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Grade 11 Learners' Ability to Formulate Mathematics and Mathematical Literacy Questions within a Real-World Soccer Context in Tshwane, South Africa

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ABSTRACT

Learners are often tasked with activities that require them to solve problems in mathematics classrooms. Problem posing is one of the teaching strategies that can enable learners to appreciate the mathematics concepts to be extracted from familiar or everyday situations. However, problem posing, as a teaching and learning strategy, is mostly under-utilised, despite its potential to enhance mathematics learning. This article explores how Grade 11 learners pose Mathematics and Mathematical Literacy questions from a 2010 FIFA World Cup soccer match and determines the extent to which the questions posed by learners mirror the given soccer context. The study involved 42 participants, comprising 22 Mathematics and 20 Mathematical Literacy learners from a high school in the Soshanguve township in Tshwane, South Africa. Participants were selected through purposive sampling. Data were collected through a written task in which learners were given a scenario in the form of an extract from a 2010 FIFA World Cup soccer match report. The qualitative findings of the study show that learners were generally capable of posing or formulating questions based on the real-life soccer context provided. The analysis showed that (a) Mathematics learners formulated more questions with more mathematical terms in them than Mathematical Literacy learners did, and (b) Mathematical Literacy learners formulated questions that were more aligned to the analysis of the game than was the case with Mathematics learners. We argue that learners' responses to the task were consistent with how they were socialised with the Mathematics and Mathematical Literacy discourse.

KEYWORDS

Mathematics; mathematical literacy; soccer context; problem formulation.

INTRODUCTION

Calls for curricula to concentrate on applications of mathematics to real-world issues rather than mathematics in isolation reflect the growing emphasis on the use of mathematics in 'realistic' contexts (Organisation for Economic Co-operation and Development, 2010; Zhou, Lo & Liu, 2023). Mathematical Literacy is a school topic that is required for students who are not studying Mathematics in Grades 10–12 in South Africa in an effort to move the focus of mathematics education toward applications in everyday life. The following is how mathematical literacy is defined in curriculum documents:

The competencies developed through Mathematical Literacy allow individuals to make sense of, participate in and contribute to the twenty-first century world—a world characterised by numbers, numerically based arguments and data represented and misrepresented in a number of different ways. (Department of Basic Education [DBE], 2011a, p. 8)

Inflation, probability and statistics, taxes, tariff systems, maps and scale drawing, household expenses, health difficulties, and exchange rates, are a few of the subjects included in the South African Mathematical Literacy school curriculum (Department of Basic Education, 2011a). The idea of inflation, which is generally not taught in a Mathematics class but is an application of the fundamental idea of percentage growth and reduction, is of relevance to this subject (Bansilal, 2017). Probability, for example, calculating the probability of election results, or predicting the weather, also falls within the educational domain of Mathematical Literacy as a school subject. Mathematical Literacy qualifications at Further Education and Training (FET) level have been available within the adult learning sector since 2001, but this paper focuses primarily on the current school-based introduction to Mathematical Literacy as a school subject (Venkatakrishnan & Graven, 2006).

Across the world, problem-solving is a crucial aspect of mathematics education (Makgakga, 2023). Problem posing, in which students construct their own problems, has also been recognised as a crucial activity in mathematics education, in addition to answering problems that have been given to the class by the teacher or from a textbook. Problem posing is at the core of mathematical activity, according to some mathematicians and mathematics educators (Kojima, Miwa, and Matsui, 2015). Posing problems is a talent that is required for problem-solving in daily life. When using mathematics in real-world situations, structured issues are not offered, thus problem solvers must identify and create their own. There has not been any systematic research on mathematical problem posing, nor is there any coherent, comprehensive explanation of problem posing as a component of the mathematics curriculum. Although mathematical problem posing has great importance in mathematics education, it has received little attention from students, teachers, and researchers (Passarella, 2021). For instance, Akben (2020) claims that while the problems themselves have received a lot of attention, less focus has been placed on varying the sources for the problems that students are encouraged to think about in class. As a result, it is critical to investigate the sources of these mathematical problems. In this regard, the following essential and comprehensive questions must be addressed: Where did these mathematical problems come from? Who developed them? In what context are do these problems posed?

Therefore, it is important to investigate the kinds of problems that students solve in mathematics classrooms. In this article, we explore the ability of Grade 11 learners to pose Mathematics and Mathematical Literacy questions or tasks when given information from the everyday context of soccer. It is acknowledged that the emphasis in the current curriculum is on the need to fuse familiar contexts in mathematics to make mathematics more easily accessible to learners (DBE, 2011a). In mathematics, the use of context is considered pivotal to bridging the gap between everyday life and school content (Machaba & Du Plooy, 2019). Establishing such a bridge is intended to provide learners with the opportunity to draw knowledge from their everyday experiences when interacting with classroom situations. It is advocated that teaching processes need to start from the known to the unknown context (Machaba & Mwakapenda, 2017; Skemp, 1978). Therefore, integrating learning with everyday contexts and prior knowledge serves as a vehicle for enabling learners' understanding of classroom mathematics content (Boaler et al., 2022).

It is a common practice for learners to engage in solving problems during and after learning experiences in mathematics classrooms. Solving problems is a regular form of activity that ensures that learners are assessed and decisions are made from these assessments to establish the level of performance of learners in mathematics at all levels. However, despite proposals in the new curriculum to involve learners in posing problems, very little regular practice in most classrooms involves requiring students to formulate problems. Learners are rarely asked to pose Mathematics or Mathematical Literacy questions, questions that go beyond the traditional oral or verbal types that are experienced during lessons. The formulation of questions is therefore taken to be an activity reserved for the teacher. It is as if the teacher is the only one who knows how to formulate formal classwork questions. Within these current teaching and assessment practices, there seems to be a boundary between the teacher and the learners in terms of who holds the power to formulate tasks or questions in Mathematics and Mathematical Literacy classrooms. In this article, the learner is acknowledged to also formulate questions that can be used as resources for learning and classwork activity. Therefore, this research attempts to explore implications for Mathematics and Mathematical Literacy practices when this boundary concerning task formulation is broken (Machaba & Du Plooy, 2019). Thus, this article is guided by the following research questions:

- To what extent are Grade 11 learners able to pose Mathematics and Mathematical Literacy questions from a given soccer context?
- In what ways do the problems posed by learners mirror the given soccer context?

What is Mathematical Problem Posing?

For Silver (1994), problem posing is the cognitive activity of either reformulating given problems or generating new problems. These descriptions imply that problem posing could occur before, during, or after problem-solving. For Silver (1994) and Cai and Hwang (2020) problem posing is the cognitive activity of either reformulating given problems or generating new problems.

We must understand what problem posing entails. In the context of this study, there is first a need to describe what constitutes a mathematical problem. Various sources (Akben, 2020; Baumanns & Rott, 2022; Cai et al., 2020) refer to a mathematical problem as a task involving mathematical concepts and principles for which the solution method is not known in advance by the person(s) engaged in it. Such a conceptualisation presumes that a particular task can or cannot be seen as a mathematical problem, depending on the mathematical background and attitude of its solvers, as well as on the conditions under which the task is dealt with (Baumanns & Rott, 2022). The above description puts the problem solver, that is, the learner, at the centre of the problem. As a problem solver, the learner holds the key to recognising whether the task provided may be considered a problem in the solver's world. Another key concern is the background of the solver. It needs to be taken into consideration whether the solver is familiar with the essential principles and concepts involved in the mathematical problem at hand.

Therefore, when learners are allowed to pose problems, the task will reflect the above characteristics, that is, the task or problem/question formulated will reflect the learners' backgrounds and familiarity with key concepts and principles embedded in the task. Existing studies have presented a clear relationship between problem posing and problem-solving as well as the magnitude of this relationship. For example, Kojima et al. (2015) argue that although problem-solving and problem posing differ, having different cognitive activities, they are, however, closely related. This suggests that problem-solving ability and problem-posing performance are correlated, and that problem posing positively influences problem-solving. They further argue that problem-solving and problem posing differ in the features and formats of their tasks. Problem-solving is a comprehension task in which a learner extracts a mathematical structure from given information and reaches the correct answer. In contrast, problem posing is a production task that requires the generation of information and its synthesis. Learners show difficulty in problem posing even if they can easily solve the problems. In their work, Xie and Masingila (2017) found that problem posing contributes to problem-solving effectiveness, while problem-solving supports participants in posing more reasonable problems. A good problem solver is usually a good problem poser, and vice versa.

There are advantages to problem posing that include, for example, that it enhances the problem-solving ability and the grasp of mathematical concepts, generates diverse and flexible thinking, alerts both teachers and learners to misunderstandings, and improves learners' attitudes and confidence in mathematics (Silver, 1994). Researchers, for example, Silver (1994), have also found that problem posing can enhance learners' mathematical conceptual understanding, dispositions toward mathematics, and mathematical creative thinking.

Problem posing has been advocated in the curriculum. For example, in competency descriptions in Grade 12, a learner is expected to extend investigations and pose insightful questions (DBE, 2011b). Although the curriculum offers the chance to formalise the process of raising problems in mathematics teaching and learning, there is not much evidence in the research literature to suggest that this is a common practice in education in South African classrooms. This research attempts to fill this gap in what is known about problem-posing experiences in the mathematics curriculum at Grade 11 in selected schools in South Africa. The researchers 'experience is that certain forms of problem posing, though undocumented, are practised in class. However, this practice is restricted to educators. Learners are not compelled to be involved. When they are involved, posing problems is limited to asking verbal questions that are not formally presented in written form as part of formal assessments. Mathematics and Mathematical Literacy are stated as distinct learning areas in the South African curriculum. Both of these learning areas are intended to help learners access critical forms of mathematical knowledge that are important for using and applying mathematics in a range of given contexts within and outside of school. However, given that Mathematics and Mathematical Literacy are taken to constitute different fields of the mathematical experience, it is important to understand how learners from these learning areas interact with contexts from everyday life and how those contexts link with the mathematical knowledge displayed in problem-posing tasks. The study attempted to interrogate the assumed boundaries between Mathematics and Mathematical Literacy. In their study, Venkat and Adler (2008) were interested in the objects that can be viewed as boundaries in the activity system as they explain, boundaries can be viewed as the discontinuities of practice between activity systems. In this study, we considered the interaction between the teacher and the learner and their roles in terms of who poses and formulates problems.

It is anticipated that this research could provide an opportunity to obtain deeper insights into how learners think and what they need to learn concerning problem posing in the mathematics classroom. Previous research has shown that learners in the context of mathematics tests typically do not pay attention to realistic considerations when constructing their responses to word problems that embed arithmetic operations in textually represented contexts (Cooper & Harries 2002). This issue needed to be considered further in this study. Essentially, the research acknowledges the importance of student-generated problems as a component of instructional activity.

RESEARCH DESIGN and METHODOLOGY

The aims of this study were: (a) to determine how Grade 11 learners pose Mathematics and Mathematical Literacy questions from a given soccer context, and (b) to ascertain the extent to which the questions posed by learners reflect a given context—the soccer context in this case (Sibanda, 2014). Asking the question as to whether learners can formulate tasks is an issue that is linked to exploration Therefore, in identifying a possible research approach (design) for the study, it is important to identify a range of methodologies that are best suited to the label of exploratory methodologies. In locating a possible methodology for this research, this study considered the categories given by Guba and Lincoln (1982) in their articulation of research approaches for the social sciences.

This study did not require learners to solve problems but rather to pose them. Posing a problem is not a routine (predetermined) activity for learners. The study being reported was therefore an exploratory qualitative study. The use of a qualitative case study affords the researcher an opportunity to collect extensive data on the individual(s), programme(s), or event(s) on which the investigation is focused, and the collection of such data includes observation, interviews, documents, records, and audiovisual materials such as videotapes, photographs, or audiotapes (Leedy & Ormrod, 2004). Neuman (1997) indicates that qualitative researchers use a case study approach to gather a large amount of information on one or a few cases, gain deeper insight, and get more details on the cases being examined. This study involved Grade 11 learners doing Mathematics and Mathematical Literacy in a secondary school in Soshanguve, Pretoria.

Motivation for the use of Soccer as a Context

The context of soccer (Figure 1) that was used for the data collection in this study was selected due to the interest that soccer as a sport generated before and during the 2010 World Cup in South Africa. Asking learners to formulate a task in a soccer context was considered more meaningful because of their familiarity with the context. Also, in mathematics education, some studies have investigated the use of soccer in classroom mathematics. For example, Nyabanyaba (1999), in his discussion with teachers, found that teachers agreed that soccer could be used in mathematics on the topic of statistics and probability. Because of the promotion and awareness that this context received during the 2010 World Cup, this research considered that soccer was a suitable context for the data collection for the study.

Research Context and Participants

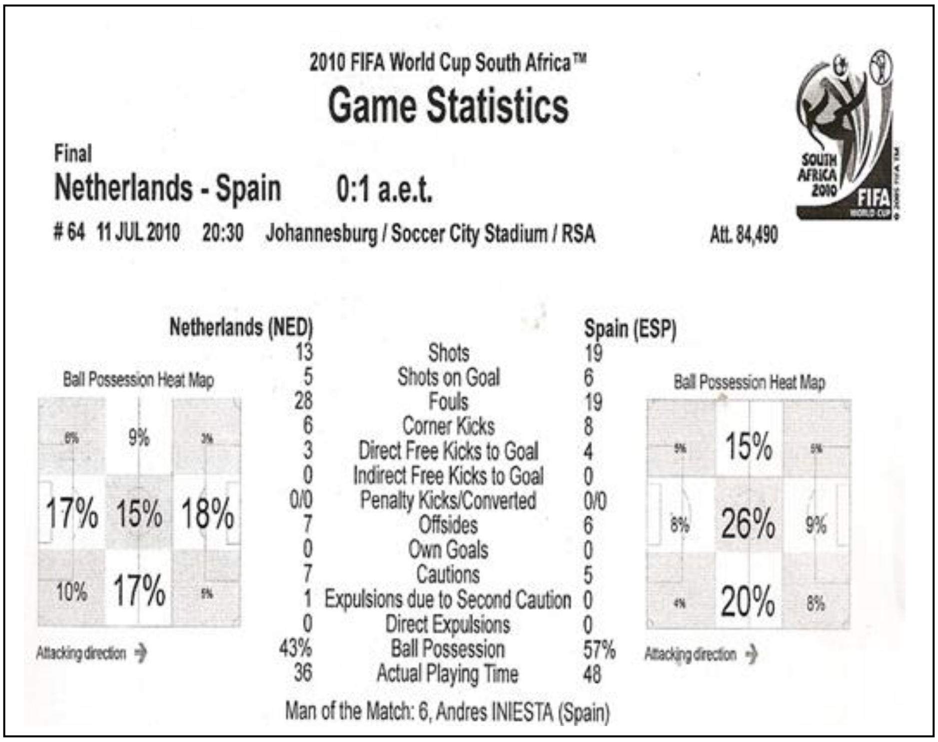
The research was conducted at a secondary school where both Mathematics and Mathematical Literacy learning areas are taught. At the time of data collection, the main author was teaching both Mathematics and Mathematical Literacy at the school. The school is located in a previously disadvantaged area, as it is classified in quintile 1(non-fee-paying school). It is a non-fee-paying school and serves children who are predominantly poor and less affluent. Some of the learners doing Mathematical Literacy have a Grade 10 Mathematics background. Learners were moved to the Mathematical Literacy class due to their poor performance in mathematics. The school's enrolment was approximately 1400 learners. This study involved two top-performing classes of participating learners in Mathematical Literacy and Mathematics. As these learners were performing above average in Mathematics and Mathematical Literacy, we assumed that these learners were well suited to successfully respond to unfamiliar tasks outside the scope of their everyday learning experiences. The Mathematics group consisted of 22 learners (8 boys and 14 girls), and the Mathematical Literacy group consisted of 20 learners (12 boys and 8 girls).

The Task was Given to Learners

The task (Figure 2) that was given to learners is described below. It was prepared from an extract from the FIFA World Cup 2010 match reports (Figure 1). Figure 1 below shows an extract from a match report.

Figure 1.

Heat Map from the World Cup 2010 Match Report: Netherlands vs Spain (Sibanda, 2014, p. 7)



The extract was presented to learners. Learners were asked to respond to the task shown in Figure 2. As can be seen in the task, learners were asked to respond to an open-ended task. This was in line with the qualitative nature of the study. Thus, the research was expected to generate open-ended responses from learners. However, asking learners to state whether they were from a Mathematical Literacy or Mathematics group was intended to assist the first author in understanding why learners responded in the way they did. For example, it was considered important for the study to examine the general nature of responses from learners in the Mathematics class. It was also important to ascertain if there were any differences among learners who were taking Mathematics. Nevertheless, the key issue was to determine the extent to which learners can pose problems. By actively engaging learners within the context of soccer, the idea was to offer them the opportunity to appreciate the practical value of mathematics for everyday activities such as soccer.

Figure 2.

Task for Grade 11 Learners (Sibanda, 2014)

Task for Learners (Grade 11)

Your Name: ____

Your Learning Area (tick which one you are taking)	Mathematics	
	Mathematical Literacy	

You are given the above information concerning the 2010 FIFA World Cup in South Africa. In this task, you are required to formulate two questions for Grade 10, a question for Grade 10 Mathematics learners, and a question for Grade 10 Mathematical Literacy learners.

Question 1: (a Mathematics Question)

(put your question on the sheet provided by your educator)

Question 2: (a Mathematical Literacy Question):

(put your question on the sheet provided by your educator)

Take a look at the questions that you have formulated. Indicate which of the two questions you think Grade 10 learners will find more difficult. Please explain why. (Put your responses on the sheet provided. Explain as much as you can).

Qualitative Content Analysis

In the analysis of the collected data, one of the key aspects to be considered was the issue of authenticity, that is, whether the problems learners formulated fell under the category that can be called mathematics questions. In the analysis, it was important to consider what was mathematical about the mathematics questions they formulated. A qualitative content analysis was performed on the qualitative dataset, consisting of learners' responses to formulate mathematical problems. The qualitative data (problems formulated by learners) were grouped according to learners' learning areas, that is, Mathematics and Mathematical Literacy. The mathematical problems formulated by learners from these two learning areas were then qualitatively explored, and instances recorded of learners' formulation of mathematical problems reflecting the following mathematical concepts: median, mode, range, probability, graphs and tables, five-number summary, box and whisker, hyperbola, and sine. During the qualitative data analysis, learners' responses were closely examined in terms of how they link to the context of soccer as well as their everyday classroom practices. The qualitative data of participating Grade 11 learners were organised and grouped together according to these mathematical concepts, for interpretation and discussion of the qualitative findings. Trustworthiness and credibility of the qualitative data were ensured by means of: (a) Only real-life learners, who are enrolled in the school, and were taking either Mathematics and

Mathematical Literacy as school subjects, were invited to participate voluntarily and anonymously; (b) Triangulation of the findings was performed by the two authors, who independently grouped and organized the qualitative data into interrelated themes of data; and (c) the authors verified the correctness of their interpretation of the findings, by presenting their findings to the participants, after the data was analysed.

FINDINGS and DISCUSSIONS

By examining the data, the following concepts were identified from the learners' responses: probability, mean, median, mode, range, hyperbola, sine, five-number summary, box and whisker, graphs, tables, and diagrams. In this analysis, the first part involved looking at specific concepts (e.g., probability) mentioned in the questions formulated by learners. The analysis looked at the nature of the questions in terms of their authenticity. Learner 1 was coded as L1, and Mathematical Literacy was Mathematical Literacy. Thus, L1 Mathematical Literacy was Learner 1 from the Mathematical Literacy class. L1 (Mathematics) was coded as Learner 1 from Mathematics class. To reiterate, Mathematics and Mathematical Literacy learners were required to formulate two questions for Grade 10 - a question for Grade 10 Mathematics learners, and a question for Grade 10 Mathematical Literacy learners. Furthermore, learners were asked to indicate which of the two questions that they had formulated they thought Grade 10 learners would find more difficult.

The Concept of Probability

Table 1 shows learners' responses involving the concept of probability.

Table 1.

Learners' Responses Involving the Term Probability

Learner ID	Learners' Formulated Problems Involving Probability
Learner 1: Mathematical Literacy	What is the probability of offside for both teams?
Learner 2: Mathematical Literacy	What is the probability of getting the points? What is the probability of own playing group?
Learner 3: Mathematical Literacy	What is the probability of the shots being made?
Learner 4: Mathematical Literacy	What is probability?
Learner 5: Mathematical Literacy	Calculate the probability of having 13 goals in the Netherlands.
Learner 7: Mathematical Literacy	a) What is the probability of pointing zero at the Netherlands? b) What is the probability of a number greater than 2? c) What is the probability of your own goal?
Learner 8: Mathematical Literacy	Give the probability of shots in Spain.
Learner 16: Mathematical Literacy	a) What is the probability of getting caution in Team Spain? a) Find the probability of getting offside on both sides.
Learner 17: Mathematical Literacy	Give the probability of a shot in Spain.
Learner 18: Mathematical Literacy	What is the probability of Spain and the Netherlands?

Table 1 shows the questions that learners formulated involving the concept of probability. It needs to be observed that the concept of probability is taught in both Mathematics and Mathematical Literacy learning areas. As can be seen in Table 1 ten

Mathematical Literacy learners formulated questions with the term probability. No Mathematics learners formulated a question involving the concept of probability. The themes that emanated from the analysis of the study are the concepts of familiarity, nature of questions, understanding, and meaningfulness.

Familiarity

It is rather surprising that no Mathematics learners formulated questions involving probability, as presented in Table 1 above, although probability is a topic in their learning area of Mathematics. Why did none of the Mathematics learners include the concept of probability in their responses? Does this mean that Mathematics learners are not familiar with the concept of probability? Or could it be that the Mathematics learners concerned are not familiar with how probability questions are formulated? Or could it be that the context provided to the learners was not 'inviting' for Mathematics learners to formulate questions involving probability? These are important questions to consider, given that they involve learners' familiarity with the concept of probability in addition to the context in which the concept might be embedded. This finding is in line with that of Li et al. (2022) who found that teachers exhibited a different pattern, reporting a little familiarity with problem posing before the workshop, familiarity after the first workshop, back down to a little familiarity after the second workshop, and finally somewhat familiar after the final workshop. This means the teachers showed different increases in familiarity with problem posing after participating in the series of workshops.

What then can be observed from the result that all the learners who formulated questions involving probability were Mathematical Literacy learners? The data suggest that Mathematical Literacy learners demonstrate familiarity with the concept of probability. However, we need to ask the question: Why are Mathematical Literacy learners appearing to be familiar with the concept of probability whereas their Mathematics counterparts are not? The data seem to suggest that this concept may have been more drilled into (or exposed to) (Li et al., 2022) the Mathematical Literacy learners participating in this study. However, it is not suggested that more exposure to the concept implies that the learners can perform better in tasks that involve this concept. This issue, establishing a connection between exposure to a concept and performance, is addressed later in the discussion section. Patac et al. (2022) argue that a task's familiarity and intricacy could contribute to the difficulty or easiness to pose a mathematical problem.

Nature of Questions

An examination of the nature of the questions reveals an interesting aspect linked to assessment in school mathematics. The data in Table 1 mirror how questions involving probability are normally presented in classroom assessments. For example, the way the questions are stated: "What is the probability...?" (L1, L2, L3, L7, L16, L18), "Calculate the probability..." (L5), "Find the probability..." (L16), demonstrate typical ways in which questions involving the term probability are framed.

Eight learners presented questions in this conventional format. This illustrates that these learners are familiar with the discourse of assessment in school mathematics. The question "What is probability?" formulated by Learner 4 is different from the rest of the questions. This question is more general since it invites a more theoretical response. The rest of the questions are largely more practical and are linked directly to the context of soccer. They demand responses that are specific to the given context.

Meaningfulness

What can be said regarding the significance of the problems that the *learners* came up with (see Table 1)? In this aspect, it is important to examine the problems in terms of their meaning. We need to ask: What does the question formulated by the learner mean? Also, is one able to provide an answer, given the way the question is asked? Let us consider the following question, asked by Learner 1 for example: "What is the probability of offside for both teams?" What does this question mean? And can this question be answered in a way that is appropriate to the concept of probability? It is easier to respond to a problem requiring a learner to compute the proportion of offsides committed for Team A compared to the total number of offsides in the match. However, is this the question that Learner 1 intended to ask? Without unpacking it, the question does not immediately lead to a sensible answer. The rest of the questions asked by learners concerning the concept of probability require unpacking to be answerable. They remain rather meaningless without further unpacking. The questions "What is the probability of your own goal?", and "Give the probability of shots in Spain", are rather meaningless and *empty* although they are linked to the real-life context of soccer. It is seen here that the provision of a real-life context does not necessarily make it possible for learners to ask meaningful questions involving a mathematical concept. The context and content are both available; however, this does not lead to learners formulating questions that can be meaningfully answered.

Understanding

To what extent do the learners understand the concept of probability? Given the above analysis, it is suggested here that, although learners included the concept of probability in their formulations, there is limited understanding of this concept. Why might this be the case? It is suspected that learners might not have mastered the basic ideas of probability. What concepts of probability do these learners appear to have not grasped? According to *Spot on mathematical literacy grade 10* (Olivier & Fourie, 2012, p. 114), the probability is calculated by dividing the number of favourable outcomes for the selected event by the total number of possible outcomes. It is not possible for learners who have not understood the concept to formulate a meaningful question involving that concept. This occurred despite the richness of the context that was made available to the learner. Table 2 shows how learners formulated questions from the concepts of median, mode, and range.

The Concepts: Median, Mode and Range

Table 2.

Learners' Responses Involving the Terms Median, Mode, and Range

Terms	Learner ID	Learners' Formulated Problems Involving Median, Mode and Range
Median	Mathematical Literacy	What is the median for the team? (L4) Calculate the median for the Netherlands. (L7) Calculate the median. (L13) Calculate the following, median. (L14)
Median	Mathematics	Define the following, the median. (L5) Using the information provided for the Netherlands, determine the median. (L9) Calculate the following from Spain's percentage (%) of ball possession on the heat map. Median. (L10) Calculate the median. (L16) Use the game statistics to find the following, median. (L17)
Mode	Mathematical Literacy	What is the mode of Netherlands and Spain? (L7) The mean mode. (L8) Calculate mode. (L13) Calculate the mean and mode, range number of Spain. (L17) What is the mean and the mode of Spain? (L18)
Mode	Mathematics	Arrange the number of both teams and get the mode. (L2) Mode of Netherlands and Spain? (L6) Using the data provided for the Netherlands team, determine the mode. (L9) Determine the following mode. (L12) Calculate the mode. (L16) Use the game statistics to find the following, the mode. (L17)
Range	Mathematical Literacy	What is the mean for the team? Range. (L4) Calculate the range. (L6) Calculate the range of Spain. (L7) When is the mean, mode, range of the playing time? (L8) Calculate the range. (L13) Calculate the range. (L14) Calculate the mean, mode and range of Spain. (L17)
Range	Mathematics	Calculate the range and the domain. (L4) Define the range. (L5) Using the data provided for the Netherlands team, determine the range. (L9) Using the data provided for the Spain team, determine the range. (L12) Calculate the range from Spain's percentage (%) of the ball on the heat map. (L13) Using the game statistics, find the range. (L17)

It needs to be noted that the concepts median and mode are measures of central tendencies, with range being a measure of spread. In the researchers' classroom experience as a teacher, learners generally tend to be excited when studying these topics in class.

Table 3.

Summary of Terms

	Instances (Freq) Recorded in the Problems Formulated by Learners from the Subject Mathematics	Freq %	Instances (Freq) Recorded in the Problems Formulated by Learners from the Subject Mathematical Literacy	Freq %	Total Instances (Freq) Recorded
Mean	11	73.33	4	26.66	15
Probability	0	0	10	100.00	10
Median	5	55.55	4	44.44	9
Mode	6	54.54	5	45.45	11
Range	7	50.00	7	50.00	14
Graphs and Tables	18	85.71	3	14.29	21
Five -Number Summary	5	100.00	0	0	5
Box and Whisker	11	100.00	0	0	11
Hyperbola	0	0	1	100.00	1
Sine	0	0	1	100.00	1
Totals	63		35		

Table 3 shows the mathematical terms and the number of times they appeared in the questions formulated by learners. In total, Mathematics learners formulated questions that contained 63 mathematical terms, compared to 35 mathematical terms mentioned by the Mathematical Literacy learners. It is not surprising that Mathematical Literacy learners did not formulate questions that involved terms such as box-and-whisker and five-number summary, considering that these are exclusively mathematics terms, and therefore might not be familiar to them. However, the use of terms such as sine and hyperbola formulated by Mathematical Literacy learners is rather surprising, given that no Mathematics learner formulated questions involving these terms. This perhaps suggests that these learners have a mathematical background from which they are drawing their responses. It is also surprising that no Mathematics learner formulated questions that involved the term probability, given that probability is a concept that is addressed in both Mathematics and Mathematical Literacy. Perhaps the learners did not see the context as presenting opportunities to pose such questions.

The data presented and analysed in this section have revealed several key issues that are linked to learners' formulation of questions based on the context of soccer. These aspects are concerned with the link between questions formulated by the learners and mathematical concepts, learning outcomes, game analysis, and, most importantly, the nature of the justification's learners provided in motivating which questions they perceived as difficult. In the next section, we discuss these central aspects and link them to the existing literature.

Relevance for Game Analysis

The issue of game analysis in the context of this study refers to questions that learners formulated that put more emphasis on commenting on the game of soccer itself. The questions in this category did not appear to reflect any explicit links to concepts in Mathematics or Mathematical Literacy. Such questions tended to reflect knowledge related to the game of soccer instead of mathematical knowledge and skills. Examples of some of these questions are: "How many corner kicks were there in the Netherlands?"; "How many fouls were there in Spain?" and "How much time should a player have to play inside?" These were questions that linked more to the context embedded in the task than to mathematical concepts relevant to the context. This means that it is the social context (soccer) that is more foregrounded than the mathematical concepts that are embedded in the context.

This behaviour of foregrounding the social (soccer) context over mathematical concepts and skills is not new. Sethole (2004) and Machaba (2018) also observed this finding in the analysis of the task that was prepared by participants in their research. The task had no explicit (i.e., visible) reference to a specialised activity in which mathematics would be a meaningful tool. In this connection, Bernstein (2000) has observed that there are consequences for those children who can exploit the possibilities of pedagogic practice, namely visible and invisible pedagogies. The result is that children from different social classes acquire knowledge differently; that is, children from middle-class communities will learn or interpret information differently from those from working-class communities due to different exposure to after-school help. Children from the middle class have an advantage when it comes to invisible pedagogies.

These observations concur with findings from the current study, considering that most learners who participated in this study originated from working-class communities. Therefore, their invisible pedagogies tend to suffer. We can notice that this observation was made regarding the lesson presentation. We can also note that in problem formulation, social concerns may dominate over mathematical skills. As a result, the questions learners formulated ended up having limited mathematical meaning relevant to the context.

Moreover, the study established that Mathematical Literacy learners formulated fewer questions with mathematical terms than Mathematics learners. It is being suggested that perhaps these learners might have been 'lost' in the context. Cooper and Harries (2002) argue that when a given context contains too little or too much information, it can mislead the learner. Since this was established in the context of problem-solving, it is argued the role of the real-life situation needs to be taken into consideration when questions are presented to learners.

There is also the issue of realistic problems formulated by learners in terms of the soccer context provided. There is a need to consider whether the questions posed by the learners reflect mathematical content, the soccer context, or both. This may be reflected in the questions learners formulated, considering that one of the aims of the study was to determine the extent to which Grade 11 learners can formulate problems. In their research, Cooper and Harries (2002) and Machaba and Mwakapenda (2016) gave learners items that had in common the potential for the child's responses to include realistic considerations—in the sense of what would be a relevant consideration in the everyday world suggested by the context.

Relevance and Mathematical Concepts

The analysis established that Mathematical Literacy learners demonstrated familiarity with the concept of probability. This illustrates that these learners are familiar with the discourse of assessment in school mathematics. However, there were questions that the learners formulated which appear to be rather meaningless and barren even though they are linked to the real-life context of soccer. The following questions formulated by Leaner 3 (Mathematical Literacy) provide examples of such questions:

"How much time should a player have to play inside?
How many kilometres that the player should run to score?
How many corner kicks were made by the Netherlands?"

Learner 3 Mathematical Literacy's questions above, particularly the first question ("*How much time should a player have to play inside?"*), as well as the second question (*"How many kilometres that the player should run to score?"*), though having a context, are quite meaningless. Asking *"How much time should a player have to play inside?"* is a question that is too broad, especially since it does not specify which player is being referred to. The second question is also meaningless. Links to specific mathematical concepts have not been made in the two questions. They are questions requiring a connection with time and distance, concepts that are basic and may not be out of reach for learners in Grades 10 or 11.

It is seen here that the provision of a real-life context does not necessarily make it possible for learners to ask meaningful questions involving a mathematical concept. Such questions give the reader the impression that the assessor assesses the readers' knowledge of the game. Questions such as these perhaps indicate learners' limited understanding. For Learner 3 Mathematical Literacy, anything that involves enquiring about numbers (e.g., how much time) seems to be about mathematics.

This question in the context of mathematics does not appear to assess any mathematical concept or knowledge. The reader is not invited to refer to any specific skills or methods acquired in the mathematics classroom. In contrast, Mathematics learners formulated more meaningful questions which were more detailed and could guide the reader to respond with more clarity compared to questions formulated by Mathematical Literacy learners.

The following question was formulated by L1 Mathematics:

"After looking at the information given, you must determine the following.
a) The mean, b) Five- number summary"

This question guides the reader to pay attention to the given information. It makes the reader aware that without reference to the given information it would be difficult to answer the questions asked. However, the question could have been more mathematical and more pragmatically formulated, explicitly linking the soccer scenario to the mathematical concepts mean and five-number summary. The mathematical concept *"mean"* is a core mathematical concept relevant to both Grade 11 Mathematics, as well as Mathematical Literacy. However, the mathematical concept five-number summary, is a concept only introduced in the subject Mathematics, and not Mathematical Literacy.

Scrutiny of the questions that the two groups of learners formulated shows a marked distinction in their approaches to question formulation. The Mathematical Literacy group used a short and more open-ended approach to questions, giving only limited detail to assist in answering the questions.

Limitations and Recommended Questions for Future Research

Further investigation through interviews with learners would be useful. We highlighted the importance of considering the social and cultural context of the learners and note that the findings may not be generalisable to other contexts. Additionally, our study focused on a specific task and our findings may not necessarily apply to other tasks or contexts. Overall, the reader should take into account these limitations of our study and the need for further research to confirm and extend the findings.

The key findings of this study are that participating Grade 11 Mathematics and Mathematical Literacy learners struggled to integrate the given soccer context with mathematics, and that Mathematics learners responded differently from Mathematical Literacy learners as far as task formulation is concerned. These findings suggest that there may be an imbalance in the way that these two groups of learners respond to the task of formulating questions, and that task formulation cannot be separated from curriculum development. The findings may be relevant to broader debates about the role of real-world contexts in mathematics education, and about the relationship between mathematics and other disciplines. The findings may also have implications for curriculum development and teacher training in Mathematics and Mathematical Literacy.

Our research found that Grade 11 Mathematics and Mathematical Literacy learners in Tshwane were capable of formulating a variety of questions in Mathematics and Mathematical Literacy that reflect their everyday experiences in the classroom. However, it seems that there may be an imbalance in the way that Mathematics and Mathematical Literacy learners respond to real-world contexts in mathematics education, and that task formulation cannot be separated from curriculum development. These findings have implications for curriculum development and teacher training in mathematics and mathematical literacy and highlight the need for further research to better understand the relationship between real-world contexts, task formulation, and curriculum development in mathematics education.

The following research questions came to mind during our research, and necessitate the attention of future research initiatives:

- How do learners feel about being asked to formulate questions for Mathematics and Mathematical Literacy for a given everyday context?
- What is the relationship between real-world contexts, task formulation, and curriculum development in Mathematics and Mathematical Literacy?
- Can the findings of our study be confirmed and extended to other tasks and contexts?

CONCLUSION

The study found that Grade 11 mathematics learners are quite capable of formulating basic-level questions that reflect their everyday experiences in the classroom through sources such as question papers, textbooks, and their subject teachers. It is demonstrated through phrases such as "how many", "how much" and "determine", for example, that learners are capable of formulating a variety of questions in Mathematics and Mathematical Literacy. Questions that learners formulated in general embedded mathematical terms in them. This demonstrates that learners were able to integrate the soccer context into Mathematics and Mathematical Literacy questions. Furthermore, the questions posed by the learners mirror the soccer context given to them in its entirety. Some learners went to the extent of completely ignoring the instructions and formulating questions based solely on soccer. Some learners, particularly those in Mathematical Literacy, struggled to integrate the given soccer context with mathematics. These two key findings indicate some form of imbalance in the way that these two groups of learners responded to the task of formulating questions. While the issue of balance needs to be considered a contested issue, it is nevertheless clear from the research findings that Mathematics learners responded differently from Mathematical Literacy learners as far as task formulation is concerned.

In addition, as mentioned earlier, task formulation cannot be separated from curriculum development; these processes are intertwined. Based on the findings from our study, it is recommended that there is a need to document, from the perspective of curriculum providers and textbook writers, what processes they engage with to come up with the types of problems that are included in textbooks given to school learners. How do they develop those tasks and questions? To what extent are wider audiences, especially learners, included in any of these processes? This recommendation is important because it is being suggested that there is a need to involve learners a lot more in processes related to their curriculum. They should not be seen as mere consumers of the curriculum, but as producers as well.

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