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Analysis of Geo-informatics Teaching Capabilities of Teachers in Thai High Schools by Geographic Information System

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Abstract

This study was aimed to create criteria and develop a teaching capability model of geo-informatics in Thai high Schools. The 19-item-closed questionnaires, developed using key information in social studies strands approved by the Ministry of Education and weightings of major and minor criteria judged by 10 geo-information experts, were responded by 57 teachers of geo-informatics as target group and interviews were made with the same group. The questionnaire data gained were used to construct the GIS Model to assess teaching geo-informatics capabilities in schools. Weighting criteria as the most important criteria included personnel (73%), tool (16%), and teaching methods (11%). The most important minor criteria consisted of experience (28%) and training (12%), and geo-informatics teachers (9%). Based on analysis of geo-informatics teaching capabilities in schools, as a whole, schools' capabilities in teaching geo-informatics were found at high (12%), moderate (26%), low (54%), and the lowest (7%) levels respectively.

Keywords: Geo-informatics, Social Studies Teachers in High Schools, GIS

1. Introduction

Presently, geo-informatics has been a teaching tool for teaching geography from elementary to college levels (Bednarz & Van der Schee 2006; Demirci & Karaburun 2009; Kemp 1997; Melissa & Bradley 2011). In Thailand, as stipulated in the High School Curriculum under the National Education Act, and Basic Education Curriculum B.E. 2551 (2008), the Ministry of Education has emphasized use of geo-informatics tools in Social Studies classes for Grades 10-12 (Ministry of Education 2008). The aforementioned tools are called "3S" and comprise Remote Sensing (RS), Geographic Information System (GIS) and Global Positioning System (GPS) (Geo-Informatics and Space Technology Development Agency 2009).

The objectives of teaching and learning of geo-informatics are that students will understand issues about geology more clearly and widely and be able to develop their thinking and learning processes such as environment, economy, history, society, science, agriculture, and so on (Overman 2008; Johanson 2003; Kerski 2003; Bednarz 2004). In addition, teachers of geography need to teach geo-informatics in school since they will be able to analyze spatial and attribute data which contribute to image and statistic data. Such data can be used to construct a spatial model (Taylor & Johnson 1995) and enhance teaching and learning of geography as a tool to verify solutions to environmental problems which vary according to diverse areas. Geo-informatics then becomes a prominent tool for business world in the 21st century.

Digital data from geo-informatics were applied into planning, educational management (Banskota 2009), data collection including physical and resource allocation, school efficiency and development of the World's learning (Suwanlee 2010) as well as environmental analysis and problem resolution at the local level (Bednarz 2004). Such issues are related to strategies on scientific and technology development.

From previous literature review, geo-informatics teaching in schools was classified into 2 groups, that is, "teaching with GIS" referring to teaching and explaining about the GIS and "teaching about GIS" requiring teaching aids as examples of GIS (Lemberg & Stoltman 2001; Kerski 2003; Bednarz 2004). Evidently, the use of the GIS in the US in 2000 was less than 5% and the UK, France, Sweden and Finland obtained the GIS (54.9%) which had not been used (OFSTED 2004). The use of the GIS in New Zealand was about 8% (Olsen 2002), while the highest usage rate was in Singapore, making 43.8% (Yap *et al*. 2008). Both developed and developing countries were likely to encounter curriculum problems (Johanson 2006). Although developing countries, including Thailand, have added geo-informatics topics to the curriculum since 2002, they do not have geo-informatics experts, textbooks, computers, equipment and software (Hunter & Lewandowski 2004; Lloyd 2001; Ottesen 2006; Zhang 2007; Keengwe & Onchwari 2008; Suwanlee 2010). Such problems seem to be obstacles for teaching and learning geo-informatics in those countries.

However, on the same issues, there has been no research on the assessment of geo-informatics teaching capabilities at schools in Thailand. Therefore, this research is considered the basic step to develop geo-informatics teaching in schools in Thailand and Maha Sarakham Province, which is the educational center for teacher professional learning, was a research site. This study covered prominent criteria used to prioritize geo-informatics teaching capabilities and develop a database on assessment of teaching capabilities of teachers of social studies courses. To this respect, the GIS was employed as a tool for assessing geo-informatics teaching capabilities. The results would be used as guidelines to develop teaching capabilities and to enhance the efficiency of the schools and teachers.

2. Materials and Methods

Maha Sarakham province, locally known as "Takkasilanakhon" or "Center of Education", has several higher educational institutions. It has been a destination of many students from all over Thailand and become the center of the teacher professional learning. As a result, the researcher chose Maha Sarakham Province as a research site to develop a geo-informatics teaching database of 57 teachers of Social Studies courses who represented 57 high schools throughout Maha Sarakham province (Figure 1). To reach the objectives of the present study, the geo-informatics teaching information for high schools designed in Basic Education Curriculum B.E. 2551 (2008) by the Ministry of Education was used as descriptors for designing questionnaires.

2.1 Research Tools

To collect latitudes and longitudes of schools, the filed survey tools consisted of the GPS and topographic maps of scales **1**: 50,000 of the Royal Thai Survey Department. Questionnaires were used to collect general information of schools, teachers and teaching tools. The ArcMap 10 Program with the PC was used to analyze geo-informatics teaching capabilities.

2.2 Data Analysis

2.2.1 Factor Affecting Prioritization

To test the factors affecting geo-informatics teaching capabilities, variables and weights of factors were determined by 10 experts comprising the Director of Educational Regional Area, school directors, domestic and international university lecturers (geography), geo-informatics experts and school teachers. Later, the Analytic Hierarchy Process (AHP) was conducted and used to determine the factors in the following 3 steps: 1) 10 experts indicated whether or not they agreed upon the proposed major factors and minor factors (Figure 2); 2) 10 experts compared pairs of major factors and determined their weights (Table 1); and 3) 10 experts considered the level of importance of each minor factor and calculated their weights which constituted 100 in total.

3.2.2 Data Analysis (Questionnaire and Interview)

The 19-item-questionnaire in closed and open-ended format was constructed and then piloted to see whether the items were reliable and understandable. Then, the complete questionnaires were posted to 57 teachers of geo-informatics as informants. In the same time, telephone and in-person interviews were made with those teachers to validate the data given as use of triangulation. The data were then analyzed by means of percentage.

3.2.3 Analysis of Geo-informatics Teaching Capabilities in Schools

Data gained in the study was used to prepare the database for the GIS and the process was as follows:

- Spatial Data included data about administrative boundary and school locations which were determined by GPS and such data were compared with topographic map,
- Attribute Data consisted of descriptive data about major and minor factors which were changed to tabulated data and transferred to database management system (DBMS),
- Analysis of data in DBMS was a process of the data calculated by the GIS and ten experts weighed and rated each layer of the factors as shown in Figure 2. Then, the results of weightings and ratings were used to create the following equation using ArcMap 10 Program.

$$S = W_1R_1 + W_2R_2 + W_3R_3 + \ldots + W_nR_n$$

$W_1 \ldots W_n$: The weighting mean of the first factor to n

$R_1 \ldots R_n$: The rating of the data class of the first factor to n

With reference to data obtained from the questionnaire, the geo-informatics teaching capabilities of the teachers who represented schools' geo-informatics teaching capabilities as a whole were analyzed by the GIS, which was used to create following the above equation.

Based on the assessment factors and standard scores, the teaching capabilities of the geo-informatics teachers were divided into 4 levels. The interval scales were set as high level (2.51 - 3.00), moderate level (2.01 - 2.50), low level (1.51- 2.00) and the lowest level (1.00 - 1.50), respectively.

4. Result

4.1 Analysis of Factors Affecting Geo-informatics Teaching Capabilities

When factors affecting geo-informatics teaching capabilities were assessed by 10 experts, the experts agreed upon all major and minor criteria and the Analytical Hierarchy Process (AHP) by Expert Choice Program. With reference to the Pair wise Comparison, the weightings as used for constructing criteria were personnel (73%), tool (16%) and teaching methods (11%) respectively.

The experts prioritized 19 minor criteria according to percentage because the Pair wise Comparison was not improper and might provide incorrect results. The weighted average was the multiplication of weighting of major and minor criteria. For the criteria for personnel in terms of experience and training, teaching hours, the number of teachers, students, and teaching assistants, weighted averages were 28, 12, 9, and 6 respectively. For the criteria for tools in aspects of computer and the Internet, the GIS, RS, GPS, textbook and video, and globe, compass and map, weighted averages were 4, 3, 2, and 1 respectively. According to the criteria for teaching methods with particular reference to GIS teaching, RS teaching, GPS teaching, content difficulty and teaching procedures, and student performance, weighted averages were 2 and 1 respectively.

4.2 Geo-informatics Teaching Database

Based on the data gained from the questionnaire responded by 57 geo-informatics teachers of 57 high schools in Maha Sarakham, the survey results were used to build a databases on geo-informatics teaching capabilities of each school which were used as guidelines for constructing a model.

4.2.1 General Information of Geo-informatics Teachers

Geo-informatics teachers were female (51%) and male (49%). They aged 41-50 years (53%), followed by 50 years and over (21%) and 31-40 years (14%), respectively. Most of the geo-informatics teachers completed a bachelor's degree (81%) in geology, history, social studies, educational management, general management, social development, psychology, whereas some (19%) held a master degree in educational management, educational technology and Thai Studies. About 9% of the geo-informatics teachers completed geology programs, so most of them encountered teaching difficulties. Most geo-informatics teachers have been teaching Social Studies for more than 20 years (40%), followed by 10-20 years (36%), and 1-5 years (16%), respectively. The school sizes were small (43%), middle (36%) and large (21%).

4.2.2 Information of Geo-informatics Teachers

The social studies course contents are categorized into 5 groups, namely, (1) contents about religion, morals, and ethics, (2) contents about citizenship, culture and social living, (3) contents about economics, (4) contents about history, and (5) contents about geography. Most teachers (70%) had weekly teaching loads of 11-20 hours and the rest (30%) taught more than 20 hours per week. As a compulsory teaching duty, teachers mostly in small and middle-sized schools have to teach almost every content which is expected to cover all 5 categories in one semester. As a result, such teaching loads reduce their time for preparing materials and searching for more information which turns out to be lack of knowledge and skills for such subjects.

The teaching experiences of teachers of geo-informatics, usually using a variety of course books which provided related topics and were approved by the Ministry of Education, were 1-5 years (61%), above 10 years (16%) and 6-10 years (12%). Also, the number of teachers teaching only geo-informatics courses was more than 3 (44%), followed by 1 (28%) and 2 (19%) respectively. The number of students per class showed about 20 – 30 (40%), 31 – 40 (40%) and above 40 (18%). In terms of geo-informatics teaching, most teachers had never been trained (82%) and the rest were trained only once two years ago (18%) because these teachers were not informed of the training workshops and there were shortages of teachers in schools.

4.2.3 Geo-informatics Teaching Tool

In terms of provisions of computers for teaching and learning of geo-informatics, it was found that the ratio of a computer per a student was at 1:1 – 1:5 (82%), followed by 1:6 – 1:10 (14%) and 1:11 – 1:15 (2%), respectively. However, such computers were not implemented in most of the geo-informatics classes since they were taken for computer classes. With reference to the Internet system, most schools had the Internet with normal speed (47%) and slow speed (37%), while some schools had defected computers (16%). In addition, most schools had difficulties in getting connected to the Internet system because schools often changed the Internet system which caused problems on teaching and learning geo-informatics. In terms of use of the geo-informatics tools (GIS, RS, and GPS), all schools (100%) had no such tools since most of the problems derived from teacher's lack of knowledge on using the tools as well as insufficient budgets. In aspects of use of textbooks for geo-informatics courses, most schools (68%) used neither geo-informatics textbooks nor video, while some schools (32%) used 1-5 geo-informatics textbooks. For teaching aids such as globe, compass and map, most of the schools (91%) obtained 1-5 pieces of obsolete globes, whereas every school had neither compass nor map, and some schools (9%) had no teaching aids for geo-informatics at all.

4.2.4 Teaching Methods of Geo-informatics in Classroom

Teachers of geo-informatics of all schools (100%) had not been teaching the GIS program. Teachers of geo-informatics of most schools (96%) had not been teaching RS, except for only 4% of those teaching this topic for 1 -2 hours using the information from Google Earth. In a similar manner, the GPS had not been taught in most schools (98%), while 2% of the teachers of geo-informatics had been practicing for 1-2 hours because of their own interest.

In terms of the level of teacher's understanding of the contents as content difficulty, it was found that 61% for fairly low level, 32% for moderate level, and 7% for the lowest level. For teaching methods and information exploitation, most teachers (68%) emphasized textbooks approved by the Ministry of Education as a major information source, and the rest (32%) looked for another source such as the information on the Internet. As for the follow-up activities, most teachers (95%) assigned students geo-informatics homework, while some teachers (5%) did not have any assignment at all.

4.3 Analysis on Schools' Geo-informatics Teaching Capabilities

According to the Weighting Overlay Model constructed based on obtained school database, it was found that teachers' teaching capabilities of geo-informatics were found at the lowest level (7%), the low level (54%), the moderate level (26%), and the high level (3%) respectively as shown in Figure 3.

5. Conclusions

Both in practice and literature, there has no ranking of the importance level of factors in teaching and learning of geo-informatics in Thai Educational System so far. This causes doubts and curiosity about why teaching of geo-informatics has not been advanced in high schools in Thai contexts. The present study then revealed basic information collected from a survey research. Overall, first, most of the teachers who teach geo-informatics courses in high schools are about 45 years old on average and seem to be behind the time when new technology as geo-informatics tools were introduced. Furthermore, they have too many teaching loads and are unable to participate in the training workshops on geo-informatics tools elsewhere in Thailand. Second, budgets allocated for new geo-informatics tools, textbooks, or even basic teaching aids such as globe, compass, and map are not sufficient. To this respect, teachers who are assigned to teach geo-informatics courses manage such classes with different textbooks and provide students with different information which causes different teaching methods ending up with different results in term of contents and skills. Third, teaching methods of the geo-informatics teachers are found limited since the teachers themselves lack content knowledge as well as skills in using geo-informatics tools. To get these problems solved, most of the teachers turn to rely on what the textbooks provide which could not give as much geo-informatics information as students are expected to learn. In sum, the problems on geo-informatics taught in high schools in Maha Sarakham province reflect the skills in teaching geo-informatics courses which teachers should obtain and what the schools themselves should provide to enhance such capabilities.

According to what the present study found as the objectives required, the information about personnel and geo-informatics tools would be an example of basic guidelines for constructing online database for geo-informatics teaching capabilities all over a country. In practice, regarding problems on personnel who are responsible for geo-informatics courses, schools should assign the teachers who completed a program in geo-informatics to teach such classes. If not, schools should provide teachers who have to take care of those classes, but do not have much knowledge on geo-informatics with ample opportunity to take part in training workshops on geo-informatics. In terms of teaching aids, Open Source on the Internet together with Google Earth which are easy to be downloaded would be alternatives for replacing traditional teaching methods. Moreover, a complete step of geo-information teaching capabilities requires co-ordinations and co-operations of different sectors such as educational institutions, university lecturers, school directors, and teachers for improving standards in teaching and learning geo-informatics in high schools throughout a country.

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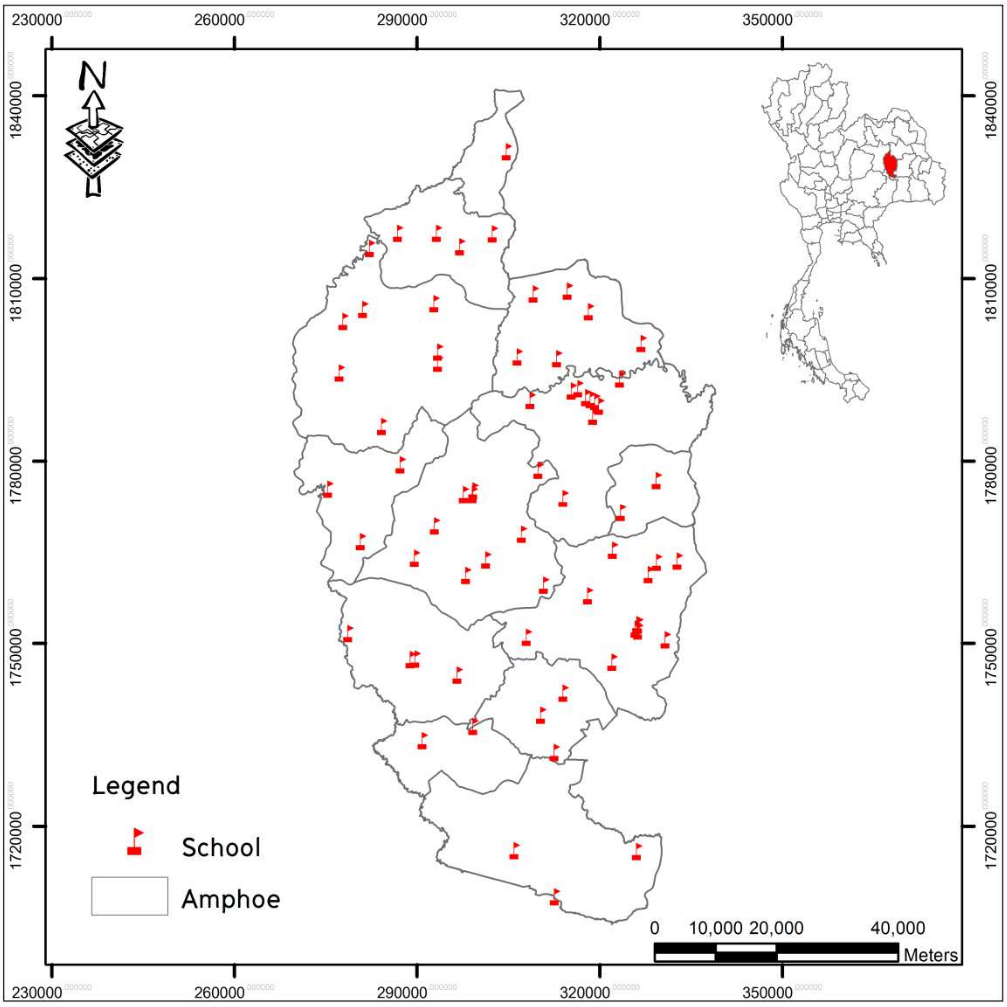

Figure 1. A Survey of 57 High Schools in Maha Sarakham Province as a Research Site

Factors Affecting Geo-informatics Teaching Capabilities

Personnel	Tool	Teaching Methods
• Experience • Teaching hours • Number of Teachers • Number of Students • Training 3S • Training Assistants	• Computer • Internet • GIS Software • RS Software • GPS Software • Text book and Video • Globe, Compass and Map	• Teaching GIS • Teaching RS • Teaching GPS • Understand Levels of 3S • Teaching Product • Student's Project

Figure 2. Factors Affecting Geo-informatics Teaching Capabilities

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Table 1. Criteria for level of importance

No.	Criteria A	Important A than B					Important B than A				Criteria B
		Very High	High	moderate	Low	equal	Low	moderate	High	Very High	
1	Personal ❶	9	7	5	3	1	3	5	7	9	❷ Tool
2	Personal ❶	9	7	5	3	1	3	5	7	9	❸ Teaching Methods
3	Tool ❷	9	7	5	3	1	3	5	7	9	❸ Teaching Methods

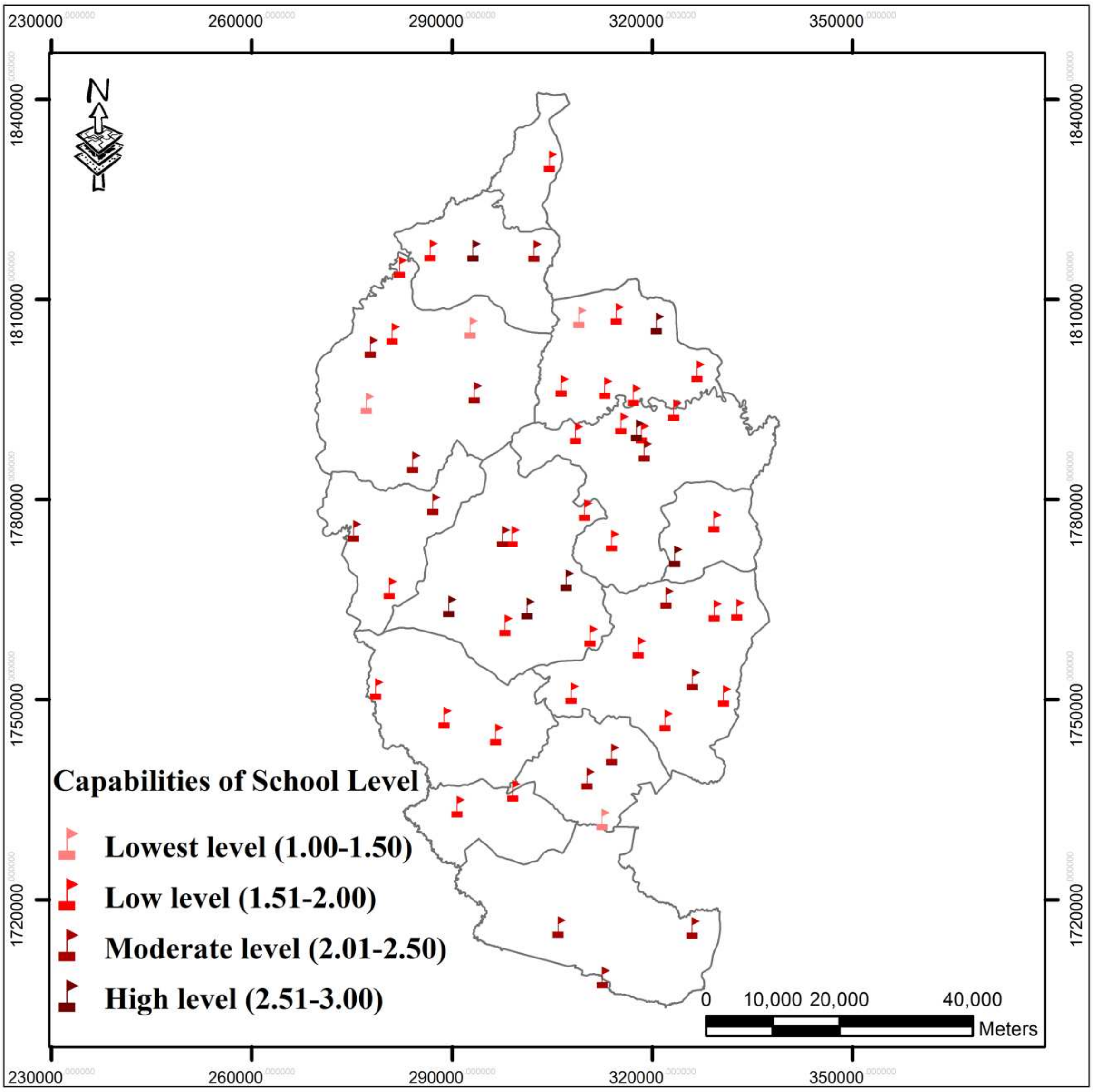

Figure 3. Geo-Informatics Teaching Capabilities of High Schools in Maha Sarakham Province

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