics teachers who had attended the same schooling system would also have not received meaningful pedagogical training on this topic. Makwakwa and Mogari (2011) affirmed that most of the mathematics teachers did not receive proper training in their teacher training programs. Hence, introducing a new and non-familiar topic in the mathematics curriculum would possibly have dire educational consequences to the learning experiences of affected students.

Mutara (2015) noted that this curriculum change imposed several difficulties to students and teachers. This led teachers to ask some questions such as, (1) what are students' abilities that are needed to learn the topic of probability meaningfully?; (2) how will students interpret situations requiring the knowledge of probability?; and, (3) what are the documented students' experiences in solving probability problems? Given this background, the current study was commissioned to explore the experiences and challenges that students encountering when attempting to solve probability problems in grade 11 mathematics classrooms.

This study was conducted in schools located in the Soshanguve township in South Africa. At the time of conducting this research, the topic of probability had already been packaged in the FET mathematics curriculum and various opinions had sprang out regarding this curriculum infusion. Some authors cautioned that the topic would be difficult to teach in South African schools (Rubin, 2019; Pale, 2016).In recent years the Department of Basic Education (DBE) has been flagging instances of students' poor performance in probability in public schools. In its annual educational report DBE (2020) announced that most high schools in South Africa cater for students who have acquired limited knowledge and skills in probability. These observations are more visible and affirmed in rural and township schools, where the human capacity resource is largely characterized by inadequacy and inappropriateness of teacher-oriented qualifications.

In school South African, the weighting of probability content in the mathematics curriculum is(20 ± 3) %percentage, this policy provision informs the setting of end-of-year question papers (DBE, 2011). The end-of-year examination in grade 12 consists of three papers, namely, Paper 1, Paper 2 and Paper 3, and probability is placed within the confines of Paper 1 in which it would claim the stake of (20 ± 3) %. Hence the mathematics content that is covered in Paper 1 would largely cover the algebra related topics. Therefore, one realizes that the topic of probability takes up a relatively bigger portion of marks in Paper 1 of mathematics in grade 12, and if students' knowledge in this topic is shallow, this would adversely affect the overall outcome in students' mathematics scores. DBE (2017) has raised concerns that poor performance in mathematics suppresses students' prospects of pursuing mathematics related

careers in higher education (tertiary).This research aimed to study the learning experiences and challenges of mathematics students when learning the topic of probability in grade 11 classrooms. Mainly, this aim would be achieved by asking the following research questions; what are the challenges, if any, experienced by students when solving probability problems in grade 11?;how do students manifest their problem-solving patterns of reasoning and analyzing in probability tasks?; and, what contributes to students' learning challenges of the topic of probability?

THEORETICAL FRAMING OF THE STUDY

This study found value and solace in utilizing aspects of socio-constructivist approach to study students' knowledge construction, students' understanding and subsequent mathematical performance within the space of learning the topic of probability in grade 11. Specifically, aspects of socio-constructivist learning approach that embraced the zone of proximal development (ZPD), scaffolding and collaboration learning were utilized in this study to assess educational instances of probability learning (Vygotsky 1978). Influenced by this theoretical framing and disposition, the authors assessed probability learning in terms of what it would produce and the outcome it would achieve educationally. Being guided by this theoretical positioning, the researchers move entailed, (1) testing, the diagnostic test was administered to students to assess their cognitive aspect of learning; (2) direct observation, one of the researchers observed students' learning styles manifested while a probability lesson played out. This segment also documented teaching approaches and their efficiency in advancing meaningful learning; (3) oral responses, this segment privileged one of the researchers to gain access to types of dialogues and verbalizations that were playing out in the course of mathematics instruction, reflecting on students' moves and forms of interactions, comments and verbal questioning. (4) written responses, these were achieved through testing, using techniques implied in the socio-constructivism literature review; and, (5) interviews, in this segment one of the researchers interacted with students to gauge their impression of the diagnostic test they had written earlier.

RESEARCH METHODOLOGY

The study employed a mixed-methods research approach, using a sequential explanatory research design. This design was opted to extrapolate from quantitative and qualitative data to account for quantitative observations. The research paradigm for the study was pragmatism, which embraced aspects of positivist and interpretive paradigms in a single study.

Participation in the study

The study population consisted of grade 11 students attending the public schools in the Tshwane West District, in the Gauteng province of South Africa, and their teachers. At the time of conducting the study, there were 58 schools offering grade 11 mathematics in this district. These schools had 3676 registered students who were taking mathematics at grade 11 and 70 teachers who taught mathematics in that grade. This population was targeted due the primary researcher's (first author) familiarity with educational issues in the district since the first author was a practicing mathematics teacher in the district. In addition, the primary researcher stayed within reasonable proximities of schools in this population. Prior to the commencement of the study one of the researchers collected data to establish participation suitability. The study targeted schools with declining and deviating performances in

grade 12 mathematics in the years 2016 to 2018.Selected schools were coded as Schools A, B and C, where the capital letter A referred to the numerical order of the school that was visited first, and B referring to a school that was visited next, and so on. During these visitations one of the researchers

Figure 1: The grade 12 end-of-year mathematics performance in Schools B and C from 2016 to 2018

Source: Zhou (2019, p. 63)

According to Figure 1 the performance averages of schools in the years 2016 to 2018 were relatively low, and less than a threshold of 50%. Only in 2018 did School B managed to achieve 64%. Using this selection tool, the researchers assembled schools with almost comparable scholastic performance trends that fitted the description of "perpetuating poor performance in comparable scholastic performance trends that fitted the description of "perpetuating poor performance in grade 12 mathematics results" (Zhou, 2019, p. 64). This sampling process of schools met the requirements of purposive sampling targeting information-rich cases for the study (Palinkas, Hurwitz, Green, Wisdom, Duan &Hoagwood, 2015). Using purposive sampling techniques, the researchers sampled three schools (Schools A, B & C) that generated 380 grade 11 students of mathematics.

School A, with 78 students and one teacher, was assigned to a pilot process while Schools B and C participated in the main study. In School B there were 189 students and two teachers participated in the study. This group consisted of six classes with an average of 33 students per class. Each of the two teachers taught in three classes. In School C there were 113 students and two teachers who participated, averaging a size of 30 students per class. Each teacher in this group taught two classes. Teachers were included in this study on the perception that teaching strategies exert significant influence on students' mathematical performance (Zhou, 2019). Summary table of schools, students and teachers who participated in the study is provided in Table 1.

Table 1: Allocation of schools (n=3), students (n=380) and teachers (n=5) to research roles

		of grade 11 maths[6] classes	of grade 11 teachers	of grade 11 classes	Allocation of teachers to participating grade 11 mathematics classes	
A	78	2	1	2xClass	Class 1 = Teacher A_1 Class 2 = Teacher A_2	Participated in Pilot study
B	189	2	2	2xClasses	Class 1= Teacher B_1 Class 2 = Teacher B_2	Participated in Main study
C	113	2	2	2xClasses	Class 1 = Teacher C_1 Class 2 = Teacher C_2	

In Table 1, teachers' pseudonym was generated to provide hints on the school from which teachers were placed. For instance, Teacher B2 refers to a teacher that taught the second group (class) in School B, which participated in the main study. The same notations were used to distinguish participating students and to preserve their actual identities. For instance, Student C113 refers to a student in School C who was placed in position 113 in the class list and was taught by Teacher C2.

Instrumentation process for the study

This study used three data collection instruments, namely, the diagnostic test, semi-structured interviews and lesson observations. The diagnostic test was designed mainly to answer the First Research Question.The researchers developed questions for the diagnostic test using standardized past examination question papers for 2015 and 2016 that covered the topic of probability in grade 10 as the entry level of Further Education and Training (FET) phase. In this regard, the standardized past examination question papers referred to the end-of-year examination items set and moderated by the Gauteng Department of Education (GDE). It is compulsory that all public schools in the Gauteng Province administer common year ending examinations.

Figure 2: Example of an item from a diagnostic test

In a certain class of 42 boys:

- *27 play hockey (H)*
- *32 play soccer (S)*
- *7 do not play hockey or soccer*
- *An unknown number (x) play both hockey and soccer*

Source: Zhou (2019, p. 69)

The test consisted of Questions 1 and 2, each of which consisted of sub-questions. Table 2 shows a summary structure of the test with mathematical issues addressed in each component.

Table 2: Types of question in the diagnostic test for the study

Question 1	Question 2
1.1.1 Venn diagram **1.1.2** (a) Computing probability from random selection **1.1.3** (b) Probability that boy plays soccer (not hockey) **1.2.1** Representing total number of balls in bag **1.2.2** Probability of choosing blue ball from bag **1.3.1** Mutually exclusive events **1.3.2** Probability of events occurrence, P(A or B)	**2.1** The 64 boys and their sporting codes **2.1.1** Representing information in Venn diagram **2.1.2** (a) Probability that boy plays soccer and rugby **2.1.2** (b) Probability that boy plays soccer or rugby **2.1.3** Mutual exclusiveness of scenario in 2.1 **2.2** Probability calculations **2.3** Dice throwing (probability that 6 will not show)

Interviews were designed to help researchers to respond to the Second Research Question. All interviews took the format of a semi-structured outplay. This format allowed respondents and the researchers to probe and respond to emerging issues, apart from those in the schedule, deemed relating to the interview discourse.Interview items were developed by first author subsequent to the analysis of students' written responses to a diagnostic test. In this developmental process the incorrect test responses were mainly targeted to tap into students' applied reasoning and thought processes when writing the test. For example, one item attended the notion of language in probability.

> What aspect(s) of probability do you find difficult to learn?

> What could be the cause(s) of the challenges that you are experiencing with the learning of probability, do you think?

It was anticipated that the lesson observations would help to respond to the Third Research Question. The study adopted and modified the lesson observation tool from Sepeng (2010) to source data during lesson visitations. In some items of the lesson observation schedule, the researchers used a five-point scale rating to score the observed events. The five-point rating scale developed by Sepeng (2010) consisted of the following descriptors, excellent, good, average, needs more attention, and not applicable to the lesson. A rating scale coded excellent meant that five points would be allocated, and good would allocate four points, and so on.

Table 3: Example of items observed during a lesson of probability in a grade 11 mathematics class

Reflective skills	Excellent		Average	Needs more attention	Not applicable to the lesson

Addressing issues of scientific rigour and trustworthiness in the research process

The terms rigour and trustworthiness refer to the "quality of scientific thoroughness that influences the technical aspects of the research process" (Chibale, 2018, p. 51). All data collection instruments had to pass the tests of scientific rigour and assessment of trustworthiness before being used in the study. A similar diagnostic test was administered in a pilot study and in the main study. This administrative practice tested aspects of reliability and consistency with which the test would evoke equivalent test responses and outcome in each instance of implementation. The diagnostic test achieved test-retest reliability as it produced the same results with repeated implementation on the same individuals possessing similar educational characteristics. The past examination question papers were used to construct a test that covered the cognitive levels as stipulated in the grade 10 mathematics curriculum (DBE, 2011). The content validity ensured that the test addressed the topic of probability adequately. The other type of validity important to this study was criterion validity, which endeavoured to relate the results of one instrument to another external criterion (Cohen, Manion, & Morrison, 2011: 189). The test was moderated by experts in mathematics education. This process enhanced reliability of the test tool, and the possibility of collecting validated data was optimized.

Trustworthiness is a quality criterion in qualitative research that ensures the rigour of the qualitative findings. Interviews and lesson observations were then judged against this quality.To achieve trustworthiness, the researchers endeavoured to address four aspects of quality criteria, namely, credibility, transferability, dependability and confirmability. The use of multiple data sources (data triangulation) helped to attend to issues of credibility. This multiple usage of data collection tool helped to prolong engagements with informants. In the end, the researchers returned to the interview respondents to ask their feedback on the data and to confirm data interpretations by researchers. The process subscribed to member-checking processes and helped to enhance the credibility of the qualitative research process. The findings of this study are transferable. The authors argue that the findings of this study are not unique but transferable, or in resonance with existing literature in a different context. Authors have strived to present the study findings in a meaningful way describing the findings in-depth and, in their context (thick description), thus attending to the aspect of transferability.

Aspects of dependability have also been addressed. The analysis of qualitative data from the interviews and lesson observations was not a single process activity. While interacting with data, researchers continuously re-examined data using insights that were emerging from the data analysis process. Researchers allowed themselves to be flexible and open to newly emerging research insights. There was also an element of saturation in that in some instances, different instruments were used to continuously to address the same issue in the research process. Conformability refers to the extent to which the study findings are directly drawn from study informants and their context, and less the product of researcher's bias. In this study, the literature pool was used to look out for evidence that could disconfirm the study findings. One of the researchers was the primary researcher; however, he always discussed and confirmed the research process with the second and third researchers, ensuring that the findings of the study are not largely influenced by perspectives of an individual. This process accounted for peer debriefing, which is one aspect of achieving conformability.

UNPACKING THE RESEARCH PROCESS (METHOD)

All data collection instruments were piloted before the main study. The rationale to pilot the data collection instruments was to enhance the efficiency of instruments to optimize the validity of study data. The research process in the pilot school and schools in the main study consisted of two phases. The first phase entailed the administering of a diagnostic test to identify students' problem-solving challenges when interacting with probability tasks in grade 11. The second phase consisted of interviews and lesson observations. The pilot process helped to identify items that were not clearly cast and were deemed ambiguous in terms of language. The pilot test revealed that the diagnostic test should be more than 45min, and in the end the duration of test was adjusted to 1hour. This test was not to make a count to students' year mark, and hence it was administered after tuition time in both pilot and main studies. The analysis of the test showed that students had misunderstanding, committed errors, and were showing instances of inconsistent mathematical reasoning.

In the pilot study interviews were meant to identify items that could be 'unclear or ambiguous' (Zhou, 2019, p. 77). All interviews were audio recorded to capture all verbal facets of the interaction. All interviews took place between 14h30 and 16h00 in the respective schools of all respondents. Only students participated in interviews. The lesson observation component was apportioned to real-time mathematics lessons presented to address the topic of probability in grade 11. One of the researchers visited all schools to collect data that were observational in nature. The episodes of instructional observations were run to confirm some of the information that emerged while administering other data collection tools. The next segment of this research was subjected to the analysis processes that eventually generated the study findings.

FINDINGS OF THE STUDY AND DISCUSSIONS

Descriptive statistics was to analyse quantitative data from the diagnostic test using Excel program. In the pilot study, 47 of the 78 students (60.01%) wrote the test while in the main study all 380(100%) students wrote the test. Reduced participation in the pilot phase could have possibly been triggered by students' perceptions that the test would not impact on their year mark. Measures of central tendency were computed to summarize data for the test variables while measures of dispersion helped to understand the variability of the scores for the test variable (Zhou, 2019, p. 85).

Figure 3: Representation of students' test responses of question 1 and its sub-questions

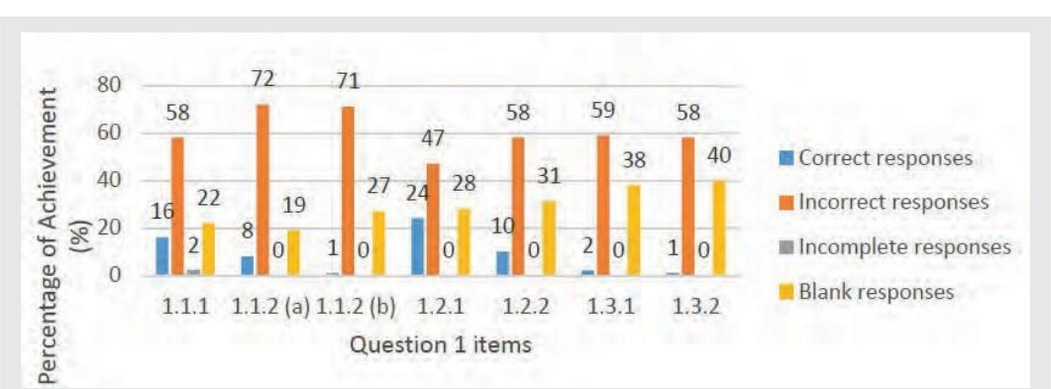
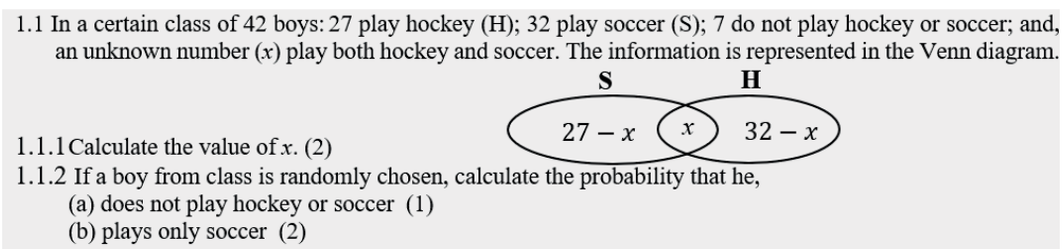


Figure 4 shows that in question 1.1.1 only 16% of test-takers generated correct responses. This percentage is much lower in questions 1.1.2 and 1.1.3, both of which generated 1% of correct responses. Question 1.2.1 produced the highest percentage of correct responses (24%). Figure 4 shows a relatively high prevalence of incorrect responses, which are averaged at 60.4% (against an average of 8.9% for correct responses in question1). In terms of Research Question 1, Figure 4 shows that there were problems and challenges characterizing students' responses to Question 1 of the test. See Figure 5 for Question 1 of the diagnostic test.

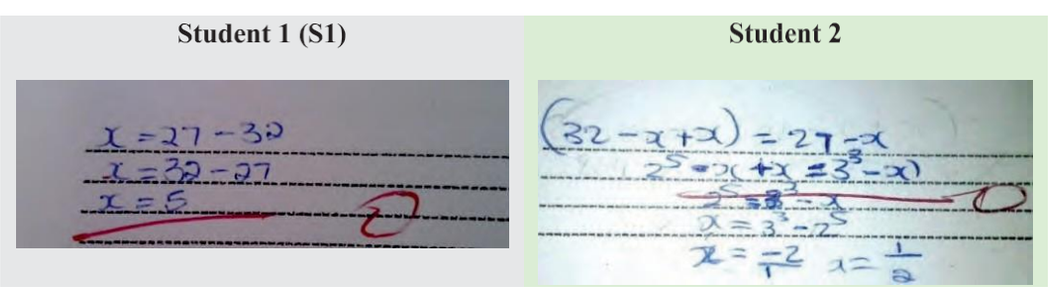
Figure 4: Example of Question 1 of the diagnostic test written by grade 11 mathematics students


1.1 In a certain class of 42 boys: 27 play hockey (H); 32 play soccer (S); 7 do not play hockey or soccer; and, an unknown number (x) play both hockey and soccer. The information is represented in the Venn diagram.

1.1.1 Calculate the value of x. (2)
1.1.2 If a boy from class is randomly chosen, calculate the probability that he,
(a) does not play hockey or soccer (1)
(b) plays only soccer (2)

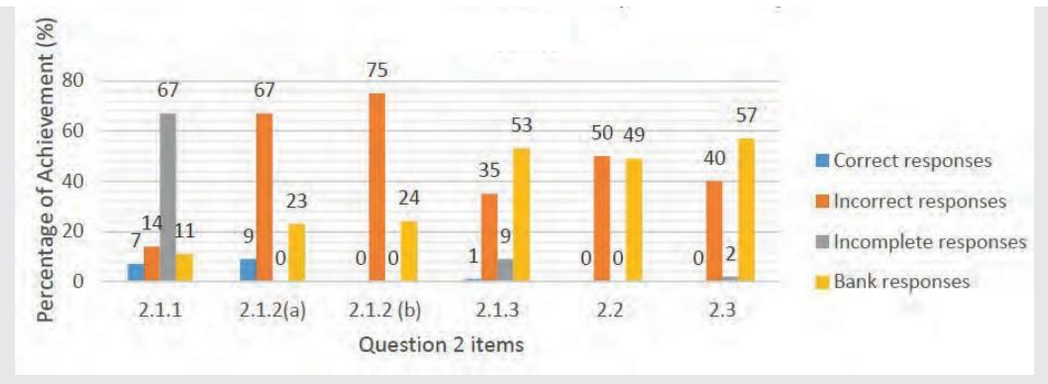
The nature of challenges that students encountered when responding to Question 1 provides a contextualized interpretation of the data in Figure 4. Examples of students' responses to some of Question 1 items are shown in Figure 6. Figure 6 shows that instead of students (S1 and S2) writing the equation, 27-x+x+32-x = 42 and then solving for x, it seems that S1 and S2 did not consider the total number of students in the class. Looking into students' ways of responding to the probability task suggests that there were instances of random guessing in their problem-solving processes. Also, an absence of procedural knowledge is evident in students' problem-solving processes.

Figure 5: Actual extracts of students' responses to Question 1.1.1



Ellis and Shintani's (2014) noted that students often struggle with mathematical tasks built on probability knowledge. Figure 6 also shows that S1 and S2 struggled to correctly conceptualize words like 'and', 'both' and 'or' embedded in the given probability task. For instance, when interviewed, one student responded that, "…These words sometimes confuse me, and I don't understand the terminology used in this question…. Sir, probability language is difficult to understand". Students' inabilities to deal effectively with these words could be indicative of lack of conceptual knowledge. In Question 1.2 students were expected to use the equation P (notA) =1-P(A) to work out the probability of boys playing hockey or soccer. Figure 4 shows that 92% of students (test takers) answered the question incorrectly.

Figure 6: Representation of students' test responses of question 2 and its sub-questions



Data in Figure 7 also affirm that most students struggled with Question 2 items of the test. Prominent in students' percentage scores are, 67% of incomplete responses for Question 2.1.1, incomplete responses (67% for Question 2.1.2), (75% for Question 2.1.2), (50% for Question 2.2) and (40% for Question 2.3). The dominance of these response types illustrates students' challenges in successfully solving probability-related task in grade 11.

The analysis of qualitative data from interviews and school visitations helped to answer the 2nd and 3rd research questions. Researchers established patterns and themes to make sense of corpus data sourced through qualitative means. In the interview segment, verbatim transcription of students' responses was done. The analysis of quantitative data (from test) had earlier generated themes that were later used to develop qualitative data collection tools and analyse this data. The themes are, computational methods; procedural knowledge; conceptual knowledge; probability concepts; curriculum issues. When asked to respond to questions relating to these themes, students (S) gave out responses such as,

> **S1:** I think I don't understand the basic concepts in Venn diagram interpretations
> **S2:** … I'm not sure how I got the answer ……

The response by S2 could have been an interview question referring to Question 1.1.1 of the diagnostic test (see, Figure 5 & Figure 6). For instance, one of the researchers asked another student (S3) on the problem-solving procedures that were employed to work out the solution of 1.1.1.

Researcher: When I analysed your script in Question 1.1, I realised that you seemingly struggled to get the correct solution. Can you please explain to me your thought processes as you were solving probability word problems?

> **S3:** I don't understand the population of words and terminology used in defining sets. I mean that I do not understand the probability terminology

In terms of analysis, such a response (from S3) would be placed under the theme of probability concepts. Following this method of qualitative data analysis, the interview data revealed that students (respondents), (1) were struggling to demonstrate effective computational knowledge when solving probability problems. One student said, "I cannot remember the formula for calculating probability event"; (2)did not have adequate skills and procedural knowledge to tackle probability problems. One respondent acknowledged that, "I don't have sound skills to deal with sets and interactions"; (3) found

it difficult to exhibit subject-specific or conceptual knowledge required to solve probability problems. One student acknowledged that, “Idon’t understand the terminology used in this question” (this response referred specifically to 1.3.1 and 1.3.2.). In addition, one respondent replied, “I don’t like probability learning because it’s full of words and terminology which is difficult to understand”; (4) do not understand probability concepts. One respondent noted that, “probability language is difficult to understand”; and, (5) felt that the topic of probability is not given enough coverage (treatment) in the curriculum. One respondent replied, “we did not do probability last year” (referring to grade 10). The student went on to say, “our teacher explained the definition to us towards writing the final examination”.

Interview data revealed that, generally students find it difficult to learn the topic of probability in grade 11. It seems that these difficulties could be exacerbated by lack of foundational knowledge, incorrect perceptions that this topic is difficult. It also emerged from the analysis that some of students’ challenges are tied to the type of classroom instruction that they had been exposed to. For instance, some students (respondents) lamented that the topic of probability was not sufficiently treated in the previous grade level. In some instances, students revealed that teachers tend not to allocate more time on the treatment of this mathematical topic. Also, the issue of attitudes emerged when interacting with students’ responses. In this regard, one respondent reacted, “I don’t like probability learning because it’s full of words and terminology which is difficult to understand”.

The analysis of lesson observations shows that, (1) generally, students’ knowledge development is constrained; (2) students find it difficult to link their mathematical knowledge to real-life problem-solving experiences in the classroom; (3) students lack mathematical knowledge and terminology to express themselves meaningfully in problem solving tasks; (4) students lack skills needed to connect real-world experiences to mathematics encounters in the classroom. This inability has a way of educationally constraining students’ efforts to contextualize mathematical learning encounters to make meaning of their learning experiences.

CONCLUSIONS

Mainly, this study strived to answer three research questions, namely, (1) what are students’ abilities that are needed to learn the topic of probability meaningfully?; (2) how will students interpret situations requiring the knowledge of probability?; and, (3) what are the documented students’ experiences in solving probability problems? The test that was administered in the initial stages of this research has revealed that, on the whole, students have a deficiency of problem-solving abilities. The data gave rise to themes that pointed to problem-solving abilities that should be developed to accelerate students’ performance in the topic of probability.

The second research question enquired to know if students’ problem-solving abilities would successfully enable them to make sense of or interpret problem-solving task in probability. The word ‘interpret’ has been construed as bearing a reference to ‘making meaning or sense of the learning content’. If this meaning-making attribute is successfully acquired, then students can learn meaningfully (with understanding). The enquiry in this study has revealed that students are continuously struggling to make sense of probability content in grade 11 mathematics classroom. They then fall short in advancing envisaged skills of interpreting problem-solving events that are framed within the classroom dialogue of probability.

The last research question found solace in data that emerged in almost all data collection sources, which firmly pronounced non-desirable educational experiences of students when they learn the topic of probability in grade 11. For instance, interviews revealed that such experiences could have been the function or may be tied to the type of classroom experience that are seemingly not promoting students' interest in learning probability. Qualitative data further show that learning experiences (encounters) may promote certain perception and attitudes that may erode students from making meaningful educational contributions in mathematics classroom.

RECOMMENDATIONS

Lastly, it is the view of the authors that the findings of this study may carry important implications for educational stakeholders to pay attention to monitoring students' learning experiences of mathematics and further developing effective instructional strategies to boost student problem-solving abilities in topics such as probability.

REFERENCES

Adu, E., & Gasa, L. (2014). The role of Data Handling in teaching and learning of mathematics in Grade7 classes: South African experience. *Mediterranean Journal of Social Sciences,* 5(23), 1151.

Brijlall, D. (2014). Exploring the pedagogical content knowledge for teaching probability in middle school: A South African case study. *International Journal of Educational Sciences,* 7(3), 719-726.

Chibale, M. (2018). *Investigating factors contributing to lower performance of grade 12 female learners in mathematics: a case of Manzini District in Swaziland.* Unpublished MEd Dissertation, University of South Africa, Pretoria, SA.

Cocks, M., Alexander, J., Mogano, L., & Vetter, S. (2016). Ways of belonging: meanings of "nature" among Xhosa-speaking township residents in South Africa. *Journal of Ethnobiology,* 36(4), 820-842.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education.* (7, Ed.) Routledge.

Department of Basic Education, (2011). *Curriculum and Assessment Policy Statement (CAPS) for mathematics Grades* 10-12. Final draft. Pretoria: Department of Basic Education.

Department of Basic Education, (2020). National senior certificate: diagnostic. Pretoria: Department of Basic Education.

Elbehary, S. G. A. (2021). Reasoning under uncertainty within the context of probability education. A case study of preservice mathematics teachers. Pythagoras, 42, a630.

Ellis, R., & Shintani, N. (2014). *Exploring language pedagogy through second language acquisition research.* London: Routledge.

Kilpatrick, K., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics.* Washington DC: Mathematics National Academy Press.

Makwakwa, E., & Mogari, D. (2011). Investigating problems experienced by grade 11 mathematics teachers in the teaching of probability. In A. M. D. Mogari (Ed.), AMESA (pp. 122-128). Pretoria: Proceedings of Institute of Science and Technology Education International Conference. Retrieved

Mutara, L. (2015). Exploring grade 10 learners' errors and misconceptions involved in solving probability problems using different representations. *Doctorate Thesis.* Pretoria, South Africa: University of South Africa.

Mutodi, P &Ngirande, H (2014). The nature of misconceptions and cognitive obstacles faced by secondary school mathematics students in understanding probability:
A case study of selected Polokwane secondary schools. *Mediterranean Journal of Social Sciences,* 5(8), 446.

Pale, J. W. (2016). Teacher and student based instructions on probability achievement outcomes and attitudes of secondary school students in Bungoma North, Kenya. Journal of Education and Practice, 5(24), 43-53.

Palinkas, L., Horwitz, S., Green, C., Wisdom, J., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research, 42(5), 533-544.*

Paul, M., &Hlanganipai, N. (2014). Exploring Mathematics Students' Understanding of Language of Estimative Probability in Relation to the Probability Scale. *International Journal of Educational Sciences,* 7(3), 439-447.

Podems, D. (2017). *Democratic evaluation and democracy: Exploring the reality.* Information Age Publishing, Inc.

Sepeng, J. (2010). Grade 9 second-language learners in township schools: Issues of language and mathematics when solving word problems. *Unpublished doctoral dissertation.* Nelson Mandela Metropolitan University, Port Elizabeth, South Africa. Retrieved from Available from http://www. nmmu. ac. za/documents/theses/Johannes, 20.

Trends in International Mathematics and Science Study (TIMSS, 2015). Assessment framework. Retrieved from Boston College, TIMSS & PIRLS International Study Center website.

Visser, M., Juan, A., & Feza, N. (2015). Home and school resources as predictors of mathematics performance in South Africa. South African Journal of Education, 35(1).

Vygotsky, L. S. (1978). Mind in society: *The development of higher psychological processes.* Cambridge: MA: Harvard University Press.

Wilkinson, P. (1998). Housing policy in South Africa. Habitat International, 22(3), 215-229.

Zhou, T. (2019). *Exploring the grade 11 mathematics learners' experiences and challenges in solving probability problems in selected Soshanguve schools.* Unpublished MEd dissertation, University of South Africa, Pretoria, SA.