Geographic Information System in Teaching Geography: A Meta-analytic Study

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Abstract

In this paper an attempt has been made to know the effectiveness of Geographical Information System (GIS) in teaching Geography in secondary school level. It is based on Meta-analysis, a meta-analytic method is a quantitative, formal, epidemiological study design used to systematically assess the various aspects of the studies in general results of previous research in particular to derive conclusions about that body of researches. For this purpose literatures on Geographical Information System were analysed about ten years, from the year 2010 to 2020. It is also throws light on Geographical Information System, teaching aids in Geography and importance of Geographical Information System. An analysis of the literature on GIS makes it clear that, GIS is an effective way of instructing Geography at school level. It creates a sense of interest and curiosity in the learners, motivates them, makes the learnt concepts concrete and also helps in long term retention of the learnt things. Thus, GIS has been envisioned to be a strategy that can contribute to new ways of teaching, learning and understanding of the geographical things around us as well as around the earth.

KEYWORDS: Geographical Information System, meta-analytic method, quantitative and epidemiological.

Introduction

At present Geography is one of the part of social studies subject in school curriculum. Geography derives a lot of material from such subjects as Biology, Anthropology, Sociology, Economics, Mathematics, Chemistry and other sciences. The subject matter of Geography includes study of natural environment of man and also the study of social and cultural environment. Thus, Geography has a very wide scope unparalleled by any other subject.

Geography is a science and as well as an art. It tries to train and develop good citizens who may be able to solve various social, economic and political problems of the country. The importance of Geography can be understood more clearly by considering the effect of Geography teaching on man as a human being, as an administrator, as a politician etc.

In the present day world Geography is no more considered as a mere collection of meaningless facts to be memorised and reproduced whenever required. Present day Geography covers a vast field and comprises many branches. The method of scientific study has taken a full control of the scope and study of Geography. The scope of study of Geography is growing everyday. The scope of Geography has become so vast and complex that a need a specialized instructional methods.

When the students reach the secondary school level they become mature and also become intelligent. At this maturity and intelligence level they can establish

cause and effect relationship. At this age the psychological requirements are different for them it is necessary to give a properly organized and scientifically planned syllabus and a good method of teaching.

Geographical Information System and Education

The Geographic Information System commonly abbreviated as 'GIS' is a special information system that manages data that has spatial information (spatial reference) or in a narrower sense, is a computer system that has the ability to build, store, manage and display information that is geographically referenced, for example data identified according to its location, in a database. It is one simple but powerful and versatile application, and is proven to be able to solve many real world location problems from vehicle tracking, shipping goods, recording detailed planning applications, to global atmospheric modeling.

Research statistics also agrees that, the implementation of GIS in education throughout the world has been developed in two main lines, namely, 'teaching about GIS' and 'teaching with GIS'. The first is related to teaching GIS as the main subject. Some researchers propose the need to have a stand-alone GIS curriculum in schools for enhancement of spatial reasoning in all areas of life. The second path is teaching with GIS in the context of other subjects, namely combining GIS in lessons as a tool to achieve the objectives of the subject.

Today it is possible to use technology in many areas of the education process. One of these areas is Geography education. For, both with its subjects and its structure, Geography is a scientific area where technology can be applied successfully. Today one of the most important novelties which technology has brought to the science of Geography is the Geographic Information Systems (Degerliyurt&Cabuk, 2015). It is a computer-based information system performing the functions of visualisation of spatial data obtained through position-based procedures, data collection, analysis, storage and presenting to users in an integrated way (Broda& Baxter, 2003; Kinniburgh, 2010; Liu & Zhu, 2008; Madsen & Rump, 2012; Swanson, 2008; Yomralioglu, 2009). Moreover, with the help of GIS, answers can be found quickly and easily to such questions as what, where and how which the discipline of Geography tries to answer (Fitzpatrick, 2001). Thus, teaching Geography lessons with the help of GIS ensures active learning and makes geography lessons more enjoyable (Artvinli, 2010).

Teaching Aids in Geography

Teaching aids should be used to supplement the process of teaching. Most of the teaching aids are sensory aids and their function is to make teaching concrete, effective and interesting. Geographical aids are the means of modernization of methods of teaching Geography in schools. In the absence of teaching aids in Geography, lesson becomes dry and ineffective.

Change is the rule of nature and everybody has to adopt the changes for their survival. The methods of teaching Geography have also undergone changes. The methodology of teaching Geography that was prevailing in the past is being replaced by modern innovations of information and communication technology such as GIS. Therefore, the teaching of Geography is bound to suffer in the absence of proper and updated teaching aids.

Importance of GIS

Geographic Information Systems is a comprehensive mapping system designed for capturing, storing, analyzing, synthesizing, querying, editing, retrieving, manipulating and displaying spatial data obtained from earth's surface in the form of

charts, tables, 3D images and maps based on the richness of the information entered into the GIS database.

Numerous studies done on GIS in education in the international context indicated that, in addition to increasing student and teacher motivation, GIS are very effective tools for incorporating project-based teaching and learning, and promoting students' geographic skills such as thinking geographically, analyzing and synthesizing spatial data, map reading and interpreting (Tinker, 1992; Geography Education Standards Project [GESP], 1994; Palladino, 1994; Audet&Abegg, 1996; Lemberg&Stoltman, 1999; Pottle, 2001; Shin, 2006).

Tinker (1992), Palladino (1994), and Audit &Abegg (1996), who were the leading academicians, conducted the first research on education with GIS and underlined the positive relationships between education with GIS and the development of spatial skills of the students.

The use of information technologies in the field of Geography, an important discipline in social sciences, contributes to rendering abstract phenomena and concepts concrete, thereby increasing high school education students' interest in geographic education.

Objective: To review and analyse the GIS in teaching Geography subject at school level and to draw conclusions.

Methodology

This paper is based on Meta-analysis,a meta-analytic method is a quantitative, formal, epidemiological study design used to systematically assess the results of previous research to derive conclusions about that body of research.

Review of Related Literature

Geographic Information Systems (GIS) education in South Africa and elsewhere has been envisioned to be a strategy that can contribute to new ways of teaching, learning and understanding. However, very few studies have assessed how GIS is taught in South African high schools. In this regard the study conducted by Mkhongi and Musakwa (2020) analyzed the GIS education dynamics and perspectives in uMgungundlovu District, KwaZulu-Natal Province, South Africa. A survey with both open and close-ended questions was conducted with Geography teachers and students. Questions focused on GIS content, how the content is taught, challenges in GIS education, educators' GIS proficiency and GIS education perspectives. Purposive sampling technique was used to select the schools with the desired qualities. From the results, it was evident that GIS is progressively taught in secondary schools. However, the full potential of GIS education has been restricted by challenges such as inadequate resources and limited exposure of students to GIS's practical uses. Subsequently, the study recommended that GIS education in South African schools should be accompanied by appropriate hardware, software and opportunities for exposing students and educators to practical methods of teaching and learning GIS. Furthermore, educators should also be trained to be able to adequately equip students with GIS skills and knowledge.

The use of GIS is attracting growing global enthusiasm among scholars and in the scientific world. Due to the significance of GIS and the increased demand for its use, its application in secondary school education has also become very important at both national and international levels. The study conducted by Mzuzu and Westhuizen (2019) reviewed the current state of GIS application in southern African secondary schools. Although GIS is included in the education curriculum in several African countries, some countries still trail behind. Furthermore, despite the fact that good progress has been made with GIS education, many learning institutions in Africa

still face challenges regarding its development and application as a teaching and learning tool. The absence of GIS education in secondary school curricula; the shortage of experienced teachers; the lack of knowledge and technical expertise; the unwillingness of teachers to change their mode of teaching; a shortage of funds, and inadequate resources etc were some of the problems identified by this study. This study hoped to inform bodies of scholars about the state of GIS application in secondary school education in southern Africa and to infuse interest and collaboration across borders to exchange knowledge and support.

A qualitative study to determine the Geography teachers' opinions about how often, for what reasons and for what subjects the GIS are used in Geography lessons were conducted by Degirmenci (2018). This study was carried out based on phenomenological design. The study included 15 Geography teachers servicing at different schools in Turkey. The teachers' opinions were obtained via the semi-structured interview form developed by the researcher and the series of obtained data were analysed via the content analysis method. The results showed that, a great majority of the teachers did not use the GIS in their lessons and the reason for this was that they are not having sufficient knowledge about how to use them. Also, the teachers emphasised the insufficiency of possibilities, infrastructure, software and hardware. However, it was observed that all the teachers agreed on the necessity of using the GIS in geography lessons.

Rickleset.al, (2017) in their study explored the results from an online survey and interviews conducted between July 2014 and August 2015 with participants from the UK, the US and Europe on how interdisciplinary researchers learned GIS and which resources and platforms were utilised. Findings showed that, interdisciplinary researchers want to use GIS to capture, analyse and visualise information; they largely use informal learning approaches such as internet searches, watching a video, ask a more experienced person; and they predominantly use ArcGIS, QGIS and web GIS platforms.

The study conducted by Singh et.al (2016) applied a concurrent triangulation mixed method model to determine the effect of GIS based teaching on underachieving students' achievement and their motivation to learn Geography. The quantitative data were collected through a quasi-experimental design while the qualitative data were collected through students' interviews. The treatment groups included 44 students and control group with 40 students. For the treatment group, a unit on the type and distribution of world vegetation was given with GIS-based lesson material. For the control group, the same subject matter was presented using the traditional teaching methods. The quantitative evaluation showed the mastery goal and achievement post-test mean score of experiment group student participants' are significantly higher than control group student participants. The evaluations of student participants' interviews are consistent with quantitative findings. The triangulation of the quantitative and qualitative data revealed that, GIS-based teaching had a more positive effect as compared to traditional teaching methods in enhancing participants' mastery goal learning motivation and achievement in the topics being taught in the classroom. Hence, this study concludes that, GIS based teaching has a positive impact on the students' achievement and motivation to learn Geography.

Baker (2015) in his study reported that, amongst many uses of GIS, students' ability to use it or understand its versatility could go a long way to open future avenues for them, be it furthering their education or their career opportunities. A professional GIS package is an integration of components designed to create, store, retrieve, manipulate, and display various types of geographic information. He also

opined that, GIS fascinates educators of their ability to swiftly and dynamically represent the world and its issues from a variety of spatial perspectives.

Agyei (2014) in his study opined that, the current opportunity for achieving sustainable educational reform is enhanced by an emerging understanding about how education is delivered and the advent of powerful educational technologies like GIS.

Kerski et.al (2013) in their study proposed recommendations for advancing the implementation and effectiveness of GIS in secondary school education from an international perspective. Thirty three countries were considered in the present study to assess the landscape of educational GIS by analyzing in terms of how GIS is recognized, approached and used across the world. Major challenges and opportunities were also studied. The findings of the study revealed that, the current global landscape of GIS remains small for secondary education. However, the innovations and emergence in the field of information and communication technologies could result in the usage of GIS in schools by teachers and students.

The application of new educational technologies in teaching Geography was investigated by Komlenovic et.al, (2013). The study found majority of students familiar with the GIS, but only a few students said to have the theoretical knowledge and practical skills for its use. Students who used GIS opined it as a useful tool which contributes to the development of cartographic skills and it is also highly interactive, systematic and precise. The study reported that, GIS and other tools of ICT are yet to be used in teaching Geography.

The findings of the study conducted by Tiwari and Tewari (2012) showed that, the role of GIS is still limited to its use as a pedagogical tool among private schools that mostly cater to elite populations in major urban centers across India. Despite a growing demand for GIS skills, its inclusion as a core component of secondary education remains unfulfilled due to a variety of reasons. They identified some of the key challenges that secondary schools across the country face in adopting GIS and its associated technologies as part of their core curriculums. They also identified specific opportunities for GIS education at secondary school level in India.

Demirci (2011) based on his research study reported that, implementing GIS exercises in a classroom with one teacher demonstrating it on a single computer can be an effective teaching and learning method especially for schools in which there is a lack of computing resources available to geography teachers.

Henrickson (2010) did a comparative study of databases and the application of geographical information systems for education researchers. It was a citation study, which included quantitative and qualitative analyses of three databases namely, AEI, BEI and ERIC. The findings of the study indicated that, a wide variety of uses of GIS technology have emerged over the last twenty years, and new technological methods have started taking hold in educational systems.

Conclusion

Technology and its innovations haveinfiltrated into every aspect of human life and the field of education is not an exception. With the change of time the methods of teaching Geography that were prevailing were replaced by modern teaching methods. An analysis of the literature on GIS makes it clear that, GIS is an effective way of instructing Geography at secondary school level. It creates a sense of interest in the learners, motivates them, makes the concepts taught concrete and also helps in long term retention of the concepts learnt. Thus, it can be said that, every teacher of Geography would adopt GIS technology into their routine classroom transaction activity.

References

Agyei, D. D. (2014). Analysis of Technology Integration in Teacher Education in Ghana.*Journal of Global Initiatives: Policy, Pedagogy, Perspective. 8*, (1), 69-86.

Artvinli, E. (2010). The contribution of geographic information systems (GIS) to geography education and secondary school students' attitudes related to GIS. *Educational Sciences: Theory & Practice, 10*(3), 1255–1292.

Audet, R.H. &Abegg, G.L. (1996). Geographic information systems: Implications for problem solving. *Journal of Research in Science Teaching*.33(1), 21-45.

Baker, T. R. (2015). WebGIS in education. In O. Muniz-Solari, A. Demirci, & J. van der Schee (Eds.), *Geospatial technologies and geography education in a changing world: Geospatial practices and lessons learned* (pp. 105-115). Tokyo, Japan: Springer.

Broda, H. W. & Baxter, R. E. (2003).Using GIS and GPS technology as an instructional tool.*The Social Studies, 94*(4), 158–160.

Degerliyurt, M. &Cabuk, S. N. (2015).Defining the geography by geographical information systems.*Eastern Geographical Review, 20*(33).

Felicity AphiweMkhongi and Walter Musakwa (2020), Perspectives of GIS Education in High Schools: An Evaluation of uMgungundlovu District, KwaZulu-Natal, South Africa, *Education Sciences, 10 (5): 131*, 1-15, DOI: 10.3390/educsci1005031

Fitzpatrick, C. (2001). A trainer's view of GIS in schools.*International Research in Geographical and Environmental Education, 10*(1), 85–87.

GESP (Geography Education Standards Project). (1994). *Geography for Life: National Geography Standards.* Washington, DC: National Geographic Research and Exploration.

Kerski,J.J., Demirci, A., & Milson, A.J.(2013).The Global Landscape of GIS in Secondary Education.*Journal of Geography*,112(6),232-247, doi: 10.1080/00221341.2013.801506

Kinniburgh, J. (2010). A constructivist approach to using GIS in the New Zealand classroom. *New Zealand Geographer, 66*, 74–84.

Komlenovic, D., Manic, E., &Malinic, D.(2013). The geographic information system (GIS) in secondary education in Serbia.*Perspectives in Education*,31(1),36-41.

Lemberg, D. &Stoltman, J.P. (1999). Geography teaching and the new technologies: opportunities and challenges. *Journal of Education*, 181(3), 63-76.

Liu, S. & Zhu, X. (2008). Designing a structured and ınteractive learning environment based on GIS for secondary geography education. *Journal of Geography, 107*(1), 12–19.

Madsen, L. M. & Rump, C. (2012) Considerations of how to study learning processes when students use GIS as an instrument for developing spatial thinking skills.*Journal of Geography in Higher Education, 36*(1), 97–116.

Maureen KaputeMzuzu and Cp Van der Westhuizen (2019), Review on the State of GIS Application in Secondary Schools in the Southern African Region, *The South Africal Geographical Journal, ISSN: 0373-6245*, 1-16, DOI: 10.1080/03736245.2019.1579110

Palladino, S. (1994). A role of geographic information systems in the secondary schools: an assessment of the current status and future possibilities. Available athttp://www.ncgia.ucsb.edu/~spalladi/thesis/title.html

PatrichRickles, Claire Ellul and MukiHaklay (2017), A Suggested Framework and Guidelines for Learning GIS in Interdisciplinary Research, *Geography and Environment-An Open Access Journal, 4(2)*, 1-18.

Pottle, T. (2001).*Geography and GIS: GIS Activities for Students*. Irwin Publishing Ltd., Toronto.

Shin, E. (2006). Using geographic information system (GIS) to improve fourth graders' geographic content knowledge and map skills. *Journal of Geography*, 105(3), 109-120.

Soon Singh Bikar Singh, BalanRathakrishnan, Sabariah Sharif, Rosy Talin, Oliver Valentine Eboy (2016), The Effects of Geography Information System (GIS) Based Teaching on Underachieving Students' Mastery Goal and Achievement, *The Turkish Online Journal of Educational Technology, 15(4)*,119-134.

Swanson, S. E. (2008). GIS.*Journal of Hospital Librarianship, 1*(3), 83–89.

Tinker, R.F. (1992).Mapware: educational applications of geographic information systems. *Journal of Science Educational and Technology*, 1(1), 35-48.

YavuzDegirmenci (2018). Use of Geographic Information System (GIS) in Geography Lessons According to Teachers' Opinions, *World Journal of Educational Technology: Current Issues, 10(3),* 186-196, DOI: 10.18844/wjet.v10i3.3559

Yomralioglu, T. (2009).*Cografibilgisistemleri.Temelkavramlarveuygulamalar*. Trabzon, Turkey: Akademikitabevi.