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Context integration GIS of education relevant in secondary school TVET

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Abstract. An initiative approach that focuses on software for the integration of GIS technology in the secondary school curriculum is the same, regardless of whether one teaches technical secondary school science, social secondary school, or basic art. While demonstration of sample resources and project approaches, technology-based education reforms, structured / standardized professional development workshops or courses, and teacher education programs that focus on technology are different because students need to learn GIS technology using learning materials tailored to their needs and situations. unique. The 'Learn about GIS' approach for TVET secondary school students is an effective way to operate software, with supporting instructions in cartography, database design, and programming. Learning to think of the world through the mediation perspective provided by technology can influence geospatial thinking and its development. The researcher notes that individual teacher support, local data usage, local problem scenarios, and administrative commitment, are critical issues for the development of professional GIS in TVET Middle School. Reforming the science and technology curriculum involving the acceptance of GIS in learning requires continuous professional development, related to the implementation of the GIS curriculum. Therefore, it is important to investigate the skills needed to improve the workability of TVET secondary schools in the Geomatics and Geospatial Engineering department.

1. Introduction

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 [1]. GIS (Geographic Information System) 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 [2].

Geographical research justifies, there are three rationalities that deliver GIS to enter into education, namely: 1) educational justification, supporting geography and environmental education teaching and learning; 2) Justification of the workplace: GIS is an important tool for knowledge workers in the 21st century; and 3) Justification based on place: GIS is an ideal tool for use in studying geographical problems on various scales [3]. Research 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" [4]. The first is related to teaching GIS as the main subject. Some researchers propose the



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need to have a stand-alone GIS curriculum in schools for enhancement of spatial reasoning in all areas of life [5]. 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 [6].

Many benefits are felt when GIS is integrated with the secondary school education curriculum, including: useful to increase the success of cooperative learning and collaboration in the classroom [7], support application problem solving and many other constructivist teaching and learning strategies in education [8]. GIS exposure has been shown to increase spatial thinking or awareness [9]. Using project-based GIS answers questions in producing, querying, analyzing, displaying, and visualizing data. Research shows that using GIS in class *"helps students think critically, uses authentic data, and connects them to their own communities"* [10]. Implementation of GIS education is easier in other disciplines, especially with the availability of online GIS [11]. This opens up new opportunities in teaching and learning spatial analysis of the information contained in Web GIS for spatial case studies in certain areas [12]. Although previous research has proven the usefulness and effectiveness of geographic information systems (GIS) in K-12, teacher adoption rates are still low. The main barriers identified for use are the lack of background and teacher experience. To overcome this limitation, many organizations have provided GIS-related teacher training using a variety of GIS learning materials [13]. On the basis of assumptions where successful use of GIS in education requires teachers to have a strong understanding of; a) knowledge of relevant content; b) GIS software applications; c) data analysis techniques; and d) implementation of pedagogical strategies that meet student needs [14].

The purpose of this article is to highlight current best practices in supporting science/vocational teaching with GIS technology and identifying contributing characteristics that involve students in the use of geospatial technology (GIS) in the classroom. From this study, it is expected to be extracted into the GIS education of vocational high schools (TVET) in the country of researchers (Indonesia), which is only five years integrating 'GIS' in science/vocational education. The composition of writing this article is as follows. In the first section, the authors provide a brief description of the status and development of GIS in international education, especially in secondary schools, followed by the second section exploring the adoption of international GIS and constraints that constrain the diffusion process of GIS in general. In the third section the authors report how to find and select journals that are relevant to empirical studies, as well as how these studies are analyzed in the method section. Finally, the research topics identified and their related findings are reported in the results section; this was followed by discussion and conclusions from the review.

2. Literature review

2.1. International perspectives on 'GIS' in schools K-12

The application of geographic information systems (GIS) and other mapping technologies is increasingly penetrating all levels of industry and society, many argue that it is a national necessity to increase the capacity of schools and universities to prepare students for the "geospatial revolution" [15]. While the adaptation of GIS to education is slower compared to other sectors. GIS has been used in higher education almost from the beginning, but its use in secondary education only began in the early 1990s when it was seen by some experts as a tool that could introduce students to the use of technology and encourage them to be motivated in careers in science and engineering [16].

Adaptation of technological innovations in GIS education occurs in four stages: 1) awareness; 2) understanding; 3) guided exercises; and 4) implementation [17]. In the first phase, it is characterized as the 'What is GIS' Phase, a teacher becomes aware of GIS, perhaps from real-world meetings at local government offices, or in educational settings such as at conferences, or from school district staff development workshops. He has a potential relationship with the current curriculum, moving to the second stage, understanding. At this stage, the teacher must overcome the problem 'How can I teach geography with GIS'. In the United States, most geography and social science teachers are in the category of pre-awareness. It is difficult to move from Phase 1 to Phase 2 because, the geographic curriculum in most US classrooms is a descriptive study of places and regions [18]. Although steps have

been made to improve technology and teacher development, there is still a lot of work to be done. As said [6] "*rapid technological development gives teachers new opportunities to test more software packages and websites in their learning*" (p. 43). While technological capabilities abound, integration is slow. Teachers have not yet realized the high level of effective use of technology both in the United States and internationally [19]. Access is not enough to build technological integration in the classroom [20] because there are various factors that influence the use of technology by teachers, so it is difficult to predict exactly the level at which teachers will choose to apply technology. This is in line with the statement [21] without the support of external mechanisms and GIS reforms likely to remain only for innovators and early users. What are the mechanisms and reforms. One that is needed is that educators must publish what they do to other teachers, students, and school administrators.

Table 1. Five phases in GIS adaptation..

	Stage	Key Question
1	Pre-awareness	
2	Awareness	What is GIS.
3	Understanding	How can I teach geography with GIS
4	Guiding practice	How do I doing GIS.
5	Implementation	

(Adapted from: Bednarz and Ludwig [18])

2.2. Framework 'GIS' in vocational high school (TVET)

The inclusion of GIS TVET secondary school education in 2013, when the 2013 curriculum reforms, and geomatics and geospatial engineering majors were fields of expertise that included GIS integrated with the curriculum. The duration of GIS learning time is 316 hours and Remote Sensing 314 hours, but in a laboratory practice a package is always developed considering the analysis needs involve both subjects. The number of hours per week averages 4-5 hours a week at levels 11 and 12. The use of GIS in vocational schools is still very young, and the readiness to implement it is somewhat slow and stagnant, given its expensive infrastructure. For example, most teachers in operating GIS are forced to copy 'GIS' cracks on the grounds of teaching needs, while to buy licenses to ESRI as the software production party, the vocational school has not been able to remember the price of expensive software. It is said that science/vocational teachers have better access to computers than their counterparts in social sciences [22]. Whether the argument is true or not, it is quite clear that technical classrooms and social sciences initially access and use technology for different reasons [11]. Engineering teachers, increasingly trying to model class activities in the form of scientific investigations, foster an environment where student data collection and analysis is common [23]. Laboratories and field studies that are typical in vocational, and the logical development of these activities often requires some form of data analysis [24]. Based on the Regulation of the Geospatial Information Agency (BIG) Number 7 of 2017 concerning Work Competencies in the Geospatial Information and Implementation of Indonesian National Qualification Framework Standards (SKKNI), graduates of Vocational Information Systems (GIS) are in the third level at the GIS Operator level and the GIS curriculum at vocational schools is equivalent to the third level (operator) of the type of unit determined by the Geospatial Information Agency.

Table 2. Basic Geographic Information System Subject Competence

No	KNOWLEDGE AND SKILLS OF GIS	Time (hours)
1.	Understand and Presenting the concept of Geographic Information Systems	10
2.	Understand and Presenting spatial data and non-spatial data	15
3.	Analyze and Presents the need for spatial data	20
4.	Analyze and Presenting the need for non-spatial data	20
5.	Implementing and Using spatial and non-spatial data sources	25
6.	Analyze and Presenting spatial data	25
7.	Analyzing and Presenting non-spatial data	25
8.	Apply and Converts the spatial data conversion method	15
9.	Apply the method of converting non-spatial data	10
10.	Evaluate and Presents the results of spatial data conversion and non-spatial data	10
11.	Evaluate and Presents the results of spatial data conversion and non-spatial data	15

Source: [25]

3. Method

3.1. Research methods

To provide a further general overview of research [21] regarding available and convincing research, we have chosen to limit our analysis to articles from 2006-2018 (12 years randomly selected) that were reviewed by researchers published in the journal- indexed journals such as; ScienceDirect, Taylor & Francis, Springer, Wiley, Cite and Sage Journal. This choice is based on several businesses including; to present results that persist from minimal scientific quality testing through systematic reviews that are usually provided by research journals; second, to ensure that the journal is not published by the author other than those owned by the scientific community; and the third, more fundamental is that GIS found more places in the secondary school curriculum in North America and Europe [26]. For reasons of eligibility, we also choose to limit our search to educational resource information centers through the ERIC website (<http://www.eric.ed.gov/>) and the Google Scholar website (<https://scholar.google.co.id/>) which is by far the most popular and complete indexing system for educational research. This article starts from the exploration of 'Books, International Perspectives on Teaching and Learning with GIS in Secondary Schools' [27]. This book tells stories from 34 countries on the continents of Europe, America, Australia and several countries on the Asian continent that illustrate their experiences that can be extracted while bringing GIS education to secondary schools. Then in the second part, it was continued by identifying comparative factors that played an important role in adopting GIS in secondary schools on the European-American continent with the Asian-Australian continent from several studies.

3.2. Sampling methods

We have chosen and limited the choice of articles with keywords such as 'adoption', 'diffusion', 'implementation' and 'GIS curriculum integration' in secondary education. To provide a comprehensive understanding of GIS in secondary education, we provide a review of the literature that teachers need for technology integration is the same regardless of whether one teaches technical secondary school science, social secondary school, or basic arts. The choice of articles not written in English is not included by the author because of limitations in language. In order for this review to remain manageable in size, we also chose to limit our analysis to articles relating to GIS education at the secondary school level, and the collection and screening of journals were also carried out in two parts, namely; The first author collected GIS journals in secondary school education, followed by a search based on the sub-themes of the needs of this article. To avoid post hoc correlation analysis in disclosing the content of the selected article, we will answer this part of the research question based on the vision of using integrated

technology in the class at this time and past that has been conceptualized with five general approaches namely; a) Initiatives that focus on software; b) Demonstration of sample lessons on resources and projects; c) Technology-based education reform; d) Structured/standardized professional development workshops or courses; and e) Teacher education programs that focus on technology [28].

3.3. Procedure for selecting articles

The article selection procedure followed by this article is under the heading "*Interest, motivation and attitude towards science and technology at K-12 levels: a systematic review of 12 years of educational research*", which approves and validates ways to interrogate ERIC databases and limit compromises in terms of corpus wealth. In early October 2018, using the website <http://www.eric.ed.gov/> the database is looking for 'peer-reviewed' journal articles from 2006 to 2018 with the title "GIS Education High School (K12)" As many as 269 articles. Each journal article containing one or more of the four words of adoption/diffusion/implementation and integration of GIS and one or more words of GIS or Geospatial as many as 191 articles fall within this criterion. Our second screening phase is released from corpus articles that are not published in special journals for secondary school GIS education or for education in general and for journal titles do not mention GIS, Geospatial or GIS & T (considered as title keywords), or keywords 'secondary education', totaling 170 articles. Based on opinions the vision of the use of integrated technology in the class at the present and the past has been conceptualized with five general approaches, namely; Initiatives that focus on software; Demonstration of sample resources, Lessons and projects; Technology-based education reform; Structured/standardized professional development workshops or courses; and Teacher education programs that focus on technology [28]. From these results we have selected 58 articles that can be used as the basis for using integrated GIS technology in TVET secondary schools.

4. Results

Based on opinions vision of the use of integrated technology in the class at the present and the past has been conceptualized with five general approaches, namely; "Initiatives that focus on software; Demonstration of sample resources, lessons and projects; Technology-based education reform; Structured/standardized professional development workshops or courses; and teacher education programs that focus on technology" [28]. From these results we have selected 58 articles that can be used as the basis for using integrated GIS technology in TVET secondary schools. For successful technology integration, many scholars have emphasized the importance of the role of teachers, for example [29]. Teachers must be confident and competent enough to use technology with their students [30]. In order to persuade teachers to use technology in the classroom, there must be strong support and guidance for teachers, such as providing content-specific examples of technology-based lesson plans and technology integrated pedagogy [31]. In other words, teachers need to learn new technologies using learning materials tailored to their unique needs and situations

Table 3. The Concept of Using Integrated Technology in Classes

No	Approach	Study	Total
1	Initiative that focuses on software	[32–55]	24
2	Demonstration of sample resource and project lessons	[56–63]	8
3	Technology-based education reform	[64–71]	8
4	Structured / standardized professional development workshops or courses	[39,71–82]	13
5	A teacher-focused technology education program	[79,83–87]	6

(source from : <http://www.eric.ed.gov/>)

4.1. The concept of use GIS technology integrated in classes of secondary school TVET

Although different from each other, this approach tends to start and organize their efforts in accordance with the educational technology used, rather than students' learning needs for curriculum-based content standards. Although many educational technology researchers have called for the integration of technology based on pedagogical content for more than a decade professional development for teachers still emphasizes and is regulated according to capabilities and technological constraints. Argue that based on the vision of the use of integrated technology in the classroom at present and in the past it has been conceptualized with five general approaches, but the use of GIS Successful techniques in education require teachers to have a strong understanding of relevant content, geospatial software applications, data analysis techniques, and pedagogical implementation strategies that meet student needs [14]. Although different from each other, this approach tends to start and organize their efforts in accordance with the educational technology used, rather than students' learning needs for curriculum-based content standards. Of the five approaches outlined above, point 1 'software-focused initiatives' shows the implicit assumption that the professional knowledge teachers need for technology integration is the same, regardless of whether someone teaches technical secondary school science, social secondary school, or basic arts, while points 2-5 the author places more emphasis on engineering or geospatial fields. The success of technology integration also recognizes the ways in which many and constantly changing contextual realities of class and school influence what teachers do and what students learn. The TPACK framework focuses on teacher competence and is valuable when designing professional development. Considering the TPACK framework, a successful strategy for teacher training is a collaborative model [51]. When applied to GIS, a collaborative investigation model was designed to address common barriers to using GIS such as lack of curriculum, support, and data [74].

4.2. What practices are best for teaching with geospatial technology in TVET secondary schools

Work through problems while simultaneously acquiring skills with GIS operations Imitate GIS applications for "real world" problems, bridging conceptual and technical learning. The use of PBL (problem-based learning) and GIS together promotes strong analytical and critical thinking skills [88]. These "pretend" problems may be planned tightly, placing the burden of design and preparation on the previous instructor, but then minimizing the possibility of unexpected data problems and software problems or other questions. What are examples of best practices for successful teaching with GIS technology to facilitate the development of geospatial thinking and the habit of spatial thinking. Maps, charts, graphs, and representations on GIS carry a view of information that will be difficult, if not obtained from direct experience in the real world. GIS facilitates data collection, spatial visualization, analysis, and filtering or querying spatial data, all activities that can be used to understand data and spatial patterns. Learning to think of the world through the mediation perspective provided by technology can influence geospatial thinking and its development [89]. Many researchers state that the use of GIS for this type of activity can help improve students' spatial thinking skills. However, empirical research in this field is limited and narrow, such as research that focuses on one class or one time GIS learning activity [45].

The absence of validated instruments to assess geospatial thinking is a barrier to advancing research around GST and geospatial thinking. Effective evaluation instruments will be able to distinguish between testing students' ability to use GIS software techniques correctly and their ability to think geospatial (see. [46,51,83]). The AAG study group analyzed samples from three introductory GIS & T courses that were used to develop standard course descriptions assessing students' knowledge, skills, and abilities in GIS & T [43]. He observes the following four types of general assessment: a) Formal tests and examinations are used to assess students' / students' knowledge, skills and abilities in GIS & T. Test items include the following formats: multiple choice, grid-in, free response (short answer), and free responses (formal essays); b) Reasoning exercises and geospatial mapping are used to evaluate students' proficiency in the use of GIS mapping software and applications such as QGIS or ArcGIS Online; c) Portfolios and projects are used to provide evidence of students' ability to apply GIS & T knowledge and skills to make products, conduct spatial analysis, or solve geographical problems

(including group collaborative work); d) The assignment of computer labs is used as a measure of how well students carry out various GIS mapping and analytical operations.

4.3. *Implementation professional development of geospatial teacher training*

In the setting of professional development, researchers have reported that individual teacher support, use of local data and localized problem scenarios, and administrative commitments, are critical problems for professional development of GIS. Curriculum material can be designed to influence teacher decision making by conveying learning practices, providing appropriate content material, or providing pedagogical implementation ideas [46]. Professional teacher development that integrates GST in educational curriculum material for teachers [39] has been found to support the growth of professional science teachers related to knowledge of geospatial pedagogy science [76]. Peer coaching, practicing teaching with students, and developing coherence with district education goals and personal goals of PD teachers have also been shown to be effective tactics, as well as relevant content for students [14], but again, in small scale studies with limited application opportunities. As is often the case, a larger scale of efficacy studies (an individual's belief in his ability to succeed in doing something) is needed to determine the effectiveness of these practices, including research to reveal how the efficacy of each practice varies in various fields of content, experience teacher with GST, class level, and student population; and examining how PD-based research at GST is applied to discipline-based content fields can greatly influence student learning.

5. Conclusion

A key component of the successful integration of technology into science and engineering teaching is technology literacy [90,91], which is defined by three dimensions, namely: (a) factual and conceptual knowledge of various technologies and functions, (b) the ability to use and solve technology choice problems chosen, and (c) critical thinking and decision making about appropriate use. Second, the aim of professional development is to prepare teachers to implement the GIS curriculum in a consistent manner, a basic teaching framework and focus on developing the application of successful geospatial technology with students. Each group of Teachers receives 30 hours of professional development and additional support sessions before implementing a development-focused curriculum for their comfort and confidence using geospatial learning and laboratory investigations with a new curriculum [39]. Third, teacher trust is considered part of the perspective of success in teaching and learning. According to him the perspective theory is a series of interrelated intentions and beliefs, intentions and objectives refer to what individuals want to achieve, while beliefs refer to interests, reasonableness, and intentions and behavioral justifications [92]. The need for research to measure the stages of acceptance of GIS for TVET teachers in Indonesia, is the first step in convincing teachers about the benefits and added value of GIS, while also reducing obstacles in the use of GIS as teachers' daily routines.

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