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EXPLORATION OF ENVIRONMENTAL CONTENT IN GRADE 12 MATHEMATICAL LITERACY SUMMATIVE ASSESSMENT

Case Study

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ABSTRACT

A qualitative exploratory design was utilised in this study through the application of assessment theory to explore the extent to which Grade 12 Mathematical Literacy national examination papers spanning from 2014 to 2018 assessed environmental content. Environmental education (EE) is a cross-curricular discipline integrated in all school subjects. The assessment of environmental content in Mathematical Literacy is important to ensure learners have adequate environmental knowledge to sustain the fragile environment. Purposive sampling was used to select Mathematical Literacy from school subjects owing to a shortage of literature on EE. Data was analysed through coding and thematic techniques. It was established that environmental content did appear in the summative assessment in the specific period, but there was a significant disparity between the marks allocated to environmental content each year. The study contributes to the fields of EE and Mathematical Literacy by highlighting disparities between the marks allocated to environmental content in the summative assessment such as examinations.

Key Words: Environmental education, Mathematical Literacy, Assessment theory

1. Introduction and Background

The aim of this paper is to explore the extent to which Grade 12 Mathematical Literacy (Maths Lit) national final examination papers assess environmental content. Curriculum reforms in South Africa led to the introduction of Mathematical Literacy as a school subject in the curriculum. This subject was introduced into the school curriculum in 2006 under the National Curriculum Statements with the intention of mitigating innumeracy and mathematical illiteracy in the country (Department of Education, 2003).

Mathematical Literacy was introduced in the curriculum of secondary schools in three phases. In the first phase, which took place in 2006, the subject was introduced in Grade 10; in the second phase, which took place in 2007, it was introduced in Grade 11; and in the third phase, which took place in 2008, it was introduced in Grade 12. Accordingly, the first Grade 12 National Senior Certificate examination for Mathematical Literacy was written at the end of 2008 (North, 2010). Since then, Mathematical Literacy has been recognised as a school subject and its content has been restructured constantly. For instance, in 2021, the structure of paper 1 (Finance, Data Handling and Probability) and paper 2 (Maps, Plans, Measurement, Probability and a small fraction of Finance) were changed to cater for the mentioned topics.

In 2012, a new policy called the Curriculum and Assessment Policy Statements (CAPS) was implemented. Mathematical Literacy was introduced in three phases under CAPS: it was introduced in Grade 10 in 2012, in Grade 11 in 2013 and in Grade 12 in 2014. This policy resulted in a new cohort of Grade 12 Mathematical Literacy learners writing the National Senior Certificate examination in 2014. It is therefore important to understand the effect of CAPS on the examination of environmental content in Mathematical Literacy since its inception.

This study delves into Grade 12 National Senior Certificate examination papers from 2014 to 2018 owing to the availability of the papers during the writing of the paper. The review period of five years is ideal for answering the research problem. Further, this study examines the assessment of environmental content due to the newness of the policy in the curriculum. It is critical to know whether past examination papers can assist with development in the environmental knowledge area with respect to adherence to the policies implemented by the Department of Basic Education (DBE) in South Africa (Msezane, 2017a). The findings could help curriculum designers and examiners consider environmental content in future curriculum amendments.

The researchers analysed examination papers spanning from 2014 to 2018. The examination papers are downloadable from the website of the DBE (https://www.education.gov.za). The analysis of the examination papers from 2014 to 2018 was informed by the implementation of CAPS with a view to ascertaining the transformation of assessment relating to environmental topics. In this lengthy period (five years), examiners may have come to understand the curriculum better. The changes in the education system influenced the examination of

environmental content in school subjects. The next section unpacks the theoretical framework for this paper.

2. Theoretical Framework

Bhamjee and Rashied (2018) highlighted the evolution of assessment theory in education over the years. Between 1900 and 1980, the dominant paradigm of learning theory and learning measurement was deeply rooted in the interaction between social efficiency curriculum, hereditation theory of the intelligence quotient, and behaviourist learning (Bhamjee & Rashied, 2018). Taras (2012) asserted that in the past 40 years, great changes have taken place in learning and teaching, and a strange separation appears with respect to assessment. This separation is evident in the examination of environmental content in Mathematical Literacy on secondary school level. The analysis of National Senior Certificate papers exposes certain gaps. From the analysis, it seems that assessment theory is often relegated to the realm of specialists (Taras, 2012).

Dreyer and Loubser (2014) averred that the different assessment types should be used to supplement one another and that each type should form part of the learning situation at appropriate times and in relevant situations. Summative assessment in the curriculum determines the overall achievement of learners and learning success. In CAPS, summative assessment is represented by end-of-year examinations and/or external examinations (Dreyer & Loubser, 2014). Summative assessment is grounded in other types of assessment for its objective to occur at the end. For instance, baseline assessment measures prior learning before the commencement of teaching and learning, diagnostic assessment identifies learning barriers, formative assessment helps to improve teaching and learning, continuous assessment affords learners opportunities for self- and peer assessment to cement the learning process, systemic evaluation monitors learners' progress in each phase and authentic assessment explores real-world situations. In this study, assessment theory is applied to evaluate assessment with reference to the assessment of environmental content in the Mathematical Literacy examination papers of years stated above.

It can be argued that assessment is crucial to all education and all learning. The application of assessment is deemed to be problematic (Taras, 2012). The selection of topics, specifically, a situation where certain topics are examined while others are not, creates a problem in the

teaching and learning process. Msezane (2017a; b) lamented this situation, stating that teachers tend to focus on topics they regard as important to prepare learners for the end-of-year examinations. The literature suggested that teachers can make small changes inside their classrooms to provide a more appropriate foundation for integrating environmental education (EE)/education for sustainable development (ESD) and Mathematics (Maths), thereby strengthening learners' critical thinking skills and improving their motivation to learn (Litner, 2016).

3. Literature Review

Fundisa for Change (2013: 2) highlights that "environment and sustainability are some of the fastest growing topics in school curricula around the world". Like many national curricula around the world, South Africa's new CAPS are rich in environment and sustainability content (Fundisa for Change, 2013: 2). Despite the richness of the environmental content, the coverage of such content in examinations needs to be analysed (Msezane, 2017b) for the betterment of the curriculum considering the rise of environmental issues in our society.

Scholars from around the world have investigated various issues in respect of mathematics, Mathematical Literacy and EE. In Spain, Garzón, Montes and Cara (2019) examined the notion that EE and mathematics can raise young people's awareness about the use of plastic. They propose that children participate in their learning process and evaluation so that they can establish their own work rhythm, learn to work with autonomy and develop competence. In the United States of America, Al-absi (2014) investigated the effect of learning through an environmental approach on third graders' problem-solving abilities in mathematics. Al-absi (2014) found that learning through an environmental approach, in general, had a positive effect on improving learners' problem-solving abilities. In Australia, Nisbet, Hurley and Weldon (2006) explored the teaching of population growth rates, where mathematics was integrated with studies of society and the environment and found that this approach increased learners' awareness of developed, developing and undeveloped countries, and the social effects of population growth rates. It further increased learners' awareness and understanding of living conditions in other parts of the world.

Liell and Bayer (2016) conducted a study in Brazil to validate whether the development of a foundation in EE and mathematics would bring changes in the conception of EE for teachers. The program influenced teachers' practices relating to environmental themes, and they worked together to devise activities relating to everyday situations. Moreover, in South Africa, Debba (2011) explored ways in which a class of Grade 12 learners in the province of KwaZulu-Natal engaged with a preparatory examination. He found that the task design was problematic for learners in terms of the order of the questions and the placement of the information necessary to answer the questions. Msezane (2017a) conducted research focusing on three school subjects, namely, Life Sciences, Agricultural Sciences and Geography, in South Africa. He intended to illustrate whether there was a correlation between stipulated content coverage in the CAPS policy and the actual examination of environmental topics in the school curriculum. He found that there was no alignment of content coverage between CAPS policy and examinations. Furthermore, Msezane (2017b) examined the coverage and examination of environmental-impact topics in the Further Education and Training Phase in the school curriculum. He found that environmental-impact topics were indeed covered in Grade 12 CAPS, but to varying degrees. The level of coverage on environmental-impact topics in examination papers also fluctuated, sometimes to levels below those stipulated in the CAPS policy.

Schools serve as good platforms for teaching learners about environmental matters. The assessment of learners' knowledge of environmental matters is important. Neglecting the assessment of environmental topics could give learners the impression that these topics are not important as Gilbert (2019:39) found that learners prioritised examinable subjects and concentrated less on subject such as EE particularly when teachers determine curriculum content and pay little attention to EE. The above-mentioned scholars explored a variety of topics in school subjects. Only two of the studies reviewed focused on the examination of environmental topics in Geography, Life Sciences and Agricultural Sciences. It is evident that there is a need to explore the examination of environmental content in Mathematical Literacy. The paucity of research focusing on the assessment of environmental content in Mathematical Literacy examination papers served as a motivation for this study. The aim of this document analysis paper is to assist in closing the gap in the literature, taking the research problem into consideration.

4. Research Problem

4.1 Purpose of the paper

The purpose of this paper is to examine the extent to which Grade 12 Mathematical Literacy national final examination papers assessed environmental content from 2014 to 2018.

4.2 Problem statement

Several changes in the curriculum since 1994 have affected the coverage, teaching and examination of environmental topics in subjects such as Life Sciences, Agricultural Sciences and Geography (Msezane, 2017a). The paradigm shifts also affected Mathematical Literacy. Imbalances related to environmental topics in the final national examination papers of Mathematical Literacy reflect a missed opportunity to teach learner's environmental content. As this could possibly be another one way of bringing in awareness on their learning. It is therefore crucial to examine environmental content in the Mathematical Literacy national examination question papers.

4.3 Research question

To what extent did Grade 12 Mathematical Literacy National Senior Certificate examination papers assess environmental content from 2014 to 2018?

5. Methodology

Methodology is concerned with how researchers acquire knowledge about the world. This includes how they collect data based on their beliefs about what exists and what is knowable (their ontology and epistemology), how they describe phenomena, and how they explain (Bertram & Christiansen, 2020). In this study, data was collected from documents comprising examination papers, ATPs and CAPS policy to explore the disparities of the environmental content using assessment theory to contribute to the body of knowledge.

5.1 Research design

An exploratory design was used in this qualitative study to explore environmental content in Grade 12 Mathematical Literacy national examination papers. According to Davis (2014: 93), the research design is a complete plan for the entire research project. It is an outline of what the researcher will do, from formulating the question(s) or the hypothesis to collecting the information and completing the final analysis. In essence, the research design is the distinctive framework according to which data pertaining to the research question will be

collected (le Roux, 2014: 206). An exploratory approach based on document analysis and literature review was utilised to explore the research problem. The process of completing a literature review and document analysis are social research methods and are important research designs in their own right (le Roux, 2014: 210).

5.2 Sampling of secondary school subjects

Secondary school comprises Grades 8–12 and offers several subjects, such as Accounting and Tourism. Since its inception in the late 1990s, Science, Technology, Engineering and Mathematics (STEM) has continued to attract attention and sizeable funding in the US, UK, and Australia (Blackley & Howell, 2015). According to Blackley and Howell (2015) science and mathematics across the globe, are given more attention and sponsors to continue with their mandate of delivering curriculum to the learners. For instance, in South Africa, these subjects receive sponsorships from organisations like Sci-Bono, as compared to other school subjects. Debba (2011: 1) asserted that mathematics transcends almost every sphere of life.

In this study, the researchers used purposive sampling to examine Mathematical Literacy examination papers spanning from 2014 to 2018 which consists of five paper 1 and five paper 2, final examination papers. In purposive sampling, we chose elements from the population that are representative or informative about the topic of interest (McMillan & Schumacher, 2010). Purposive sampling was chosen in line with study objective, delimit the scope of the study, research question and high enrolment of the learners. Grade 12 learners write national examination papers administered by the DBE, and this subject is relatively new in the curriculum. McMillan and Schumacher (2010: 138) emphasised that, based on the researcher's knowledge of the population in a study, a judgement is made about which subjects should be selected to provide the best information to address the purpose of the research.

5.3 Data collection tools

Secondary data was collected from official documents, such as previous examination papers, the annual teaching plan (ATP) of the DBE and the Mathematical Literacy CAPS to close the gap in the literature. Document analysis is the systematic procedure of finding, selecting, reviewing, and interpreting documents to uncover meaning and discover insights that are relevant to the research problem (Rich, 2019). The official documents were used to explore

the assessment of environmental content. Official documents are intended to be read as objective statements of fact, but they are socially produced and consequently reflect the prevailing ideology, and social, economic, and political trends (le Roux, 2014: 210). Assessment theory served as a lens for analysing the documents.

5.4 Data analysis

Documents were reviewed by line, phrase, sentence, and paragraph segments, paying close attention to subtle cues in the language used to describe competence throughout each document (Rich, 2019:3).This iterative process combines elements of content and thematic analysis. Content analysis allows the researcher to sift ideas that relate to the research question and then to categorise the ideas. For this study, the researchers utilised coding to analyse data obtained from the documents using tables, score percentages, graphs and figures. The coding of data was performed to determine emerging ideas. Subsequently, the ideas that came out were grouped into themes. This process was carried out with the aid of Microsoft (MS) Office, using word processing and spreadsheets. MS Office allows the integration of data. Data can be exchanged easily between the different programs, as shown in Table 2 and Graph 1.

The researchers acknowledge that document analysis has some limitations, hence the findings of this paper are limited to Mathematical Literacy in Grade 12. Bowen (2009) identifies insufficient detail, low retrievability and biased selectivity as potential flaws of document analysis.

6. Research Results

The results discussed here are derived from the Mathematical Literacy CAPS policy, Grade 12 National Senior Certificate examination question papers from 2014 to 2018 and the ATP.

Table 1: Emerging themes

Documents	Coded
Mathematical Literacy CAPS policy	• Coverage of environmental content
National examination question papers 1 and 2	• Mark allocations • Past papers on environmental topics • Assessment of environmental content

	• Environmental topics covered
ATP	• Environmental content coverage

6.1 Mark allocations

The mark allocation for Mathematical Literacy in paper 1 (as well as paper 2) was 150. The question paper counted a total of 300 marks. Marks were distributed across the topics depicted in Figure 1. However, the distribution of marks in respect of certain topics was minimal. In the case of environmental topics, the distribution of marks was below 5% on average. The marks allocated to environmental content suggested that EE was downplayed in Mathematical Literacy. Literature suggests that extensive coverage of environmental-impact topics in the curriculum may shape a new culture of responding proactively to environmental issues (Msezane, 2017b).

6.2 Mathematical Literacy CAPS policy: Coverage of environmental content

Figure 1 displays five topics taught to Grade 12 learners. The weighting of the topics shows the priority of content that will be assessed in the examinations at the end of the year. The topics presented in Figure 1 have the potential to teach learners about environmental issues. For instance, in respect of Finance, learners could calculate profit generated from garbage; in respect of Measurement, learners could measure the weight of garbage on a scale; in respect of Maps, learners could identify littered areas; in respect of Data Handling, learners could record daily waste; and in relation to Probability, learners could predict the behaviour of people in their environment.

Environmental topics hardly appear in the Mathematical Literacy CAPS, even though one of the five principles on which the National Curriculum Statement Grades R–12 is based is the principle of human rights, inclusivity, and environmental and social justice, which involves infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa, 1996 (DBE, 2011). South Africa's Constitution (Republic of South Africa, 1996) stipulates that every citizen has the right to a healthy environment, that is, an environment that is free of pollution. It seems policymakers did not consider this principle to ensure learners are assessed on environmental issues.

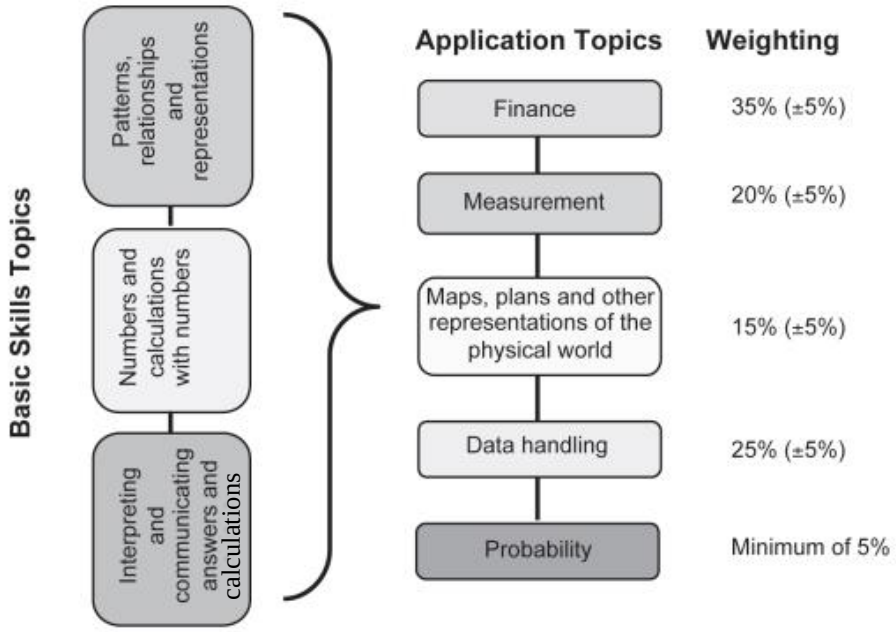


Figure 1: Mathematical Literacy content Source: DBE (2011)

6.3 Past papers on environmental topics

The results obtained in this study emanated from the document analysis performed on Grade 12 Mathematical Literacy examination papers spanning from 2014 to 2018. These papers can be accessed on the website of the DBE. Table 2 shows the analysis of previous examination papers in respect of the assessment of environmental topics.

Table 2: Past papers

	2014	**2015**	**2016**	**2017**	**2018**
Topics covered	Temperature	Word population, population growth	None	Rainfall, tropical storm, population growth	Fire, population (poverty)
Total marks	3/300	18/300	0/300	43/300	33/300
% environmental topics	1%	6%	0%	14%	11%

Source: Paper data

Table 2 clearly shows several environmental topics that were included in past papers, though the inclusion of such topics varied each year. In 2014, environmental topics accounted for three marks out of 300, which is equivalent to 1% of the total mark allocation. Learners in that year were exposed to unsatisfactory environmental awareness and knowledge. This was

the first Mathematical Literacy examination administered to Grade 12 learners under CAPS policy. Subsequently, in 2015, environmental topics accounted for 18 marks out of 300, equating to 6% of the total mark allocation. This was an improvement compared to the 2014 paper, in spite of the low percentage. However, in 2016, environmental topics were not included in the examination paper, leaving a void in learners' environmental knowledge and awareness of ecological matters. If mark allocations for environmental content had been clearly stipulated in the CAPS policy to guide examiners, this may not have happened.

During the past three years since inception of CAPS policy there was an imbalance of assessment of environmental topics in the examination papers. In the fourth (2017) and fifth (2018) years, the assessment of environmental content increased drastically. In the examination paper of 2017, environmental topics accounted for 43 marks out of 300, representing 14% of the total mark allocation. In the examination paper of 2018, environmental topics accounted for 33 out of 300 marks, equating to 11% of the total mark allocation. Environmental content therefore decreased by 10 marks from 2017 to 2018. This fluctuation of marks in the examination papers confirms the absence of guidelines on the assessment of environmental topics from the examination since the CAPS policy is silent on the coverage of environmental content in the subject.

The examination papers reviewed contained ecological topics, but the marks allocated to these topics made up a low portion of the total mark allocations. It is evident that environmental topics were side-lined in assessment. The distribution of marks to environmental content in the examination papers was not adequate, as discussed in 6.1. Table 2 shows that the percentages relating to environmental topics in the papers are below 15%. Further, the average percentage of environmental content in the combined papers (2014–2018) is 5%.

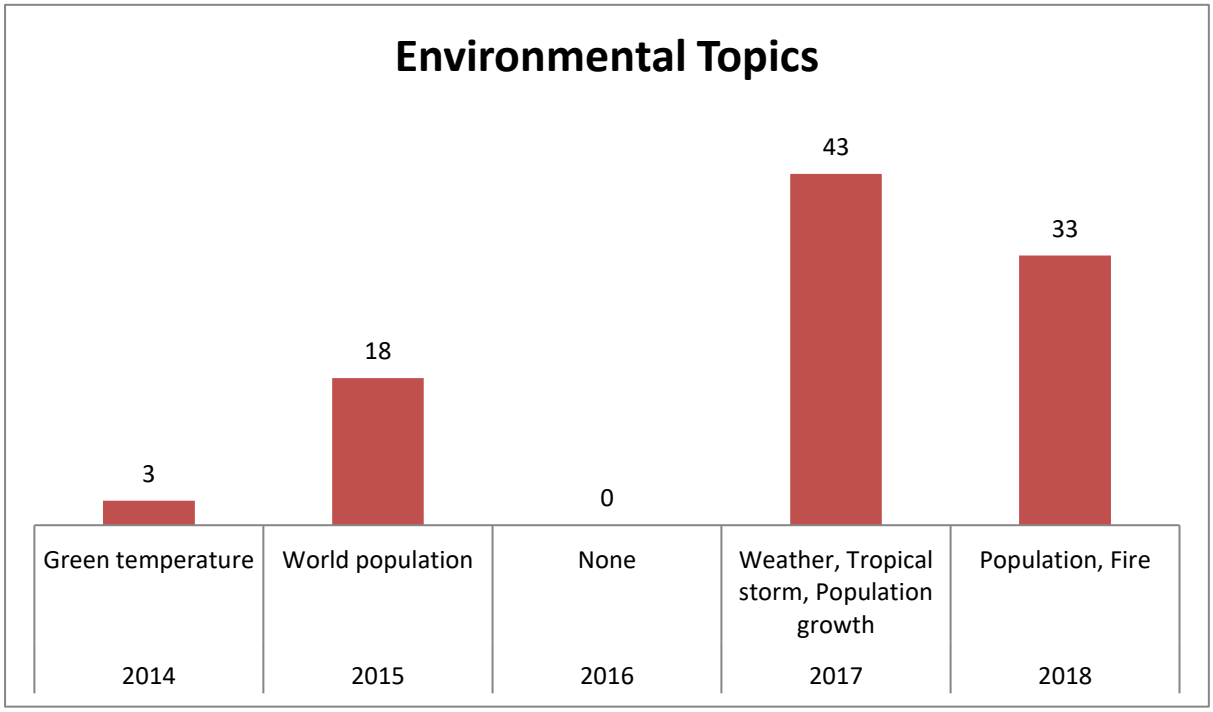
6.4 Assessment of environmental content

It is appearing from Table 2 above that there was a shortage of environmental topics in the examination question papers. For instance, the matter of litter was not covered in the examinations. A lack of attention to environmental content does not help learners to be environmentally literate. Matsekoleng (2017) reported that learners throw plastic wrappers and containers on school grounds on a daily basis. The inclusion of daily environmental issues in examination papers could help learners to develop greater environmental awareness since their

immediate environment provides an authentic context in which to assess their awareness of environmental issues.

6.5 Environmental topics covered

Graph 1 shows trends in environmental topics covered in the examination papers from 2014 to 2018. The topics that appeared in the Senior Certificate examination papers were green temperature, population, weather and tropical storm, and fire. The mark allocation for environmental topics in the papers was higher in 2017 compared to other years since the inception of the CAPS policy. The allocation of marks to environmental content varied from year to year and, in some instances, environmental content counted zero. The differences in the mark allocations for environmental content suggest that EE was not fully integrated in Mathematical Literacy, although EE was integrated across all school subjects. Environmental problems have a dire impact on the environment (Amankwah-Poku & Ofori, 2020); therefore, it is important for learners to learn about such issues in the curriculum and to be assessed on those issues.



Graph 1: Environmental topics Source: Paper data

6.6 Annual teaching plan: Environmental content coverage

The annual teaching plan (ATP) is a teaching framework that shows content that teachers should offer learners inside and outside the classroom. This framework serves as a guideline that allows teaching and learning to occur. Teachers use the ATP lesson plans and other resources, such as textbooks and previous examination papers to teach. Accordingly, examiners consider the ATP when they set year-end papers.

The ATP reviewed contains the topics illustrated in Figure 1 (Measurement, probability, finance; maps and plans, and other representations of the physical world; and data handling) that are well articulated and distributed across school terms. The ATP document makes no reference to environmental topics. Since districts supply teachers with the ATP so that teachers know which topics learners must learn in preparation for examinations, it can be concluded that environmental content was not considered in the teaching and assessment of Mathematical Literacy in the period under review. The ensuing section contains a discussion of the results.

7. Discussion

The aim of this study was to explore the extent to which Grade 12 Mathematical Literacy National Senior Certificate examination papers spanning from 2014 to 2018 assessed environmental content. Environmental education/Education for sustainable development (ESD) is a vital part of education to make learners aware of environmental issues, including global warming. An awareness of such issues should form part of examinations for EE to be effective.

Litner (2016) asserted that the role of green mathematics is to inform the public of environmental issues and to help make people more socially charged. For that reason, examiners should consider including environmental topics in examination papers. In South Africa, the DBE is responsible for setting final examination question papers and subsequently conducting the moderation and marking of scripts according to assessment guidelines with the goal of ensuring quality assurance. However, quality assurance could be questioned owing to the unsatisfactory amount of environmental content examined in examination papers. Ghaicha (2016) affirms that public examination systems often have negative consequences for the general quality of education. In a similar vein, theory and practice are disconnected due to an imbalance in the assessment of topics in subjects like Mathematical Literacy. According to the findings of the study, the average percentage of environmental content in the combined

examination papers from 2014 to 2018 is 5%. When teachers do not teach environmental content, learners may have inadequate environmental awareness and knowledge.

The Mathematical Literacy CAPS policy does not specify mark allocations in relation to environmental topics in the final examination question paper. Msezane (2017a; b) similarly found that the CAPS policy does not disclose mark allocations in respect of Geography and Agricultural Sciences for the final examination papers for Grade 12. The lack of guidelines on the examination of environmental topics in Mathematical Literacy acts as a barrier to quality in assessment and poses a challenge to examiners in the setting of papers. Table 2 above indicates an unbalanced allocation of marks in respect of environmental topics over the years. For instance, in 2016, there was an absence of environmental topics in the question paper. Ghaicha (2016) stressed that assessment theory is a powerful lever that can either boost or undermine learners' learning. The absence of other environmental issues in the examination papers undermined learners' learning.

Litner (2016) found that in the Ontario mathematics curriculum, there was not a single specific guideline that makes reference to EE. A similar finding is evident in respect of the Mathematical Literacy curriculum in South Africa since there is little information on the distribution of marks in respect of environmental topics, even though the CAPS curriculum specifies that environmental content should form part of all school subjects. Assessment theory is a vital component of any evaluation to judge the quality of content and programmes offered to a group of learners (Ghaicha, 2016). Imbalances in the assessment of environmental topics in Mathematical Literacy point to inconsistencies between policy and the administration of examinations. On the one hand, the policy document makes no reference to environmental content while, on the other hand, environmental topics were identified in the examination papers reviewed in the study. Table 2, Figure 1 and Graph 1 clearly show the inconsistencies in respect of environmental content in the subject.

In their study, Liell and Bayer (2016) found that learners became active participants in the construction of mathematical and environmental knowledge. In affirmation of this finding, Al-absi (2014) found that an environmental approach in mathematical problem-solving had a positive effect on learners' learning. Moreover, assessment theory serves as a tool for providing feedback to learners after content has been taught (Ghaicha, 2016; Taras, 2009; 2012). The inadequate amount of environmental content found in the examination question papers for

Mathematical Literacy reviewed in this study would imply that learners were only engaged in acquiring mathematical knowledge, denying them an opportunity to learn about environmental issues.

8. Conclusion

The paper contributes to the fields of EE and Mathematical Literacy with respect to policy versus practice, specifically as far as examinations are concerned. The aim of the paper was to answer the following research question: *To what extent did Grade 12 Mathematical Literacy National Senior Certificate examination papers assess environmental content from 2014 to 2018?*

According to the results of the study, the environmental topics that were included in the examination papers varied yearly. There was also a marked difference between the mark allocations in respect of environmental content in the examination papers. However, in each question paper, the mark allocation for environmental content was a low percentage of the total mark allocation. Moreover, the documents reviewed, namely, the Mathematical Literacy CAPS policy, the ATP and the examination question papers from 2014 to 2018 revealed disparities in environmental topics. These disparities have implications for learners' environmental awareness.

An appeal is made to policymakers and examiners to address the inconsistency between the Mathematical Literacy CAPS and the examination policy to ensure sufficient marks are allocated to environmental topics in examination papers. In the current situation, the Mathematical Literacy CAPS policy is quiet on marks allocated to environmental topics. It is recommended that future studies examine factors that contribute to the misalignment of policy and practice in Mathematical Literacy syllabi.

LIMITATIONS OF THE STUDY

This study focused on one school subject in Grade 12 and involved the use of qualitative methods, secondary data and purposive sampling. Therefore, the results of the study cannot be generalised to other school subjects.

REFERENCES

Al-absi, M. M. (2014). The effect of learning with the environmental approach on the third

graders' ability of mathematics problem solving. *Journal of Educational and Psychological Studies, 8*(4), 627-636.

Amankwah-Poku, M., & Ofori, G. (2020). "People have been paid to sweep the place!" – Exploring the antecedents of littering behaviour in Ghana. *Ghana Social Science Journal,* 17(1), 93-107.

Blackley, S., & Howell, J. (2015). A STEM narrative: 15 years in the making. *Australian Journal of Teacher Education, 40*(7), 102-112.

Bertram, C., & Christiansen, I. (2020). *Understanding research: An introduction to reading Research* (2nd ed.). Pretoria: Van Schaik.

Bhamjee, M., & Rashied, N. (2018). A guide to online assessment in large engineering design classrooms. Rethinking teaching and learning in the 21st Century. Proceedings of the 5th South Africa International Conference on Education, South Africa, Manhattan Hotel, Pretoria, 17-19 September, pp. 395-406.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27-40.

Davis, C. (2014). The research rationale. In F. Plooy-Cilliers, C. Davis & R. Bezuidenhout (Eds.), *Research matters* (7th ed.), pp. 92-99. Cape Town: Juta and Company Ltd.

Debba, R. (2011). *An exploration of the strategies used by Grade 12 mathematical literacy learners when answering mathematical literacy examination questions based on a variety of real-life contexts*. MEd dissertation. Durban: University of KwaZulu-Natal.

Department of Basic Education. (2011). *Curriculum and Assessment Policy Statement. Further Education and Training Phase Grades 10-12: Mathematical Literacy*. Pretoria: Department of Education.

Department of Education. (2003). *National Curriculum Statement Grades 10-12 (General): Mathematical Literacy*. Pretoria: Department of Education.

Dreyer, J., & Loubser, C. P. (Ed.). (2014). Curriculum development, teaching and learning for the environment. In C. P. Loubser (Ed.), *Environmental education and education for sustainability: Some South African perspectives* (2nd ed.), pp. 145-178. Pretoria: Van Schaik.

Fundisa for Change. (2013). *Introductory core text*. Grahamstown: Environmental Learning Research Centre, Rhodes University.

Garzón, A., Montes, M., & Cara, B. (2019). Environmental education and mathematics to raising awareness in the young population about the use of plastic. Proceedings of the ICERI2019 Conference, Seville, Spain, 11-13 November, pp. 8371-8375.

Ghaicha, A. (2016). Theoretical framework for educational assessment: A synoptic review. *Journal of Education and Practice, 7*(24), 212-231.

Le Roux, C. (2014). Environmental education research. In C. P. Loubser (Ed.), *Environmental education and education for sustainability: Some South African perspectives* (2nd ed.), pp. 199-224. Pretoria: Van Schaik.

Liell, M., & Bayer, A. (2016). Problem solving with environmental themes in Math classes. *Acta Scientiae, 18*(3), 692-706.

Litner, M. (2016). *The role of environmental education in the Ontario elementary math curriculum*. MEd dissertation. Ontario: University of Toronto.

Matsekoleng, T. K. (2017). *Learners' environmental awareness, effects on home and school practices towards littering: An action research case*. MEd dissertation. Pretoria: University of South Africa.

McMillan, J. H., & Schumacher, S. (2010). *Research in education – evidence-based inquiry* (7th ed.). International edition. Boston: Pearson Education Inc.

Msezane, S. B. (2017a). A delineation of the alignment of environmental topics coverage in the policy and examination: A content analysis of policy versus examinations. *Ecology, Environment & Conservation, 23*(4), 185-194.

Msezane, S. B. (2017b). An analysis of the policy coverage and examination of environmental-impact topics. *Southern African Journal of Environmental Education, 33*, 39-51.

Nisbet, S., Hurley, G., & Weldon, E. (2006). Population growth rates: Connecting mathematics to studies of society and the environment. *Australian Mathematics Teacher, 63*(3), 1-14.

North, M. (2010). *How mathematically literate are the matriculants of 2008? A critical analysis of the 2008 Grade 12 Mathematical Literacy examinations*. Conference Paper: AMESA 2010.

Renert, M. (2011). Mathematics for life: Sustainable mathematics education. *Learning of Mathematics, 31*(1), 20-26.

Republic of South Africa. (1996). *Constitution of the Republic of South Africa,* Act 108 of 1996. Pretoria: Government Printer.

Taras, M. (2009). Summative assessment: The missing link for formative assessment. *Journal of Further and Higher Education, 33*(1), 57-69.

Taras, M. (2012). Assessing assessment theories. *Online Educational Research Journal, 3*(12), 1-13.