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Geographic Information Systems Assessment Implementation in the Further Education and Training Phase in Schools

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ABSTRACT

National Senior Certificate (NSC) diagnostic reports for matric results indicate that learners perform poorly in Geographic Information Systems (GIS). While GIS education has made significant strides in recent years, there is a need for research that explores Geography teachers' perceptions of GIS assessment. This paper explored the perceptions of Geography teachers in implementing GIS assessment in the Further Education and Training (FET) phase in South African schools. This research is underpinned by the constructivism theory by Piaget, which argues that learners actively construct knowledge and understanding of the world through their interactions with their environment. This paper focused on the classroom environment because that is where Geography learners are taught GIS. Learners must be exposed to different teaching and learning methods that assist them in utilising their existing knowledge to construct an understanding of the world around them. Particularly, Geography learners must be taught GIS thoroughly to apply the knowledge and skills they have learnt in real situations and be better prepared for assessment. The qualitative research design and a case study methodology were used to frame this research. Six teachers from three schools were chosen to participate in this study. Semi-structured interviews were used to generate data. The findings of this study indicated that Geography teachers teach GIS for assessment. The teachers stated that teaching learners using past year papers is ineffective because the Department of Basic Education (DBE) often changes the GIS content and skills they test. Hence, it is difficult to predict what they will assess; the DBE does not provide proper guidelines on how GIS content and skills would be tested. It is recommended that there must be a collaboration between the DBE and higher education institutions to offer Geography teachers guidance and training on GIS content, skills, and assessment.

Keywords: *Geography, Geographic Information Systems (GIS), Assessment, Secondary school education.*

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INTRODUCTION

The South African basic education curriculum (Curriculum and Assessment Policy Statement) mandates the teaching of GIS in the FET phase in secondary schools. The introduction of GIS in South

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African secondary schooling in 2006 was meant to improve the teaching and learning of Geography.[1] However, it has brought many challenges to Geography teachers due to inadequate training and the lack of resources such as hardware and GIS software. Due to the latter, teachers have adopted different coping strategies to prepare Geography learners for the grade twelve exit examinations, such as teaching for assessment. The DBE is responsible for setting grade twelve exit examinations yearly, and Umalusi is responsible for the quality assurance of assessment.[2] The DBE releases NSC diagnostic reports every year which analyse learner performance in each question of a specific subject. Geography, one of the DBE's subjects, is also subject to scrutiny.

Over the last five years, the NSC diagnostic reports from the DBE indicate that Geography learners have performed poorly in the GIS section since its introduction. Firstly, the NSC diagnostic report for the grade twelve 2018 examination revealed that in Paper Two, learners could not explain the relevance of using vector data on a topographic map in Question 4.1.2. Furthermore, many learners could not suggest ways in which the scale of the topographic map and orthophoto map could be manipulated to integrate the two maps.[3] The report further states that data manipulation and integration concepts are foreign to many candidates. Secondly, the NSC diagnostic report for grade twelve 2019 examinations noted that learners struggled to understand the concepts of buffering and data integration.[4] Thirdly, the NSC diagnostic report for grade twelve 2020 examinations cited learners that lacked understanding of the data layer concept as they gave examples of data layers instead of stating what it is.[5] Lastly, the 2022 NSC diagnostic report said learners could not differentiate between a point and polygon feature and gave building instead of cultivated land as an answer.[6] These findings indicate that GIS is not taught correctly in many secondary schools. Thus, many learners are performing poorly.

The focus of the NSC diagnostic reports is on the learners' responses to the exam questions. The reports help to better understand learners' strengths and weaknesses in GIS content and skills. But they do not tell the teachers' perspective regarding GIS assessment implementation. This is why this research aimed to explore the perceptions of Geography teachers in implementing GIS assessment in the FET phase in the UGU district, Kwa-Zulu Natal. It gave teachers a platform to voice how they viewed GIS assessment implementation in the grade 12 exit examinations. Teachers are responsible for teaching GIS content and skills to learners and preparing them for assessment; therefore, their perspectives are crucial.

LITERATURE REVIEW

GIS has become integral to various disciplines, such as Geography, environmental science, urban planning, and beyond.[7] The education sector also decided to include this new technology in its curriculum. Globally, schools have been integrating GIS into their curriculum since 1994.[8] Adopting GIS in schools is a process; the contextual factors of different schools either facilitate or hinder the process. In South Africa, numerous scholars have identified several challenges in implementing GIS in secondary schools. Fleischmann and van der Westhuizen note the shortage of experienced teachers,

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[1] Elfrieda Marie-Louise Fleischmann and Christo P Van der Westhuizen, "The Interactive-GIS-Tutor (IGIST): An Option for GIS Teaching in Resource-Poor South African Schools," *South African Geographical Journal= Suid-Afrikaanse Geografiese Tydskrif* 99, no. 1 (2017): 68–85; Lorraine M Innes, "South African School Geography: Underpinning the Foundation of Geospatial Competence," *South African Journal of Geomatics* 1, no. 1 (2012): 77–91.

[2] Department of Basic Education, *National Senior Certificate Examination Report* (Pretoria: Government Printers, 2021).

[3] Department of Basic Education, *National Senior Certificate Examination Report*, 2021.

[4] Department of Basic Education, *National Senior Certificate Examination Report* (Pretoria: Government Printers, 2019).

[5] Department of Basic Education, *National Senior Certificate Examination Report* (Pretoria: Government Printers, 2020).

[6] Department of Basic Education, *National Senior Certificate Examination Report* (Pretoria: Government Printers, 2022).

[7] Krzysztof Janowicz et al., "GeoAI: Spatially Explicit Artificial Intelligence Techniques for Geographic Knowledge Discovery and Beyond," *International Journal of Geographical Information Science* (Taylor & Francis, 2020).

[8] Joseph J. Kerski, "The Implementation and Effectiveness of Geographic Information Systems Technology and Methods in Secondary Education," *Journal of Geography* 102, no. 3 (May 2003): 128–37, https://doi.org/10.1080/00221340308978534; Thomas Ray Baker, *The Effects of Geographic Information System (GIS) Technologies on Students' Attitudes, Self-Efficacy, and Achievement in Middle School Science Classrooms* (University of Kansas, 2002).

lack of knowledge and technical expertise, the unwillingness of teachers to change their teaching mode, a shortage of funds, and inadequate resources.[9] Similarly, Mkhongi and Musakwa note that the full potential of GIS education has been restricted by challenges such as inadequate resources and limited exposure of learners to GIS practicals.[10]

One of the significant challenges of implementing GIS is the lack of resources in schools.[11] Thus many teachers teach about GIS. Schools without the required hardware and software teach textbook-based GIS theory without exposing learners to GIS practicals.[12] Hence, the latter authors suggested paper-based GIS (PBGIS) as an alternative to GIS education for resource-poor schools. However, Mkhize reveals that in school, there is inadequate teacher training, teachers are unsure about the resources required to teach PBGIS, lack of teaching time, the complexity of PBGIS concepts, and improper PBGIS examination setting.[13] Again, in a different study, Mkhize reveals that Geography subject advisors (GSAs) organise PBGIS workshops for teachers to mitigate the challenges teachers face when implementing PBGIS in schools.[14] However, certain teachers do not attend workshops. The study also revealed that GSAs rely on experienced Geography teachers that are knowledgeable about PBGIS to assist in workshops by teaching others. Mkhize proposed that the DBE, in association with universities, must train teachers and provide resources, support teachers by reviewing the time allocated in the Annual Teaching Plan (ATP) for teaching GIS, engage teachers about ways to simplify GIS concepts when teaching, and guide teachers on the approaches that must be used when teaching GIS.[15]

Few studies have been conducted that addressed the issue of GIS assessment implementation in schools. Ahiaku and Mncube's study investigated the cause of the poor performance; the researcher explored grade 12 teachers' perceptions of some of the challenges that could affect the academic performance of grade 12 Geography learners.[16] The findings of the study indicated that some teachers were not taught GIS at school. As a result, while others disliked and struggled to teach GIS to learners, others did not even teach the section but duplicated copies of GIS notes for learners to learn by themselves. This led to the poor performance of learners in the GIS section. Likewise, Manik put it that learners in disadvantaged schools where resources (teacher training and tools) are absent/inadequate are taught 'about GIS' and not 'through GIS,' undermining teaching, learning, and assessment in GIS.[17] In another study, Hlatywayo and Manik point out that matric pass rates in the GIS section of Geography are low.[18] The study also revealed that most teachers used multiple teaching

[9] Fleischmann and Van der Westhuizen, "The Interactive-GIS-Tutor (IGIST): An Option for GIS Teaching in Resource-Poor South African Schools."
[10] Felicity Aphiwe Mkhongi and Walter Musakwa, "Perspectives of GIS Education in High Schools: An Evaluation of UMgungundlovu District, KwaZulu-Natal, South Africa," *Education Sciences* 10, no. 5 (May 7, 2020): 131, https://doi.org/10.3390/educsci10050131.
[11] Fleischmann and Van der Westhuizen, "The Interactive-GIS-Tutor (IGIST): An Option for GIS Teaching in Resource-Poor South African Schools."
[12] Gregory Breetzke, Sanet Eksteen, and Erika Pretorius, "Based GIS: A Practical Answer to the Implementation of GIS Education into Resource-Poor Schools in South Africa," *Journal of Geography* 110, no. 4 (2011): 148–57.
[13] Thulasizwe Fredrick Mkhize, "Teachers' Perceptions of Paper-Based GIS Implementation in The Rural Learning Ecology," *Journal of Curriculum Studies Research* 5, no. 2 (June 18, 2023): 118–35, https://doi.org/10.46303/jcsr.2023.20.
[14] Thulasizwe Fredrick Mkhize, "Experiences of the Geography Subject Advisors in the Implementation of Geographic Information Systems in KwaZulu-Natal Province," *Research in Social Sciences and Technology* 8, no. 1 (April 25, 2023): 63–73, https://doi.org/10.46303/ressat.2023.5.
[15] Mkhize, "Teachers' Perceptions of Paper-Based GIS Implementation in The Rural Learning Ecology."
[16] Philip K.A. Ahiaku and Dumsani W. Mncube, "Geography Educators'Perceptions of Learner Performance in Grade 12 Geography in Public Schools," *Alternation: Interdisciplinary Journal for the Study of the Arts and Humanities in Southern Africa* SP, no. 21 (December 1, 2018): 68–90, https://doi.org/10.29086/2519-5476/2018/sp21a4.
[17] Sadhana Manik, "Focusing on Quality, Forgetting Inequalities: Assessment Within GIS in the Geography Curriculum and Assessment Policy Statement (CAPS) in South Africa," in *Assessment in Geographical Education: An International Perspective*, 2022, 153–66, https://doi.org/10.1007/978-3-030-95139-9_8.
[18] Johane Hlatywayo and Sadhana Manik, "Teaching Geographic Information Systems (GIS) in South African High Schools in the Frances Baard District," *Universal Journal of Educational Research* 10, no. 5 (May 2022): 334–48, https://doi.org/10.13189/ujer.2022.100503.

approaches, which were mainly teacher-centred. These included lecturing, explanation, and questioning at the expense of learner-centred approaches that were fundamental for GIS instruction.[19] These methods were used due to challenges that teachers faced in GIS teaching, including a lack of physical resources to teach GIS, large classes, a lack of proper training, and time constraints. They propose that GIS topics should be taught in GIS laboratories, where learners are taught both theory and its practical application. In this way, they believe that GIS assessment performance in schools might improve.

In a different study conducted in KwaZulu-Natal, Zondi, and Tarisayi wrote a study on a learner perspective on the implementation of GIS in selected schools in KwaZulu-Natal province. A group of 50 learners (10 learners per school) were purposively selected to participate in the study. Under the additional observations of the findings section of their study, the findings revealed that there was an admission by learners that they were not well versed with GIS but passed Geography examinations which included questions on GIS.[20] The study also revealed that grade 12 learners were being asked data recall questions which can be used to explain why learners were passing Geography examinations without a proper understanding of GIS. Data recall questions mostly require learners to remember information without necessarily putting it into use.[21] Therefore, subject specialists should strengthen teachers' knowledge through in-service programmes and prioritise mapwork skills and GIS.[22]

While the above studies have made contributions to the study of GIS assessment performance and the teaching methods that teachers use to teach GIS, none of the studies has focused on the GIS assessment implementation in the FET phase in schools. Although Zondi and Tarisayi have attempted to focus on GIS assessment from a learner perspective, the aim of the paper was to explore the implementation of GIS in selected schools in KwaZulu Natal. The assessment of GIS is only found towards the end of the paper under the additional observations of the findings. This study is unique in the sense that it argues that there must be a collaboration between DBE, examiners, and higher education to provide Geography teachers with guidance and training on GIS and GIS assessment. Teachers should teach the GIS concepts and the application and relevance thereof in real-world situations to improve the poor performance in the GIS section.

In light of this, the study aims to explore Geography teachers' perceptions of GIS assessment implementation in the FET phase in schools and suggest the DBE, examiner, and higher education would mitigate the challenges geographers are facing with regard to the implementation of GIS assessment.

THEORETICAL FRAMEWORK

The study is underpinned by constructivism theory as the underlying theoretical framework that was proposed by Piaget.[23] Constructivism focuses on the construction of knowledge than its production. Piaget explains that learners are able to link new knowledge to prior knowledge, thus enabling them to construct knowledge and acquire it.[24] This, however, helps learners to extend their way of thinking and develop their cognitive level beyond the information provided to them. The researchers allowed multiple meanings of participants, thus approaching the reality of the implementation of GIS assessment in classroom practice from the constructivist point of view. Christie argues that it is an experience that helps one to construct and use new knowledge in a given context. Hence learning

[19] Hlatywayo and Manik, "Teaching Geographic Information Systems (GIS) in South African High Schools in the Frances Baard District."
[20] Kudzayi S Tarisayi and Thabile A Zondi, "A Learner Perspective on the Implementation of Geographic Information Systems in Selected Schools in KwaZulu-Natal Province," *TD: The Journal for Transdisciplinary Research in Southern Africa* 16, no. 1 (2020): 1–6.
[21] Nancy E Adams, "Bloom's Taxonomy of Cognitive Learning Objectives," *Journal of the Medical Library Association: JMLA* 103, no. 3 (2015): 152.
[22] Ahiaku and Mncube, "Geography Educators' Perceptions of Learner Performance in Grade 12 Geography in Public Schools."
[23] Jean Piaget, *The Construction of Reality in the Child*, vol. 82 (Routledge, 2013).
[24] Piaget, *The Construction of Reality in the Child*.

happens through familiarity.[25] The implementation of GIS assessment at the FET phase in Geography at school aims at the same goal, working through the mind of the learners to be able to apply it in a given assessment and be able to generate new ideas to solve geographical problems that afflict the world in this Fourth Industrial Revolution (4IR). However, proper implementation of GIS assessment by teachers is needed for learners to be able to make sense of the GIS application based on what they know.

Geography examiners are subjected to the support and guidance of teachers and learners to effectively implement and assess the concept of GIS and its application. Incorporating GIS into the curriculum helps develop the learners' cognitive skills, enabling them to easily understand, apply and respond to the questions during summative assessment (examination). The rationale for adopting this theory is that it enables teachers and learners to realise their defined roles while implementing GIS assessment in classroom practice. In support of this assertion, assessment is not unidirectional but rather involves teachers and learners through activities that enhance teaching and learning.[26]

This study sought to explore Geography teachers' perceptions of the implementation of GIS assessment in the FET phase. To this end, the constructivism theory served as a lens to provide insightful elucidation into modalities adopted by Geography examiners when assessing the concept of GIS in the FET phase. By its very nature, the constructivism theory postulates that more knowledgeable people (examiners in this context) should provide a clear guideline on how assessment on GIS will be administered during an examination. Before the actual examination is administered, clear guidance should be given for teachers to tailor and adjust the ongoing teaching and learning of GIS in accordance with a view to improving learners' achievement of the intended goals. The adoption of constructivism theory enabled the researchers to trace the extent to which teaching and learning is recognised within a constructive perspective through interaction with more knowledgeable others (examiners).

METHODOLOGY

A qualitative research design was chosen for this paper. The interpretive paradigm guided the researchers' approach to conducting research. Qualitative research and the interpretive paradigm seemed appropriate for this paper since GIS assessment implementation in the FET phase in schools was participants' lived experiences.[27] The interpretive paradigm's main assumption is that reality is socially constructed and that there are many intangible realities that people construct.[28] In this way, different interpretations from participants were obtained because their realities were not the same. The researchers adopted a case study research methodology because it systematically captured the reality of the teachers' lived experiences of implementing GIS assessment in the FET phase in schools. Purposive sampling was adopted as the sampling strategy to recruit participants. Purposive sampling is representative and non-random; the selected participants have the needed information.[29] The researchers chose six experienced Geography teachers to gain in-depth knowledge regarding teachers' perceptions of implementing GIS assessment in the FET phase in schools.[30] Semi-structured interviews were used to generate; open-ended questions enabled the researchers to ask follow-up why

[25] Christie, A. "Constructivism and its implications for educators' http://alicechristie con/ed tech/learning/constructivism/index." 2005.
[26] Siobhan Leahy et al., "Classroom Assessment: Minute by Minute, Day by Day In Classrooms That Use Assessment to Support Learning, Teachers Continually Adapt Instruction to Meet Student Needs," *Educational Leadership* 63 (January 1, 2005).
[27] David Silverman, "Qualitative Research," *Qualitative Research,* 2020, 1–520.
[28] Carol Bertram and Iben Christiansen, "Understanding Research," *An Introduction to Reading Research. Pretoria: Van Schaik Publishers,* 2014.
[29] Samar Rahi, "Research Design and Methods: A Systematic Review of Research Paradigms, Sampling Issues and Instruments Development," *International Journal of Economics & Management Sciences* 06, no. 02 (2017), https://doi.org/10.4172/2162-6359.1000403.
[30] Rahi, "Research Design and Methods: A Systematic Review of Research Paradigms, Sampling Issues and Instruments Development."

or how questions from the participants.[31] Semi-structured interviews lasted for about thirty to forty minutes for each session; one interview per teacher.[32] The thematic data analysis approach was used to see and make sense of the collective or shared meanings and experiences indicated by the data set. The data was analysed using deductive and inductive approaches. Clarke and Braun's thematic analysis of a six-phase process was adopted for familiarisation, generating initial codes, searching for themes, reviewing potential themes, defining and naming themes, and producing the report of the collected data.[33]

Ethical considerations are important in qualitative research as this approach often intrudes on participants' lives.[34] The principles of research ethics ask that researchers avoid harming participants involved in the process by respecting and considering their needs and interests.[35] Research permission was requested from the DBE, school principals, and research participants to interview Geography teachers in three selected schools within the Province of KwaZulu-Natal. Ethical clearance was granted to conduct this research. The confidentiality of the participants was guaranteed by using pseudonyms for the schools and participants to avoid revealing the individuals' identities.[36] Deductive and inductive thematic analysis approaches were used to address credibility.[37] The conclusions were only drawn from participants of this study and the findings were not generalised to other contexts.[38] Peer debriefing and member checking, and support were solicited from colleagues to check the interpretation of the data (critical peer checks).[39] Verification of the accuracy of what had been reported about participants was requested from participants.[40] The audio-recording device was used to record the interviews. This enabled the production of accurate transcripts.[41]

FINDINGS AND DISCUSSION

This section presents the findings according to the sub-themes that emerged after coding the data. This research had six participants; pseudonyms were used to report the findings. The background details of the participants are as follows: 1) Duncan is a male of thirty years of age. He holds a Bachelor of Education degree specialising in Geography and Life Sciences. He has nine years of teaching experience. 2) Mario is a male of thirty-two years of age. He holds a Bachelor of Education degree specialising in Geography. He has eight years of teaching experience. 3) Billy is a male of twenty-eight years of age. He holds a Bachelor of Education degree specialising in Geography. He has seven years of teaching experience. 4) Amahle is a female of fifty years of age. She holds a Secondary Teachers Diploma specialising in Geography. She has twenty-eight years of teaching experience. 5) Welekazi is a female of forty-five years. She holds a Secondary Teachers Diploma specialising in Geography. She has twenty-three years of teaching experience. 6) Nomathemba is a female of thirty-three years. She holds a Post-Graduate Certificate in Education, specialising in Geography. She has eleven years of teaching experience. The themes derived from the findings are discussed below.

Improper GIS Examination Paper Setting

Duncan and Mario lamented that they are not happy with the way the GIS part is set in the papers. Both participants pointed out that questions set for the examination seem to be asked differently from

[31] Kathrynn A Adams and Eva K McGuire, *Research Methods, Statistics, and Applications* (Sage Publications, 2022).
[32] Adams and McGuire, *Research Methods, Statistics, and Applications*.
[33] Virginia Braun and Victoria Clarke, "Reflecting on Reflexive Thematic Analysis," *Qualitative Research in Sport, Exercise and Health* 11, no. 4 (August 8, 2019): 589–97, https://doi.org/10.1080/2159676X.2019.1628806.
[34] Uwe Flick, "Designing Qualitative Research," *Designing Qualitative Research*, 2018, 1–200.
[35] Shahid N Khan, "Qualitative Research Method: Grounded Theory," *International Journal of Business and Management* 9, no. 11 (2014): 224–33.
[36] Bertram and Christiansen, "Understanding Research."
[37] Braun and Clarke, "Reflecting on Reflexive Thematic Analysis."
[38] Bertram and Christiansen, "Understanding Research."
[39] Peter Rule and John Vaughn. *Your guide to case study research*. Pretoria: van Schaik, 2011.
[40] Rule and Vaughn. *Your guide to case study research*.
[41] Bertram and Christiansen, "Understanding Research."

what is being taught by teachers in the classroom. The examiners do not provide teachers with proper guidance as to how the part will be assessed. Mario added that GIS is not allocated adequate marks in the papers, and this should also be questioned. Duncan, on the other hand, further complained about the complexity in the level of questioning, stating that examiners ask more practical questions, whereas he perceives questioning as something that is supposed to be textbook-based due to the lack of resources in schools. Duncan (semi-structured interview) comments:

> *"… and also, the problem is with the guys in the exam section. When they set questions, they are different from those we teach. They are more practical, whilst they are supposed to be asking questions that are more textbook-based because they have the understanding that the level of technology in our schools is not the same."*

Amahle reveals that the approach examiners use in setting GIS in examinations often causes learners to obtain lower marks in this section compared with any other section. She further commented that in the past, GIS questioning was more straightforward than it has been recently. Therefore, she perceived GIS as requiring a good understanding of English for learners to answer questions successfully. Amahle (semi-structured interview) laments:

> *"Hence, you will find that learners in the map work section…pass questions 1, 2, and 3, but when it comes to question 4, which is GIS, now learners are failing. So, one thing is that when we started GIS, it was simpler. The level of the questions was fine. In terms of level one questions, learners were able to try answering, but now even level one questions are more complex. You need learners who have a better understanding of English as a language."*

Nomathemba advised that guidance provision by examiners is crucial, considering that certain schools lack technological resources and do English as their first additional language. Nomathemba (semi-structured interview) advises:

> *"… When they included GIS, they were supposed to provide specified guidelines to say these are the type of questions that I might ask GIS is not like Geography that had been there for many years. They were supposed to give us the scope that says these are the questions we are going to be asking from taking into account that these learners are disadvantaged in terms of the technology and language."*

Similarly, Welekazi also advised that examiners should seek assistance from Environmental Systems Research Institute (ESRI) in South Africa on how to structure GIS questions. This is because ESRI is the global market leader in GIS software, location intelligence, and mapping.[42] Welekazi also viewed guidance from examiners to Geography teachers as crucial with regard to how the GIS questions are going to be structured. Welekazi also revealed that marks allocated for GIS questions are not adequate: Welekazi (semi-structured interview) laments:

> *"The questions are not asking learners more. When the map work papers are set in March, GIS only covers 5 marks, 16 marks in June, 16 marks in September, and 16 marks in the final examination. I am also not happy with the structuring of questions because what we teach in class is not normally asked in the question papers. They ask very little from what we taught learners in class. Maybe if the examiner could ask for guidance from ESRI South Africa on how to structure questions, it could assist."*

From the above extracts, it is clear that these teachers need proper guidance from examiners regarding how GIS questions will be set. According to the participants, examiners tend to be more practical, whereas Geography teachers in schools rely mainly on textbooks in teaching GIS. The guidance and support that Geography teachers require resonate with the notion of the constructivism theory in the sense that Geography examiners should support and guide teachers so that teachers can support learners with effective ways of dealing with GIS assessment.[43] In addition, one of the problems

[42] Breetzke, Eksteen, and Pretorius, "Based GIS: A Practical Answer to the Implementation of GIS Education into Resource-Poor Schools in South Africa."
[43] Piaget, *The Construction of Reality in the Child*.

identified in South Africa relates to inadequate practical experience in the use of GIS by teachers.[44] Also, GIS is not allocated sufficient marks when tested in question papers. Therefore, Welekazi advised that the examiners should approach ESRI for assistance as they are experts in the field of GIS. ESRI introduced a kind of GIS that was aimed at helping resource-poor schools in South Africa.[45] For this reason, ESRI South Africa would be in a better position to advise examiners on how to structure questions and to focus more on GIS when setting question papers.

Average Learner Performance in GIS

Mario's remarked that his learners perform exceptionally well in the GIS section. However, Amahle lamented that her learners perform poorly in the GIS section. Duncan and Billy revealed that their learners' performance in GIS is satisfactory, but there is still room for improvement. Duncan articulated that his learners may perform better if there is increased availability of resources to support the implementation of the GIS. Duncan (semi-structured interview) echoes:

> *"GIS performance for my learners is not that bad, but I would not say it is where I want it to be. They are performing. However, I feel they are not at the level they could be in if they were more resources."*

Similarly, Billy revealed that there are still areas that require improvement in the teaching and learning of GIS to improve his learners' performance in the section. He also stated that when he started teaching, there were learners who never attempted the GIS section in the exam, but over the years, he has witnessed improvement in how learners do the section. Billy (semi-structured interview) articulates:

> *"It improved, but there is a gap. GIS is 16 marks, so most of them would score more than 7 marks, but I remember when I started teaching in this school, most of them were not even attempting that section of GIS, but now most of them do score above 50% of 16 marks. So, I can say that they have improved."*

Amahle also provided reasons she perceives as hindrances to her learners' performance. She believed that learners lack confidence when answering questions in the examination because they are not taught GIS in detail. Amahle also alluded to the issue of learners focusing more on learning map work calculations at the expense of other sections. As a result, learners' performance in GIS suffers. Amahle (semi-structured interview) expounds:

> *"Because even though they were taught but they were taught the minors of the subject. So, I think they also did not have the confidence. You find that when you take a previous exam question paper that learners have written and asked them the same questions in class, that is where I realise that learners would have been able to answer the questions during the exam because they don't have the confidence. Our learners also back then used to focus on calculations. In a map work question paper of 60 marks, there are only 20 marks for calculations, so their focus was a lot on calculations. So, most learners went to the examination room knowing how to calculate even if you told them that you can still make it even if you didn't know how to calculate."*

In comparison, Mario's response revealed that he was satisfied with his learners' performance. He believes that the reason for the exceptional performance of his learners is that he is good at teaching GIS. He further argued that he teaches learners from lower grades and moves with them to the upper grades. He even teaches for other teachers in his school. Mario (Semi-structured interview) elucidates:

> *"My learners are performing extremely well in GIS because I teach them from grades ten up to grade twelve. I am the one who assists other teachers in teaching GIS in my school. So, learners move from grade to grade with the GIS content I have taught them, and as a result, they perform better."*

[44] Maureen K. Mzuza and Christo P. Van Der Westhuizen, "Review on the State of GIS Application in Secondary Schools in the Southern African Region," *South African Geographical Journal* 101, no. 2 (May 4, 2019): 175–91, https://doi.org/10.1080/03736245.2019.1579110.

[45] Breetzke, Eksteen, and Pretorius, "Based GIS: A Practical Answer to the Implementation of GIS Education into Resource-Poor Schools in South Africa."

Stating different views from the above participants, Nomathemba revealed that her learners perform poorly in GIS and that this is caused by a lack of resources in the rural learning ecologies. As a result, she ends up having to make learners visualise by utilising their imagination to understand certain GIS concepts. Therefore, this creates challenges for learners. Nomathemba (semi-structured interview) articulates:

> *"They are not performing well. I think the reason why my learners are not performing well is that I say things that will make my learners imagine and think deeply about something they have never seen before. We are also using terms that learners have never used before or heard about before. Learners have to imagine, and if they fail, it means that they will not know what we are actually talking about. It is difficult to imagine something that does not even exist in your mind. To imagine GIS, it is very challenging for learners, and this leads to poor performance."*

From the extracts above, it is evident that most participants are unhappy with learner performance in GIS. For two participants, although learners performed satisfactorily in GIS, the teachers felt that the results might have improved if learners were provided with resources and in-depth knowledge about GIS. This is consistent with the diagnostic reports for the NSC examination, which revealed that Geography learners' performance in GIS indicates that they lack fundamental GIS knowledge.[46] It is also evident from one participant's response that her learners were performing poorly in the GIS section. It was clear that she perceived the lack of resources as the main problem of her learners' poor performance. However, it was also clear from one participant's response that there are teachers who achieve great learner performance in GIS in schools.

RECOMMENDATIONS

This study proposes that there must be a collaboration between DBE, examiners, and higher education institutions to provide Geography teachers with guidance and training on GIS. Firstly, teachers should be provided with clear GIS exam guidelines. The examination guidelines will ensure that teachers are preparing learners thoroughly on GIS aspects that are going to be tested in the exam. Furthermore, the examination guidelines should also provide tips to teachers and learners as to how GIS is supposed to be taught and learnt so that the process of teaching and learning aligns with the Papers set on GIS. Secondly, the DBE should liaise with Geography subject advisors to facilitate the sharing amongst teachers on the implementation of GIS and GIS assessment in schools through platforms such as workshops. Thirdly, higher education institutions train student teachers on GIS and its assessment implementation in such a way that they become knowledgeable of how they should teach GIS to learners during teaching practice and when they become certified teachers. Lastly, teachers should teach not only the GIS concepts but also the application and relevance thereof in real-world situations.

CONCLUSION

This study concludes that Geography teachers are not pleased with the way the GIS section is assessed in the examination. Teachers feel that examiners set questions that differ from what they have taught. The examiners do not provide Geography teachers with proper guidance as to how GIS will be assessed. As a result, teachers are unable to provide effective assessment guidelines to learners when they teach GIS. This, in turn, disadvantages learners when they write external examinations. The study also revealed that learners' performance in the GIS section is average because they are not taught GIS practically, so they rely on their imagination to make sense of GIS.

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