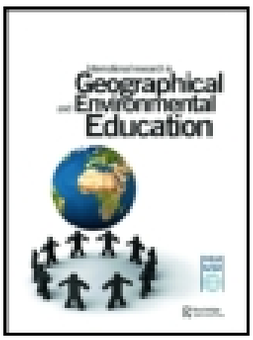

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# Inclusion of GIS in student teacher training and its significance in higher education in southern African countries

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**ABSTRACT**

Studies have been carried out on the use of geographical information systems (GIS) in teacher training, especially in the developed countries. In southern African countries, nevertheless, the scenario is different because GIS education appears to be a rather new field of study. This study therefore used systematic review to collect data. This method assists in finding and understanding the outcomes of other research conducted within the same field of study. The results reveal that only three countries (South Africa, Botswana and Malawi) teach GIS at their teacher-training universities and secondary schools. In Lesotho, GIS are only taught in secondary schools. In other countries, such as Zambia, Namibia and Zimbabwe, GIS are not taught at all at teacher-training universities and secondary schools but only at universities or departments that do not train teachers. There is no inclusion of GIS at the universities in Angola, Mozambique, Swaziland and Lesotho. Countries that use GIS have demonstrated that the course helps with decision-making, critical thinking and inquiry-based and learner-centred learning, which have the ability to improve the quality of education. Educators and policy-makers are encouraged to reinforce the inclusion of GIS and use of relevant pedagogical skills in teacher-training universities.

**KEYWORDS**

Southern Africa; geography; geographical information systems (GIS); technology; motivation tool

## 1. Introduction

Teachers perform a major role in bringing innovations into the educational system and the world (Collins & Mitchell, 2019; Curtis, 2019; Höhnle, Fögele, Mehren, & Schubert, 2016; Maude, 2018). The use of geographic information systems (GIS) has been imparted in many higher learning institutions as part of geography degrees to induce the use thereof as one of the technological teaching tools as well as for career purposes since the world is changing technologically (Bearman, Munday, & McAvoy, 2015; Cebesoy, 2019; Whyatt, Clark, & Davies, 2011). In this technological world, teaching and learning are focusing on problem-solving and GIScience or

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computational science, among others, to flourish in a scientific field (Shook et al., 2019). For example, currently most developed countries, including the USA and Canada, are progressing in techniques for intensifying the teaching of web mapping in higher education (Collins & Mitchell, 2019; Sack, 2018). Southern African countries, though trailing behind, are also moving forward in terms of technologies using the geospatial web (Amade, Painho, & Oliveira, 2018; Mzuza & Van der Westhuizen, 2019a; Van der Westhuizen & Golightly, 2018).

Studies reveal that learning through GIS and with GIS assists graduates in attaining skills such as spatial thinking, planning and environmental awareness (AP® GIS&T Study Group, 2018; Hong, 2017; Jakab, Ševcík, & Grežo, 2017; Kingi & Kalai, 2018; Mzuza & Van der Westhuizen, 2019b; Sinha et al., 2017). Teaching and learning through or with GIS imply the inclusion of some aspects of GIS (e.g. maps) when teaching or learning some subjects such as geography, social studies and many others, and facilitate the understanding of some practices of presenting and analysing geographic information (Guan, Wilson, & Knowles, 2019; Kerski, 1999). In recent years, academic researchers have been investigating how teachers are being trained in GIS, whether in pre-service or in-service training, and the impact of school amenities on the academic motivation and achievement of students and teachers in the education system (AP® GIS&T Study Group, 2018; Höhnle et al., 2016; Hong, 2017; Jakab et al., 2017; Kingi & Kalai, 2018; Mitchell, Roy, Fritch, & Wood, 2018; Sinha et al., 2017).

One of the factors that contribute to students' or teachers' achievement in education is motivation (Matoke, Okibo, & Nyamongo, 2015), which is defined as a driver of students or teachers to attain high levels of performance and overpower obstacles in the way of change (West, 2003). Motivation is also defined as a process that stimulates and orientates the performance of students or teachers towards the achievement of planned goals (Suslu, 2006). It is argued that students are mainly intrinsically motivated when they are interested in understanding content, other than just memorising it to attain good grades (Suslu, 2006).

GIS are among the motivational amenities or tools for supporting geographical and other environmental education (Hammond et al., 2018; West, 2003). For example, in educational settings, geospatial technologies offer a set of different mapping tools as learning technologies (Hammond et al., 2018; Sinha et al., 2017). A study (Xie & Reider, 2014) that was conducted in the USA involving a combination of two technologies – GIS and information assurance (IA) – is a typical example. Some of the goals of that project were to equip teachers with resources for motivating their students to take the courses and develop, implement, learn and assess involvement that inspires K-12 students to develop interest while pursuing the courses. The results indicated an increased interest in both students and teachers who were stimulated or motivated in science subjects. The students showed growth in every area covered in the surveys, including dispositions about all of the subjects attended. The power that lies in the use of particular teaching and learning tools is demonstrated in these studies.

The mode through which the tool is used, nevertheless, also matters, and this can motivate or demotivate students (Hammond et al., 2018). As a teaching and learning tool in both classroom and fieldwork, GIS need to be simplified for both teachers

and students who may not be used to working with databases and software, especially those taking non-geographic courses (Hammond et al., 2018; Riihelä & Mäki, 2015; Xie & Reider, 2014). It is also argued that there is a need to develop the appropriate means of using GIS as a tool to encourage or motivate students. For example, GIS software should not seem threatening, and teachers should be able to acquire the basic features of the tool within 1–2 h. There is also a need to pre-process geospatial data to be used in the GIS and for the data to be incorporated innately (Hammond et al., 2018; Riihelä & Mäki, 2015; Xie & Reider, 2014). In the USA, social studies teachers were involved in the procedure of developing GIS instructional materials for their classes, known as the "user-centred design" (UCD) (Hong, 2014), in which two free Web-based GIS applications – ArcGIS Explorer Online and Google Earth – were used to develop teaching and learning resources. The results show that the teachers were comfortable, able and happy to use the developed teaching materials in their classrooms (Hammond et al., 2018; Hong, 2014).

## 2. Problem statement

Although some studies have been conducted globally on the use of GIS as a tool in the teaching and learning arena, no study has been done to explain how GIS are used as a tool to train student teachers in higher education in the southern African region as a whole. This review article, therefore, aims to (i) document and analyse the inclusion of GIS and how GIS has been used as a tool in teacher-training universities in the southern African countries and (ii) discuss the significance of using GIS as a tool in the education system.

Knowledge of the application of GIS as a training tool in countries outside southern Africa is indispensable in order to understand the magnitude of the benefits thereof as a teaching and learning tool that can later be applied or adapted in the region.

## 3. Conceptual framework

The first concept reviewed in the article is the inclusion and use of GIS in teacher-training universities of some countries globally. This will help to understand how some teacher-training universities are performing in terms of GIS inclusion in teacher-training universities. Second, inclusion of GIS in teacher-training universities in the southern African countries will be discussed. Countries which include GIS in their teacher-training universities will be listed against those which do not include GIS. Thereafter benefits of teaching GIS or through GIS at university level will be discussed.

## 4. Methodology and methods

A systematic review of information was done to respond to all our research questions. For example, information on how GIS as a tool has been used in higher education in the southern African countries was collected from peer-reviewed empirical studies in

the field of pre-service teachers training on GIS education. According to Salam, Iskandar, Ibrahim, and Farooq (2019), this tactic of using systematic review helps to find and appreciate the results of most studies conducted within the same field of study. Systematic review values other researchers' outcomes particularly those who are specialists in the field (Hart, 2018). In this case, we concentrated on experts in using GIS as a tool in pre-service teachers training in higher learning institutions. University yearbooks were also used for source related information. All teacher-training universities in southern African countries were purposely selected for the study. This was done to find which teacher-training universities include GIS in their curriculum. Data from developed countries and other developing countries were selected randomly, depending on the availability of information online. The results of this review paper may be affected by the unavailability of online information, but phone calls and email correspondence were used to contact various universities to make sure we have the correct information. In addition, some universities were contacted to confirm if they include GIS in their teacher education or not to solve this problem. How GIS is used as a tool in higher education of other countries outside southern region was also documented for better understanding of what is happening in other countries especially developed countries. Last, we discussed the significance of using GIS as a tool in the education system.

## 5. Inclusion of GIS in teacher-training universities of some countries globally

GIS have been included in teacher-training universities in several countries in the world, regardless the level of development, including Finland, the USA, Malaysia, Rwanda, Tanzania, Italy and many others (Collins, 2018; Curtis, 2019; Hammond et al., 2018; Hsu, Tsai, & Chen, 2018; Johansson, 2003; Riihelä & Mäki, 2015; Schlemper, Stewart, Shetty, & Czajkowski, 2018; Singh, Rathakrishnan, Sharif, Talin, & Eboy, 2016; Sinha et al., 2017). In Finland, teaching about and teaching with GIS had been introduced in the curriculum from basic compulsory education through secondary education to university level. For example, Riihelä and Mäki (2015) observed that teaching *about* GIS technology focuses on methodological issues of geospatial tools, while teaching *with* GIS skills emphasises the use of GIS as a motivating tool for studying geography and solving geographical problems. Geography student teachers at teacher-training universities in Finland learn GIS, including all contents thereof as a requirement to be covered at secondary school level. They also need, as a further requirement, to have a master's degree. GIS were integrated into the geography course at secondary schools in 2002 in Finland as a motivating tool to gather regional data and develop thematic maps (Johansson, 2003; Virranmäki, Valta-Hulkkonen, & Rusanen, 2019). This analogy explains and underpins the need to upgrade the requirements of geography student teachers to learn all of the secondary school GIS content for the award of a master's degree. These reforms also demanded geography teachers' in-service training nationwide (Johansson, 2003; Riihelä & Mäki, 2015).

Some studies conducted in the USA also revealed that GIS were one of the tools that helped to motivate students to learn, acquire spatial thinking expertise and

appreciate the world and become part of problem-solving (Bednarz, 2004; Collins, 2018; Hammond et al., 2018; Hsu et al., 2018; Schlemper et al., 2018). A study done in Tanzania demonstrated that using participatory GIS (PGIS) as a platform for geographic education motivated the learners to develop an interest in community development skills. Furthermore, the students were also established in the geospatial geographical field knowledge (Sinha et al., 2017).

## 6. Inclusion of GIS in teacher-training universities in the southern African countries

The southern African region has 10 countries which are also part of the Southern African Development Community (SADC). These countries are Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe (see Figure 1).

Some countries teach GIS at both university and secondary school level, and others only in secondary schools, while others have GIS at neither secondary nor university level (see Table 1) (Mzuza & Van der Westhuizen, 2019a). Countries where GIS are taught in universities (teaching students who will become secondary school teachers) and secondary schools include South Africa, Botswana and Malawi (see Table 1) (Beyers, 2018; MIE, 2018; Tabulawa, 2002; Thomas, 2014; University of Botswana, 2018a; University of Malawi, 2018; UNILIA, 2018). In Lesotho, GIS are only taught in secondary schools as part of the geography course but are not included in the

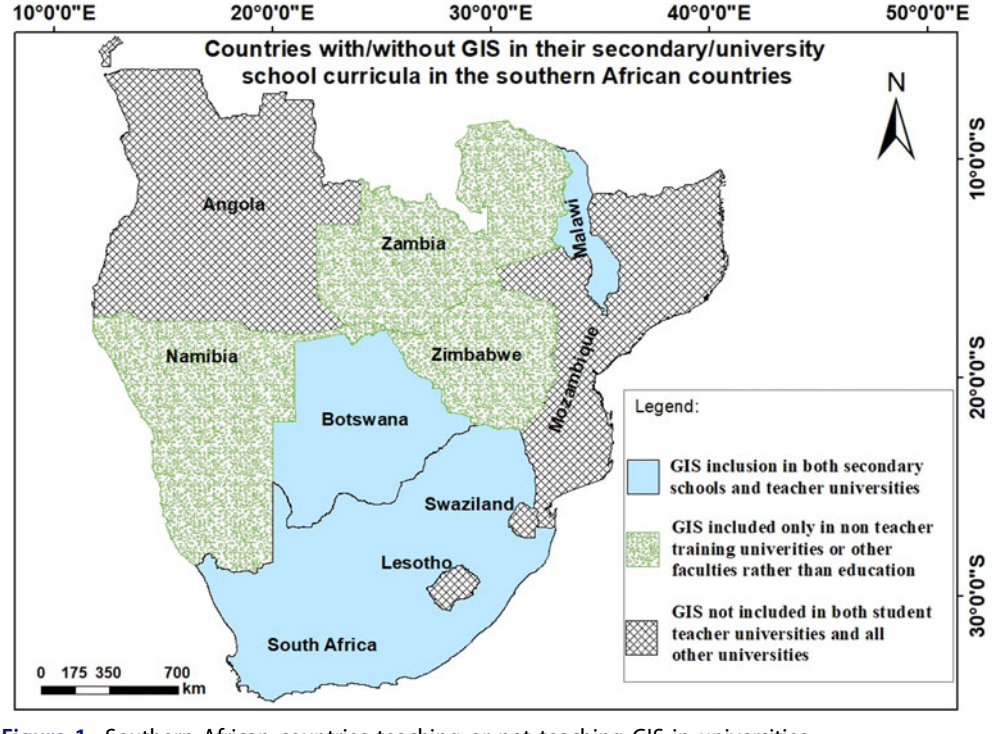


**Figure 1.** Southern African countries teaching or not teaching GIS in universities.

**Table 1.** Countries which include GIS in both teacher universities and secondary schools (√), in non-teacher-training universities and secondary schools (*) and not included neither in universities nor secondary schools (X).

| Countries | GIS in both teacher training universities and secondary schools | GIS included in non-teacher training universities and secondary schools | GIS not included neither in universities nor secondary schools |
|---|---|---|---|
| Botswana | √ | | |
| South Africa | √ | | |
| Malawi | √ | | |
| Namibia | | * | |
| Zambia | | * | |
| Zimbabwe | | * | |
| Angola | | | X |
| Lesotho | | | X |
| Mozambique | | | X |
| Swaziland | | | X |

curriculum as a standalone course (MOET, 2009; Raselimo, 2017). Countries that teach GIS neither at teacher-training universities nor at secondary schools are Angola, Mozambique, Namibia, Swaziland, Zambia and Zimbabwe (Table 1). There was no response from countries that were contacted to confirm whether GIS were or were not part of their education curriculum, except for Namibia that admitted the absence of the GIS course in its curriculum (Mzuza & Van der Westhuizen, 2019a).

South Africa is one of the countries that teaches through GIS and with GIS as a tool at both secondary school and university level (Beyers, 2018; Breetzke, Eksteen, & Pretorius, 2011; Van der Westhuizen & Golightly, 2018). Some of the universities in South Africa that teach and use GIS as a teaching and learning tool are the University of the Witwatersrand, the University of Johannesburg, the North-West University (Potchefstroom Campus), Nelson Mandela Metropolitan University, Cape Town University, Pretoria University and Rhodes University (Beyers, 2018).

At the undergraduate level, courses in the introduction to GIS and the applications of GIS are taught, where students apply GIS to solve geographical or environmental problems, while at post-graduate level, students analyse GIS and apply GIS in solving problems (Beyers, 2018). GIS are a strong motivation tool, especially when it is used to solve problems (Jakab et al., 2017). In South African secondary schools, GIS are a helpful tool from Grade 10 to Grade 12 (Breetzke et al., 2011; Fleischmann, 2012; Van der Westhuizen & Golightly, 2018). A study conducted in South Africa on the feasibility of an educationally orientated Interactive-GIS-Tutor (IGIST) application within the Further Education and Training Phase in geography also confirmed that GIS can be used as a motivation tool both to train teachers and to assist learners to understand the subject content easily (Fleischmann, 2012). A study in South Africa also demonstrated the potential for the use of GIS as a spatial motivating tool in promoting the usage of innovative technologies for understanding and solving the problems of the world (Van der Westhuizen & Golightly, 2018). GIS have been proven to help with improving geospatial thinking skills, which, in turn, improve learners' theoretical thoughts of the science of the earth, especially on how to resolve real-world problems (Van der Westhuizen & Golightly, 2018). A GIS study in South Africa involving Grade 9 geography students to explore the use of Internet-based

Geographic Information Systems (IGIS) as a motivation tool for incorporating geo-spatial technologies demonstrated that IGIS can be used as a successful tool in the teaching and learning of geography in an inductive environment (Milson & Earle, 2008).

In Malawi, GIS are taught at both university and secondary school level (MIE, 2018; University of Malawi, 2018; UNILIA, 2018). Some of the universities in Malawi that teach GIS are the Polytechnic, the Chancellor College of Malawi, Mzuzu University, the Catholic University of Malawi and the Laws Campus of the University of Livingstonia (Chikumba & Chisakasa, 2018; Harvey Chaputula, 2012; University of Malawi, 2018; UNILIA, 2018). Some of the areas dealt with in the GIS course in Malawi universities are spatial data modelling and image processing and analysis (UNILIA, 2018). In Malawi, GIS are used as a teaching and learning motivation tool, and also in universities that do not train teachers. For example, the Malawi College of Forestry and Wildlife uses GIS for detecting forest cover changes and determining the rates, causes and consequences of land-use change (U.S. Embassy in Malawi, 2017). Although GIS are encompassed in the Malawi secondary school curriculum for geography, the curriculum is not available online to be accessed by the wider public (Mzuza, Yudong, & Kapute, 2014). In addition, no published work in GIS teaching is available online. Some of the topics taught in the secondary school subject GIS in Malawi are the interpretation of GIS and the application and analysis of images using GIS (MIE, 2018).

In Botswana, GIS are also taught at both university and secondary school level (Tabulawa, 2002; Thomas, 2014; University of Botswana, 2018a). At the university, GIS are taught as a separate course, although it is not clear how the subject is taught in the Faculty of Education. Some of the universities in Botswana that teach GIS are the University of Botswana, Botswana International University of Science and Technology and Limkokwing University of Creative Technology. Some of the courses taught at university level are Principles of GIS, Spatial Data Modelling and Analysis, GIS Design and Implementation and GIS Applications (University of Botswana, 2018b). Botswana is one of the countries in southern African that is most advanced in information and communication technology (ICT). GIS are thus included in the ICT course in public secondary schools, while in private secondary schools, GIS are taught either as a standalone course or as part of the geography course (Tabulawa, 2002; Thomas, 2014). The secondary school curriculum in Botswana, however, does not clearly indicate specific areas of GIS being taught, although it includes map-making in the geography course, an indication that GIS concepts are included (Tabulawa, 2002).

It appears that GIS are not taught in teacher-training universities in Lesotho (National University of Lesotho, 2018a). There are two main universities in Lesotho, namely the National University of Lesotho and the Limkokwing University of Creative Technology (National University of Lesotho, 2018b), and GIS courses are not indicated anywhere in the programmes or courses of either these two universities or any other teacher-training colleges, suggesting the unavailability thereof at tertiary level (KOLMET, 2018; National University of Lesotho, 2018a). GIS are, nevertheless, part of secondary school geography in Lesotho although it is not clearly indicated or

shown in the secondary school curriculum of the country (KOLMET, 2018; Raselimo, 2017). Some of the geography topics linked to GIS in the secondary school syllabus are map drawing and labelling of diagrams to show geographical areas, and the analysis and presentation of data in the right form using maps, graphs and tables (MOET, 2009; Raselimo, 2017). Some scholars argue that the secondary school geography curriculum of Lesotho does not efficiently prepare its learners for real-world problem-solving (Raselimo, 2017; Raselimo & Mahao, 2015; Selepe, 2016).

## 7. Discussion

### 7.1. Analysis of the inclusion of GIS in southern African teacher-training universities

Studies have shown that only a few teacher-training universities in southern African countries teach GIS (Table 1) (Beyers, 2018; Tabulawa, 2002; University of Botswana, 2018a; University of Malawi, 2018; UNILIA, 2018; Van der Westhuizen & Golightly, 2018). Only three countries – South Africa, Botswana and Malawi – teach GIS at their secondary school teacher-training universities (Table 1). Among these three countries, South Africa seems to be more advanced in using GIS as a tool compared to the other two countries, of which information is also scarce (Gould, 2018; Mzuza & Van der Westhuizen, 2019a). Furthermore, although GIS are taught in Botswana and Malawi teacher-training universities, the course is not taught as a standalone for teachers but rather as a component in other departments, such as Forestry, Environmental Science, Physical Planning and so forth, or in geography courses (University of Malawi, 2018; UNILIA, 2018; University of Botswana, 2018a).

Studies also reveal that some countries, such as Zambia, Namibia and Zimbabwe, that do not teach GIS in their teacher-training universities, still have GIS at other non-teacher-training universities or at the same teacher-training universities but in other faculties than the Faculty of Education (Table 1). Such an assertion is confirmed by published reports by researchers or academics from different universities of these countries (Chikodzi & Mapfaka, 2018; Gwitira et al., 2019; Neene & Kabemba, 2017; Strohbach, 2018). For example, in Zambia, a GIS course is taught at the University of Zambia in the Department of Computer Science (Neene & Kabemba, 2017). In Namibia, a GIS course is taught at the Namibia University of Science and Technology in the Faculty of Natural Resources and Spatial Sciences (Strohbach, 2018), while in Zimbabwe, the course is taught at the University of Zimbabwe in the Department of Geography and Environmental Science (Chikodzi & Mapfaka, 2018; Gwitira et al., 2019).

Some countries (Angola, Mozambique, Swaziland and Lesotho) do not teach GIS at any of their universities. People from these countries learn GIS at the universities of other countries and are able to apply such information in their respective countries (Amade, Painho, & Oliveira, 2017; Dlamini, 2011; Teodoro, Duarte, Barradas, Mateus, & Neto, 2018). Furthermore, although some countries do not teach GIS at their universities, some non-governmental organisations also help with the teaching of GIS and the application thereof in solving real-life problems (Arsanjani, Fibaek, & Vaz, 2018).

In general, many southern African teacher-training universities do not consider using GIS as a teaching and learning tool in their schools, which suggests why many countries are not including the course in their teaching curriculum (Gould, 2018). Even at those universities that include GIS in their curriculum, it remains a challenge that most people do not fully utilise GIS as an important instrument; this suggests why even teachers who have graduated from teacher-training universities may still have difficulties to teach with and through GIS in secondary schools (Fleischmann, 2012; Musakwa, 2017; Raselimo & Mahao, 2015; Selepe, 2016). Therefore, there is a need to improve or change the way in which GIS are taught in institutions of higher learning, especially teacher-training universities, in order to produce experienced secondary school teachers who can ably use GIS as a tool in teaching.

### 7.2. Significance of teaching GIS at university level

GIS have contributed to the changing of academic world decision-making. Educationalists are now considering GIS as one of the trusted means of employing educational reform since GIS support critical thinking, an inquiry-based learning atmosphere, student-centred improvements in institutional services and the conveyance of quality education and serve as a tool that helps learners to use technology and stirs them to be motivated in sciences professions (Fargher, 2018; Fleischmann & Van der Westhuizen, 2017; Harvey, 2018; Jalal & Qadir, 2018; Kerski, Demirci, & Milson 2013; Lubienski & Lee, 2017; Sumari, Shao, & Kira, 2018). For example, in South Africa, a common framework for geographical information sciences was developed for all universities in the country for use when developing a university curriculum (Du Plessis & Van Niekerk, 2014). The framework was designed to meet the needs of the people where geographical information sciences, which include GIS, can be used as a motivational tool to promote the use thereof by educators or learners in solving geographical problems and, at the same time, meet the requirements of international standards (Du Plessis & Van Niekerk, 2014; Knight, 2018, 2019).

Furthermore, the IGIST was also developed in South Africa in alignment with the GIS application curriculum to solve some problems educators face in teaching which are due to a lack of pedagogical skills and a shortage of resources (Fleischmann & Van der Westhuizen, 2017). In this study, the IGIST was kept on a memory stick to support learning anytime and anywhere, and a projector was connected to a laptop computer to enhance GIS teaching and learning without engaging a computer laboratory. The results demonstrated an increase in knowledge development in both teachers and learners who were motivated to use GIS in solving geographical problems (Fleischmann & Van der Westhuizen, 2017).

To the contrary, the use of GIS as a teaching and learning tool in Botswana still lags behind in the education department (Cavric, Nedovic-Budic, & Ikgopoleng, 2003). In a study on the diffusion of GIS skills in developing countries, the education sector in Botswana, among all sectors, failed to perform in GIS despite receiving support from different non-governmental organisations (Cavric et al., 2003). This agrees with an earlier study conducted in the same country regarding the teaching of GIS at Botswana universities and universities in other developing countries where

educational and working environments are still not conducive to teaching and learning (Mulalu, 2019). A shortage of professional expertise in the GIS field, resulting in situations where educators teach GIS without understanding the basic concepts and principles thereof, could probably be the reason for the insignificant improvement in GIS (Mulalu, 2019). Such a scenario is cause for demotivating students due to teacher- rather than learner-centeredness, resulting in many students dropping the subject and, consequently, few graduates in the field of GIS, which eventually leads to a shortage of GIS teachers in secondary schools (Mulalu, 2019; Raselimo, 2017).

It is apparent that, despite the fact that GIS can be used as a motivation instrument in the teaching and learning arena, the opposite can be true that it can also demotivate teachers as well as students, depending on the available structures or the application of the course. This may explain why some countries, such as South Africa, are introducing a common Geographic Information Science (GISc) framework for all universities for use in setting or developing GISc curricula (Du Plessis & Van Niekerk, 2014). The secondary school geography curriculum for South Africa, which includes GIS, has been developed with consideration that self-directed learning skills are supported and promoted using appropriate technological teaching and learning approaches (Van der Westhuizen & Golightly, 2018).

In Malawi, GIS have been taught mainly at universities, for example at Mzuzu University, where GIS as a developing technology have been incorporated in the university curriculum (Chilonga, 2017). GIS are taught in many departments at the university, including the Faculty of Education under the Department of Geography. The GIS curriculum in the geography course has been developed in such a way that it increases the advancement of learning models that are flexible and user-friendly to learners, considering that they are coming from different educational backgrounds (Chilonga, 2017). Most students are, thus, motivated and encouraged to continue with the geography course. There is not much published work related to GIS education; however, other fields, such as health and environmental change, where GIS have been applied have been studied (Chilonga, 2017; Salehi & Ahmadian, 2017).

## 8. Conclusion

Studies show that GIS are a strong tool in education in southern Africa but only in selected countries such as South Africa, Botswana and Malawi. Some countries, such as Lesotho, teach GIS in secondary schools only, while other countries, such as Zambia, Namibia and Zimbabwe, do not teach GIS at teacher-training universities but only at those that do not train teachers. In countries such as Angola, Mozambique, Swaziland and Lesotho, GIS are not taught as a course at any of their universities. In addition to that, these countries (Angola, Mozambique and Swaziland, but excluding Lesotho) do not have GIS even in their secondary school curriculum. It is apparent, therefore, that GIS are taught only in a few southern African countries. On the importance of using GIS as a motivation tool, results have shown that GIS are a very important instrument that helps both educators and learners with decision-making, critical thinking and inquiry-based learning, in addition to facilitating

learner-centred teaching and improving the quality of education at both university and secondary school level.

There is a need to increase efforts to include GIS in the teacher-training curriculum in many southern African countries. GIS should be taught in such a way that it would motivate learners to use GIS in solving real-world problems. The materials used in the teaching and learning of GIS should also be simplified to be user-friendly, even to those who are not GIS experts, for example, learners from social courses. Educators can copy the experiences of those countries that teach GIS as well as other developed countries. Furthermore, a need exists to develop the GIS curriculum and the relevant pedagogical skills that could help in improving the use of GIS as a tool.

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No potential conflict of interest was reported by the authors.

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