Interactive-GIS-Tutor (IGIST) integration: Creating a digital space gateway within a textbook-bound South African Geography class

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ABSTRACT

Currently there is a global drive among political and educational institutions to implement geographic information system (GIS) practice in secondary schools. However, Geography teachers worldwide, including in South Africa, face significant practical challenges in this regard. Lack of curriculum aligned GIS resources, funds and teacher GIS pedagogical knowledge have been documented as key GIS practice integration challenges. Evidently, GIS development and GIS curriculum incorporation have outpaced GIS educational research. This article documents the development and tentative assessment of a GIS plug-and-play tutor application in South Africa. The Interactive GIS Tutor (IGIST) aims to create a gateway towards GIS practice, so that learning can move from textbook-oriented learning to exploring the globe through GIS software, procedures and applications. Results found within this case study indicate that IGIST is a feasible option, and fosters a positive GIS attitude among learners and teachers. Future IGIST recommendations include multiple languages and more exploratory activities.
Keywords: *GIS, geography education, multimedia, instructional technology, case study, secondary education, South Africa*

INTRODUCTION

Recently, the implementation of Geospatial Information Systems (GIS) within secondary school education has gained the attention of educational agendas worldwide (Kerski et al., 2013, UN, 2012). GIS is defined as an integrated software system supporting geospatial information management and geospatial problem solving (National Research Council, 2006). Although Geography and Science teachers are generally fascinated by the potential of GIS, the obstacles towards GIS practice outweigh teacher optimism (Demirci, 2009) and cause many to revert to textbook GIS teaching. In an attempt to add to the current educational GIS practice integration discourse, this article deals firstly with global as well as South African GIS educational challenges. Secondly, in an attempt to address these problems, the need for educational GIS applications is motivated and various possibilities are considered. Thirdly, the Interactive GIS Tutor (IGIST) is proposed as a possible solution, and its various components are discussed. This is followed by a discussion of research design used to evaluate this application. Finally, results regarding the feasibility of IGIST are discussed. The article concludes with recommendations for future IGIST development.

GIS TEACHING CHALLENGES

Recent studies from first as well as third world countries reveal deficient internet and computer usage in the classroom. Even countries such as Denmark, Finland, Japan and the UK are facing this dilemma, despite well-developed school GIS resources (Kerski et al., 2013). There are a number of reasons that this is so. Firstly, Geography teachers are uncertain of *how to teach GIS* successfully. Secondly, *limited time* for studying and implementing complex GIS software (Kerski, 2009) is a problem, because extensive professional teacher development, technical preparation (Baker, 2005) and extra instructional time is required. Because of these factors, educators who do not perceive themselves as GIS experts, will most likely not implement GIS (Kerski et al., 2013). Chun (2008) suggests that although numerous GIS educational software possibilities may exist, curriculum-oriented GIS materials are still lacking. Therefore, in the absence of affordable, user-friendly, curriculum-oriented GIS software, the educator's ability to implement GIS technology in the classroom is severely restricted (Kerski, 2009). GIS is also embraced by the South African Curriculum and Assessment Policy Statement (generally referred to as CAPS) (South Africa. Department of Basic Education, 2011). However, the slow diffusion of GIS practice through the SA education system (Scheepers, 2009) suggests that educational policy developments have outpaced supportive academic research of GIS practice within the South African context. Clear Department of Basic Education (DoBE) guidelines regarding GIS implementation in diverse school environments are lacking, despite the inclusion of GIS in the FET-phase school curriculum (Grades 10-12) (Eksteen et al., 2012). In the White Paper on E-education, the DoBE committed itself to promoting "the generation of new electronic content that is aligned with outcomes-based education" (South Africa. Department of Basic Education, 2004). During 2006, the DoBE set out to integrate GIS as a component of the Grade 10 Geography syllabus (Scheepers, 2009). However, in 2010, 88% of schools in South Africa still lacked educational tutorial software in all of the subject areas (Blignaut et al., 2010). GIS was re-embraced in the CAPS document of 2011 (South Africa. Department of Basic Education, 2011). Notwithstanding these efforts, a lack of GIS curriculum-oriented support for Geography teachers remains a serious concern. Computer inaccessibility and scarcity of computer-literate Geography teachers has resulted in GIS teaching remaining a problematic experience (Innes, 2011).

From the above-mentioned state of affairs, it is clear that lack of GIS *resources, time and support* are the three main challenges to GIS education in SA among less-privileged schools (Breetzke et al., 2011) whilst catering for the broad spectrum of cultures, languages and economic sectors within SA. However, there are schools that are well equipped and able to put GIS practice to good use in the classroom, which in turn, highlights a South African digital divide that is in fact alive and widening. The challenges impeding the advancement of GIS education on both national and international levels therefore call for urgent and pedagogically sound investigations. If current research gaps are not addressed, it is unlikely that GIS practice will flourish in the classroom.

POSSIBLE GIS TEACHING SOLUTIONS FOR SA

Evidence suggests that South African teachers tend to revert to textbook GIS teaching, in order to evade current GIS practice barriers. A number of solutions to this dilemma have been proposed: A paper-based GIS initiative, managed by ESRI South Africa (Pty) Ltd, envisages the introduction of GIS in resource-poor schools (schools without electricity and/or computers) in South Africa (Breetzke et al., 2011, Kerski et al., 2013). However, the actual potential of GIS can only be unlocked by learners who make use of the various available digital GIS platforms, such as *ArcView 3.3, Quantum GIS (QGIS)* and web-based software (National Research Council, 2006). *ArcView 3.3*, which has been designed by ESRI, has been made available in SA by GIMS and Geomatica (Innes, 2012). However, an additional learner manual is provided, which may create a

split-attention effect (learners' attention is split between viewing the program and reading the manual). Consequently, the cognitive capacity needed for constructive learning could become overloaded (Mayer and Moreno, 2003). Furthermore, the use of a learner manual could also unlock inquiry based and innovative learning activities. *QGIS,* an alternative to ArcView 3.3, is a free, downloadable and open source software option, sponsored by the Department of Land Affairs (DLA) in the Eastern Cape in SA. *QGIS* comes with a user manual, *A Gentle Introduction to GIS*, guiding the educator through a series of worksheets. In this case also, there is a learner-user guide provided alongside the software, which means that constructive learning is potentially hampered (Mayer & Moreno, 2003). *Web-based GIS*, such as Google Earth and desktop GIS are exceedingly versatile (Songer, 2010). Moreover, as Phiri and others (2014) suggested future use of tablets in rural districts of Comfimvaba in South Africa, which could therefore enlarge GIS teaching avenues with regards to Web-based GIS. However, the file sizes of these web-based GIS are large, meaning that a fast broadband connection becomes essential. Web-based GIS, within a SA context, consequently is not a workable option currently within FET-phase classrooms. Yet these have an immense potential if bandwidths and accessibility of the Internet would improve (Clark et al., 2007).

AN INTERACTIVE-GIS-TUTOR (IGIST)

It is evident that all current solutions in SA have definite practical hindrances for teachers and learners alike. In cases where time constraints, inadequate teacher support and lack of available finances are the obstacles, a self-paced, interactive GIS plug-and-play tutor application might prove to be a viable learning option. It may even serve as a 'step-up' towards more advanced educational GIS (which might include more complex industry-driven GIS software). The IGIST application has been developed to address the need for curriculum-aligned GIS applications. It can be used anytime and anywhere by teachers and learners, provided they have a computer available. In this way the GIS teacher training and external GIS support is provided.

IGIST development

IGIST is a combined effort of the GIS Department and the Geography Education Department of North-West University. ArcGIS 10 and Adobe Captivate 5.5 software programs were used to create the various tutorials, exercises and assessment tools found within this application. Through simulation, GIS procedures was executed on the actual GIS software, while Captivate recorded the process in the background. This was then compiled into an executable (*.exe) file format compatible with almost any computer. Once opened, this simulated process can then be repeated using screenshots captured during the recording process as the graphical user interface. It is important to note that the user will only be able to use the simulated features - the demonstrated process - and not the actual GIS software. These tutorials were enclosed within the IGIST application, which was then loaded on a USB flash drive ready for use.

IGIST compilation of information and routing

The IGIST application consists of approximately 90 minutes of self-paced activities, consisting of an introduction, three tutorials, four exercises and two multiple-choice assessments, as demonstrated in Figure 1. The activities can be completed in one sitting, or these can be integrated into lessons over three to four periods (or even finish the activities at home as the IGIST is mounted on a USB flash drive) in order to accommodate slow learners and to adapt to the time constraints of the curriculum.
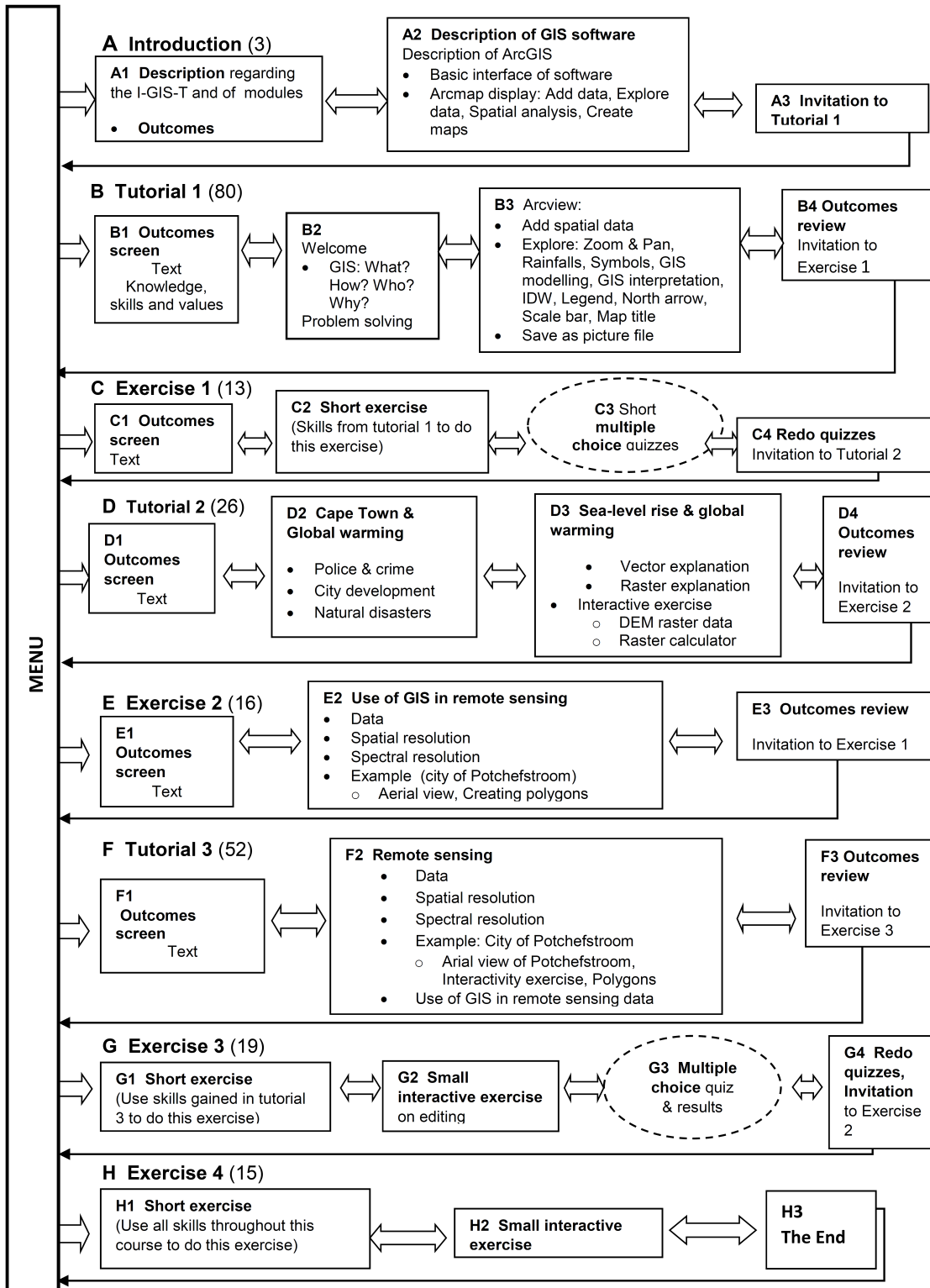
Figure 1. *IGIST summative framework*

The numbers in brackets represent the number of snippets (screenshots) within that specific activity. These snippets are linked to the rewind feature within the IGIST, where the learner can review that specific snippet of the tutorial by following the return arrows. Each block indicates the main theme of each section as well as the information sequence. The assessment sections (multiple choice) are depicted as dotted circles where the learner has the choice to redo an assessment. Each of the different activities, tutorials and exercises is directly linked to the menu, allowing access to other activities at any time. The introduction of the IGIST, depicted in Figure 1, consists of three snippets: an introductory description regarding the outcomes of this tutorial (A1), a description of GIS software, basic software interface and Arcmap display buttons (A2), and an invitation to Tutorial 1. Tutorial 1 starts with the outcomes of the tutorial (B1) and an explanation of GIS. How to solve problems through GIS is also described (B2). The features of ArcView software, as well as how to save a map, are explained (B3). Lastly, the outcomes are refreshed (B4). Exercise 1 consists of a short exercise and multiple questions (C4). Tutorial 2, starts with the outcomes screen (text) of this tutorial (D1). Thereafter, various uses of GIS are mentioned (D2). Following this, the influence of global warming (climate change) on sea levels is investigated (D3). The differences between spatial and vector data are highlighted and employed together with a raster calculator. This investigation has interactive features, where the learner follows step-by-step narration and animated guidance. Exercise 2 (D4), consists of activity outcomes (E1). Thereafter skills learned in Tutorial 2 are employed within an exercise (E2)
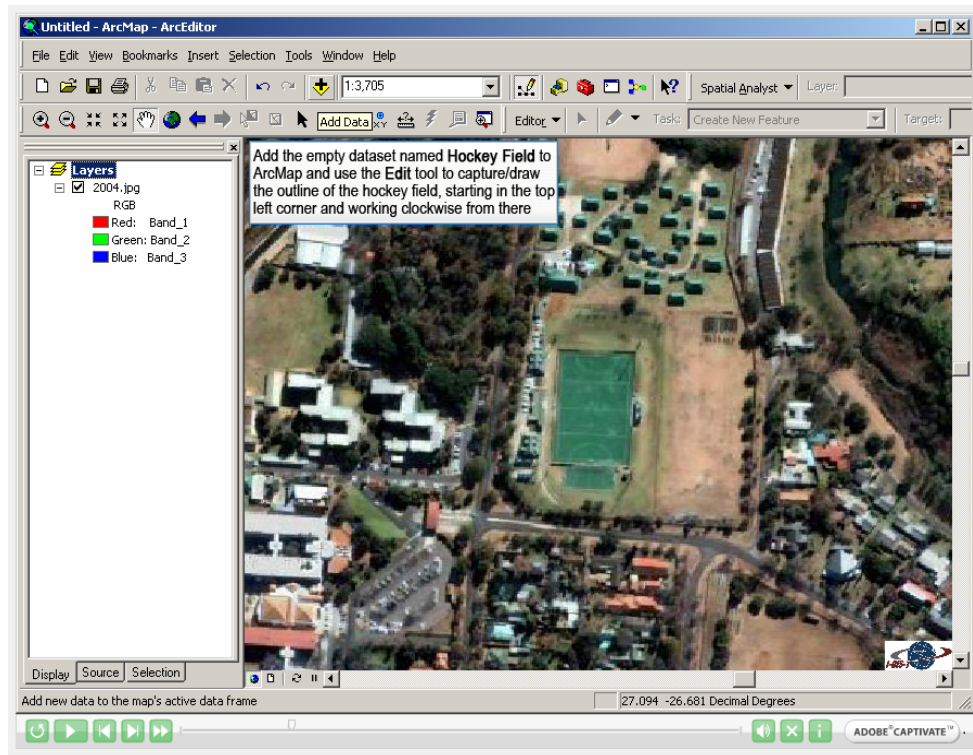

Figure 2. *An IGIST exercise screenshot*

Tutorial 3 (E3) presents the module outcomes in text (F1). Remote sensing is discussed (F2). Spectral and spatial resolution is then described, using narration and pictures. A real-life example

is used where polygons are created. Exercise 3 (F3) includes an introduction (G1), an interactive exercise (G2) where the learner employs skills acquired during Tutorial 3. Figure 2 depicts a screenshot displaying the interactivity feature of IGIST. The task is displayed within the label. If the wrong procedure is followed, a red rectangular frame appears over the correct tool. As the learner gets used to these tools, guidance gradually decreases.

RESEARCH DESIGN AND METHOD

The aim of this case study was, firstly to evaluate the viability of the IGIST application as perceived by both the Grade 11 Geography teacher and learners of a rural multi-cultural school and secondly to measure learner GIS attitudinal development. In order to evaluate the IGIST application, this study addressed the following research questions;

- To what extent does the teacher perceive the IGIST application as workable and a possible solution for GIS practice integration within her Grade 11 class?

- To what extent do the learners perceive IGIST as a workable solution for GIS practice learning.

- What influence does the IGIST application have on GIS attitude in this study?

The choice of a case study design is appropriate in gaining a detailed account and an in-depth understanding regarding IGIST practice and evaluation within the natural class setting. In line with this disposition, Milson and Earle (2007) refer to the heuristic qualities of case studies as appropriate in evaluating the integration of recent GIS innovations. Kerski (2009) also affirms that case study research leads to a more accurate understanding regarding the efficacy of GIS in education.

The sample was selected through purposeful maximal sampling, the aim being to gain different perspectives from learners of various achievement levels and cultures. Grade 11 Geography learners (n=12) and their Geography teacher (n=1) took part in the study. The class, which consisted of both weak and strong academic achievers, was comprised of learners from different socio-economic and cultural backgrounds with a variety of home languages (Afrikaans, English, German, Korean and Zulu). The teacher was in her first year of teaching, computer literate and proactive, but lacked GIS teaching experience.

The learners completed the IGIST activities in the school's computer lab. The USB flash drives were inserted and after initial guidance, learners engaged with the IGIST activities at their own pace, while the teacher facilitated. After each activity, the learners completed the corresponding questions on the IGIST evaluative questionnaire. Both pre- and post-GIS attitudinal questionnaires were completed by the learners. The teacher routed through the IGIST application and evaluated it by means of a questionnaire. Lastly, a semi-structured, one-on-one teacher interview followed by three interviews with learners selected from high achiever, average achiever and low achiever levels, as well as two focus group interviews conducted, provided a detailed and in-depth description regarding the workability of the IGIST from the teacher's perspective.

The qualitative and supportive quantitative data for this case study included classroom observations, semi-structured interviews, focus group interviews, questionnaires as well as field notes. Three semi-structured, one-on-one interviews were conducted with learners from different achievement levels in order to find out if IGIST would be suitable for each of these levels.

Inclusion of open-ended questions made allowance for the learners' perspectives regarding the workability of IGIST to emerge. Two focus group interviews within group dynamics produced new insight and lines of inquiry directly related to the workability of IGIST.

A 21-question, five-point Likert scale learner questionnaire with an open-ended comment option was also provided, with the intention of determining to what extent the learners (n=12) perceived the IGIST application to be workable. This was done in order to support findings from the interviews. The 22-question five-point Likert scale teacher questionnaire included open-ended questions to determine how the teacher perceived, experienced and evaluated IGIST. Questions were both descriptive and evaluative. Thereafter a semi-structured interview with the teacher followed. These methods made crystallisation possible. A 21-question, five-point GIS attitudinal questionnaire was administered to learners as pre- and post-tests.

During the analysis, the qualitative and quantitative datasets were analysed independently. Inferences were made that converged into a meta-inference from which an assertion for each of the secondary research questions where drawn. Qualitative analysis of data consisted of a mixture of deductive and inductive coding by means of ATLAS.ti™. Networks were constructed from these codes and inferences were drawn for both the teacher's and the learners' perceptions. Quantitative analysis of data consisted of descriptive statistics, such as means and standard deviations as well as the utilization of effect sizes.

In order to enhance the construct validity (logical relationships amongst variables), multiple sources and member checking were employed. Content validity was verified by the head of the project, and NWU Statistical Consultation Services checked questionnaires for face validity. Member checks promoted validity and reliability (Merriam, 2009).

FINDINGS

The summative network, as generated by ATLAS.ti™ software (Figure 3), presents patterns that emerged regarding the evaluation of the workability of the IGIST category. Within the context of this study, 'workable' implies: practical or feasible and capable of or suitable for being worked on as well as overcoming the main GIS practice barriers. Figure 3 portrays, firstly, perceived challenges and secondly, perceived advantages as main indicators regarding the workability of the IGIST. The first number within the brackets indicates the number of quotes and the second number indicates the number of connections to other labels. The number of quotes regarding perceived IGIST challenges came to 25, whereas the quotes portraying perceived advantages came to 85.

Further findings and discussions regarding the workability of IGIST are categorised according to Figure 3.
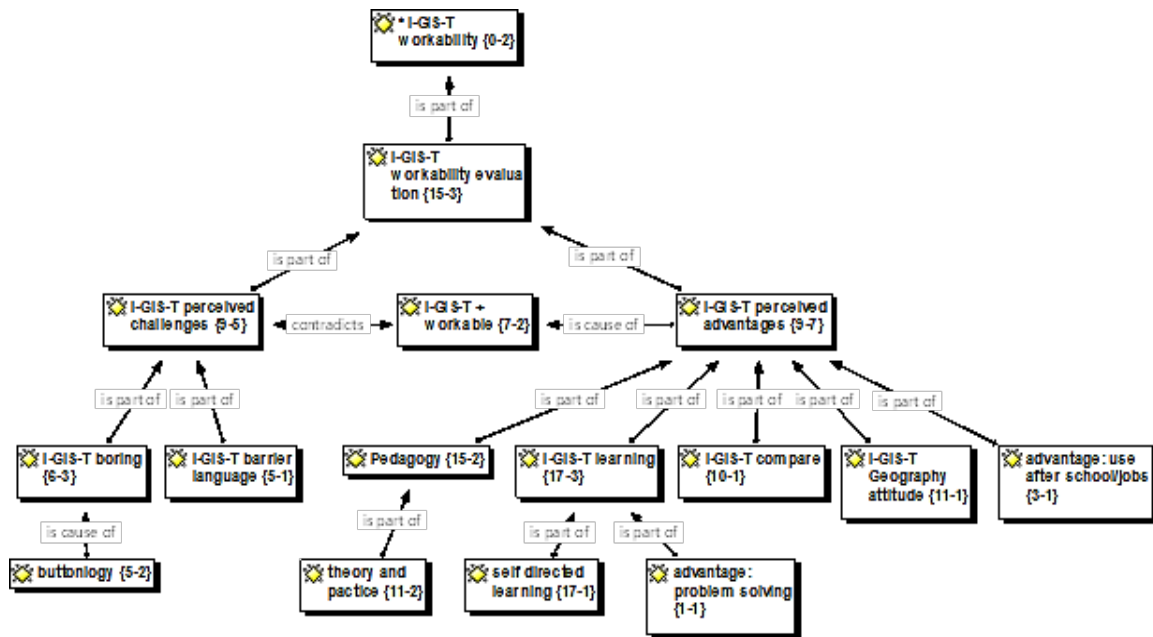
Figure 3: Network on IGIST workability

IGIST workability as perceived by the teacher

The questionnaire response indicated IGIST as being definitely workable and user friendly. It supports GIS pedagogy and is perceived to be a suitable avenue for overcoming the main GIS barriers as experienced by the teacher. In the interview, upon being asked to evaluate the application on a scale from 1-5, the teacher replied, "*I think five … it is definitely workable, because it takes you right from the beginning, not that the teacher first has to take a course before the teacher actually understands it.*" This response indicated that the teacher found IGIST to be self-explanatory and not requiring additional teacher training or time. The teacher finally remarked that she would promote the IGIST application to other Geography teachers. She indicated positively that IGIST overcame the three main GIS practice barriers in her class, namely, fear of using GIS software, time constraints regarding lesson preparation as well as class time to implement GIS practice. It is important to take note that these barriers are much the same as those faced by teachers internationally (see above, section 4). Both the primary qualitative and quantitative inferences leaned towards a positive perception regarding the workability of IGIST within the class, and therefore converged into the following assertion:

- *Assertion 1:* According to the questionnaire and the interview, the teacher perceived the IGIST application to a large extent workable and a solution for GIS practice integration within her Grade 11 class.

IGIST workability as perceived by learners

In order to determine the learners' perspectives regarding the workability of the IGIST, multiple methods of data gathering were employed.

During direct observation, it was noted that three learners required teacher facilitation in the first activity (showing how to close and open activities), after which they manoeuvred through the activities on their own. Two learners experienced technical problems, one struggling to log in and another finding that the mouse click did not want to register within IGIST. One learner in particular was not computer literate and therefore experienced more difficulties. Analysis of these findings points to the question of how learners of different achievement levels will experience the workability of the IGIST.

In order to differentiate between the different achiever levels, three learners were sampled from the high, average and low achiever groups. These also represented different culture groups. All three learners enjoyed the activities, although one learner stated that she would have preferred to explore more independently.

Two focus group interviews were also conducted. During the learner interview, the learners were asked how much they had learned about GIS, if at all. Alice and Lily responded with, "*Yes, definitely*" and, "*Yes, definitely [Laughs]. Maybe 10 on a scale of 1-10.*" Another learner exclaimed, "*Yes, very much, I have learned a lot!*" It is important to note that IGIST did support learning for Lily, an under-achiever, as well as for Helen, a high achiever, who also rated the IGIST 10 out of 10 regarding learning. According to these quotations, it seems that the IGIST caters for both under- and high achievers. The IGIST application revived interest in Geography as a subject. Helen, a high achiever, explained that she acquired a "*new vision*" of Geography and found GIS "*interesting*". Alice, an average achiever, stated, "*with this activity, it actually, it had brought an interest in me, you know it is actually nice.*" Lily, an under-achiever, confirmed within the individual interview that IGIST also renewed her interest in Geography. She declared, "*it made my heart happy and very interesting in doing Geography… yes… just to do something to do with GIS…*" From these statements, it is clear that IGIST has the capacity to spark interest in Geography within all achievement levels.

Focus Group 2 also mentioned the prospect of furthering GIS studies as enrichment activities for gifted learners, leading to projects within their communities. IGIST has therefore, according to these responses, awakened the learners to realise the usefulness of GIS. The learner who lacked basic computer skills, found IGIST activities a challenge. She admitted that she did not "*know the system*", and that she was not computer literate. However, all the other learners enjoyed the activities. It is important to note that, although computer literacy is not crucial for the teacher to facilitate the IGIST activities, learners must at least have some basic computer skills. Some learners found IGIST stimulating and suggested an additional exploration activity, as the following quote demonstrates: "*…it is another pity, that it is so short ... two hours and then it is over, and that is basically all you get and like I said you get a small piece of it, so if you could take it home and you could explore a lot more and have a lot more time with it and learning the GIS getting to know it.*" It should be noted, however, that IGIST mainly aims to teach the basic GIS practice concepts and to spark an interest in GIS, which it did.

In addition, this case study included a wide spectrum of learners, incorporating learners from both disadvantaged and privileged backgrounds. Having to cater for all these types of learners, makes GIS practice even more challenging. However, during the focus group, an under-achiever remarked that "*I like it when the person was explaining, I like it to try it out, one by one… you click again, it was nice.*" As the IGIST application enables self-paced learning, the teacher can facilitate those who struggle to understand the computer system. The multiple home languages of learners might be a reason to include more languages as an option. This challenge became evident during Focus Group 1 interviews. One learner stated that although she herself understood English, language could arise as a challenge. This statement led to the recommendation that other languages within this multimedia be integrated in the future.

Table 1: IGIST evaluation learner questionnaire

IGIST activity	Mean	STD	Comments from learners on each IGIST activity
A - Introduction: (1:30)			*"Very clear and understandable." "Understandable!" "It was not as clear is it could have been." "Excellent." "The introduction was clear." "Lips too close to mic"*
The introduction was clear.	3.9	0.6	
The graphics supported my gaining of understanding of GIS.	3.8	0.6	
B - Tutorial 1: (12 min)			*"Speechless." "Graphics used, caught my eyes and made me to understand more easily." "I like the thing that I could participate while listening," "Good, too long though." "GIS is used in many different ways." "It was a good start." "Interesting!"*
This tutorial explained GIS in a clear way.	4.0	0.4	
The graphics supported my gaining of understanding of GIS.	4.3	0.6	
C- Exercise 1: (03:00)			*"I enjoyed it very much." "It is difficult." "It was fine." "It did not work. (I wanted to do it!)" [Technological problem]. "Helps one learn quickly." "it is nice to have exercise." "It was very exciting!!"*
I gained GIS skills from this exercise.	3.9	1.2	
The graphics supported my gaining of understanding of GIS.	3.8	0.9	
D- Tutorial 2: (5:30)			*"Brilliant." "This was the most wonderful and interesting to do." "Excellent." "Nice explanation" "Interesting."*
This tutorial explained GIS in a clear way.	4.1	0.6	
The graphics supported my gaining of understanding of GIS.	4.3	0.2	
I gained new insight in GIS	4.3	0.9	
E – Exercise 2: (2:30)			*"…good accuracy, starting to understand" "It was ok." "…questions too easy,"* *"It was quite difficult for me."*
I gained GIS skills from this exercise.	4.3	0.4	
The graphics supported my gaining of understanding of GIS.	3.8	0.9	
I gained new insight in GIS.	4.1	0.3	
F- Tutorial 3: (6:00)			
This tutorial explained GIS in a clear way.	4.2	0.7	
The graphics supported my gaining of understanding of GIS.	4.4	0.3	
I have gained new GIS insight during this tutorial.	4.1	0.3	
G- Exercise 3: (2:15)			*"This was wonderful."*
I gained GIS skills from this exercise.	3.8	1.1	
The graphics supported my gaining of understanding of GIS.	3.9	1.2	
H- Exercise 4 (2:00)			*"It was enjoyable and easy to follow." "Good ending." "This tutorial and exercise gave me more information about GIS." "Quite challenging but nice!" "I am a bit shaky on this one as it seems pretty complex at first." "It is good that I did the exercise myself to ground*
The graphics supported my gaining of understanding of GIS.	4.3	0.8	
I have gained new GIS insight during this tutorial.	4.0	0.7	

			the info."				

To support the qualitative findings above it was necessary to employ a five-point Likert scale workability questionnaire (n=12). Favourable responses were considered to be a 4 (Agree) and 5 (Strongly agree), while unfavourable responses were considered to be 2 (Disagree) and 1 (Strongly disagree). Most of the evaluations scored either a four or a five on the Likert scale, (see table 1). The mean of this questionnaire indicated mostly a four or 'an agree' towards the workability of IGIST, which is considered favourable. Nine of the 12 learners supported an 'agree', or 'definitely agree' on the workability of the IGIST. The open-ended questions in this questionnaire indicated a positive workability (with regards to gaining GIS insight and skills) of the IGIST application as well.

Both the primary qualitative and quantitative inferences reflected a positive perception which converged into the following assertion:

- *Assertion 2:* The learners perceived IGIST overall as a workable solution for GIS practice learning.

IGIST and learner attitudinal development

Table 2 reflects an extract of the findings from the pre- and post-GIS attitudinal learner questionnaire. Results, descriptive statistics, dependent P-values and effect sizes are captured within Table 2.

Table 2: Result extract from attitudinal questionnaire (Adapted from Huynh, 2009)

Question number with corresponding statement on GIS attitude		Pre-test		Post-test		Dependent test P-value	Effect size
		Mean	STD	Mean	STD		
3	GIS work is fun	2.83	0.937	3.67	1.371	0.044*	0.89
4	I can apply the GIS we learn at school	3.25	0.754	3.67	1.155	0.515	0.55
5	The wide application of GIS gives me a feeling of accomplishment	3.17	0.835	3.75	1.138	0.079	0.70
6	I like GIS because it helps me understand the world around me	2.92	0.900	4.17	0.718	0.335	1.39
7	Looking at GIS data in different ways helps me to learn	3.33	0.888	4.08	0.669	0.423	0.84
12	I like working on all types of GIS problems	2.58	1.084	3.75	1.055	0.135	1.08
13	I can analyse GIS data in many different ways	2.25	0.965	3.17	0.718	0.008*	0.95
20	I like GIS because it presents me with a challenge	3.25	1.215	4.00	1.044	0.503	0.62
21	I have a growing appreciation of GIS through understanding its values, applications and processes.	3.25	1.215	4.00	1.206	0.159	0.62

Favourable responses were considered to be a 4 (Agree) and 5 (Strongly agree), while unfavourable responses were considered to be 2 (Disagree) and 1 (Strongly disagree). See also appendix A. As the sample size was only twelve (n=12) and not large enough for statistical power, effect sizes were calculated to determine if there was a practically significant increase in learner GIS attitude. Results reflected 15 out of the 21 statements indicating either a medium (>0.4) or large effect sizes (>0.8) (Ellis & Steyn, 2003). Interestingly, the IGIST activity influenced a positive attitude development on *all* the questions. These results support the following assertion:

- *Assertion 3*: The learners experienced a positive attitudinal growth towards GIS after the IGIST application activities.

IMPLICATIONS FOR THE IGIST IN EDUCATIONAL GIS PRACTICE

The assertions drawn from this study, as indicated by the learners as well as the teacher, indicate that IGIST is workable, especially within the South African context, where a digital divide is evident. Neither parties required any IGIST training beforehand, as the self-paced tutor feature of the application made any-time-any-where learning possible. It guided the learners in reaching the desired learning outcomes, and also could provide a supportive way to align GIS learning to a national standard. Where most educational GIS applications require additional time to be mastered, IGIST saved preparation and teaching time. The redo function supported the teacher's role as facilitator (circumventing pedagogical issues) while placing the learner in charge of his/her own learning. The teacher needs minimum GIS pedagogical knowledge in order to facilitate the activities. Furthermore, it was found that the IGIST bypassed network problems, internet bandwidth shortcomings and low computer memory troubles by being loaded on a USB flash drive and therefore required only a USB port. The overall low cost of the IGIST application makes it attractive to teachers aiming to bridge the digital divide. The IGIST method of instruction, could provide solutions for future GIS learning and training of professional GIS software programs.

CONCLUSIONS AND RECOMMENDATIONS

Both teacher and learners were overall positive towards the workability of the IGIST, infusing GIS learning with fresh excitement and interest. A number of learners expressed the desire to engage in future IGIST activities in order to equip them for job opportunities after school. Learners lacking general computer skills were supported by teacher facilitation during the first part of the IGIST experience. The teacher therefore experienced the IGIST activities as a welcome solution in circumventing the main GIS practice barriers. This in-depth description of the case study evaluation might therefore prove useful for teachers in the field, both locally and abroad, to *analytically* generalise the results within their own setting (Yin, 2012).

Although this case study provided in-depth insight into IGIST learning within one class, more research with larger numbers of learners is needed. In order to examine how the IGIST application performs in different environments, a multiple case, including both typical and atypical settings within SA, was selected for Phase 2 of the IGIST project. Future IGIST improvements include the incorporation of multiple tutor languages and exploratory activities. Further studies could also include a comparison study with other GIS software applications available. The authors foresee that a cross-case study, including various countries with similar GIS practice

challenges and needs, might provide more insight into the viability of IGIST within the international GIS educational landscape.

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APPENDIX A

Attitudinal questionnaire (Adapted from Huynh, 2009)
1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree

1   I feel GIS is an important part of the school curriculum
2   GIS thrills me and I like it
3   GIS work is fun
4   I can apply the GIS we learn at school
5   The wide application of GIS gives me a feeling of accomplishment
6   I like GIS because it helps me understand the world around me
7   Looking at GIS data in different ways helps me to learn
8   Using a GIS map to study data helps me to learn
9   GIS is an interesting topic
10 Explaining patterns in GIS data helps me to learn
11 In GIS, explaining why phenomena occur helps me to learn
12 I like working on all types of GIS problems
13 I can analyse GIS data in many different ways
14 I am capable of using GIS to display geographic data
15 I am capable of asking questions to help focus my GIS investigation skills
16 I can draw conclusions from GIS data
17 I am capable of using a map to analyse GIS data
18 I am capable of asking new geographic questions from data that I have drawn from GIS
19 I can study data with the help of GIS maps
20 I like GIS because it presents me with a challenge
21 I have a growing appreciation of GIS through understanding its values, applications and processes.