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GIS Education for Teachers in South Korea: Who Participates and Why?

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GIS 교사 연수: 누가, 왜 참여하는가?

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Abstract : Considering that GIS (Geographic Information Systems) has not been widely adopted by teachers despite educators' considerable efforts to incorporate it into secondary education, if some teachers voluntarily participate in GIS in-service education without guaranteed benefits, those teachers deserve attention. This study investigates why teachers actively participated in a GIS staff-development program offered by Seoul National University in South Korea. Questionnaires were distributed to teachers and interviews were conducted. Results indicate that active participants are mostly young teachers who are expected to have had experiences with GIS during pre-service education. Teachers see the potential of GIS, but they also worry about several issues. Participating teachers' primary motivation was to learn enough about GIS to incorporate it into their teaching. Suggestions to facilitate the incorporation of GIS into education are provided.

Key Words : GIS education, Active Teacher, Motivation, National GIS Education Center

요약 : 많은 교육학자들이 GIS를 교육 현장에 도입하기 위해 오랫동안 노력해왔지만 실제 교사들이 GIS를 수업에 사용하는 경우는 그리 많지 않았다. 이러한 한국의 교육 현장 상황을 고려할 때, 어떤 교사들이 보장된 인센티브 없이 자발적으로 GIS 교사 연수에 참여한다면 이는 주목할만한 현상이다. 본 연구에서는 서울대학교에서 주관하는 GIS 교사 연수에 자발적으로 참여한 교사들이 누구였는지, 그리고 어떠한 이유로 참여했는지를 살펴본다. 교사들을 대상으로 설문조사와 인터뷰를 실시하여 자료를 수집하였다. 결과를 살펴보면, 자발적으로 연수에 참여한 교사들은 대부분 대학 교육에서 GIS 관련 수업을 받았을 것으로 예상되는 젊은 교사들이었다. 그리고 연수 참여 동기는 GIS를 수업에 도입하기 위해 필요한 관련 지식 획득과 GIS에 대해 더 알고 싶은 학문적 호기심이었다. 마지막으로 GIS를 교육 현장에 도입하기 위해 고려해야 할 사안들에 대해 논의하였다.

주요어 : GIS 교육, 자발적 참여 교사, 동기, 국가 GIS 교육 센터

1. Introduction

Geographic Information System (GIS) is an "automated system for the capture, storage, retrieval, analysis, and display of spatial data" (Clarke, 1995, 13). Recently, we have witnessed dramatic development of GIS and increasing applications of GIS to geography education. The

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National Geography Standards, *Geography for Life,* (Geography Education Standards Project, 1994) recommended the incorporation of GIS into K-12 geography, and even more emphasis is given to geospatial technologies in the revised version of the National Geography Standards (Stoltman *et al.*, 2008).

Researchers have investigated the benefits of incorporating GIS into the geography classroom (e.g., Kerski, 2003; Milson and Earle, 2007; Mitchell *et al.*, 2008; Lee and Bednarz, 2009; Nielsen *et al.*, 2011). According to Patterson *et al.* (2003), GIS and GPS training conducted through a partnership between a local high school and university enhanced students' geographic understanding significantly. After the high school students were engaged in conceptual and field-based hands-on experiences using GIS and GPS, their test scores exceeded those of university students who had not used GIS and GPS. Kolvoord (2008) reported that GIS helped high school students solve a local problem with real world data. Baker and White (2003) argued that GIS learning improved students' attitudes toward technology and self-efficacy in science. West (2003) claimed the use of GIS positively affected students' perception of usefulness of computers and of their ability to control computers. Milson and Curtis (2009) indicated that students were enthusiastic about learning with GIS because GIS activities provided them with authentic and discretionary learning opportunities. Finally, Sui (1995) claimed that the introduction of GIS is one of the most noticeable trends in geography education.

In spite of this evidence supporting the benefits of GIS in education, GIS has not been incorporated into curricula as might be expected (Bednarz and Ludwig, 1997; Bednarz and Audet, 1999; Kerski, 2001; Wiegand, 2001; Kerski, 2003). Although it appears that research suggests that teachers are typically conservative regarding technology-driven change (Scott *et al.*, 1992), some teachers are not even aware of GIS or the advantages of introducing it into their classes. For example, 89 percent of educators in the states of Ohio and Oklahoma public K-12 schools had never heard of GIS (Donaldson, 2001). This suggests that GIS has not received sufficient consideration as an educational technology at least in secondary education. If teachers are unaware of GIS and its potential as a teaching tool, GIS will not find its way into the classroom (Lam *et al.*, 2009). Teachers play a critical role in educational reform and innovation (Audet and Paris, 1997; Bednarz, 2004; Bednarz and van der Schee, 2006), and therefore, teachers' opinions of and motivation for implementing GIS in their teaching are essential prerequisites for the introduction of GIS in the classroom.

Educators in South Korea have shown interest in using GIS in education (Jung and Kim, 2006; Kim, 2007). Because GIS-related content is introduced in geography textbooks and the use of GIS in Korean society is becoming widespread, geography educators have begun to consider GIS as an educational technology. The National GIS Education Center (NGEC) was created, in part, to address this situation. The center is housed in the Department of Geography Education at Seoul National University. The center offers a one-week GIS education program for teachers during winter vacation. Teachers must apply to participate in the program. Enrollment is determined on a "first come, first served" basis. Because large numbers of pre- and in-service teachers would like to participate in the program, acceptance is competitive. Considering the slow implementation of GIS into secondary education and teachers' hesitation to accept GIS as a teaching tool, teachers' interest in this GIS staff-development program deserves attention. Because participation in the GIS staff development by the NGEC is wholly voluntary without any guaranteed benefits, those who

participate in the program are termed in this article as "active participants." The purpose of this study is to investigate who these active participants are and what motivates them.

2. Description of this Study

This research is concerned with who participates in the GIS in-service program offered by the NGEC and why. To address the "who" question, active participants were asked what subject they taught, how long they had taught, and what experience they had with using GIS in their classroom. To answer the "why" question, we investigated teachers' opinions of GIS in education and active participants' motivation for attending the staff-development program. It is likely that teachers' motivation is associated with their opinion of the value of GIS in education, therefore, this category is included in the "why" part, along with explicit questions asking about motivation. In addition to asking teachers about their assessment of the value of GIS in education, they were also asked for their opinions about the appropriate methods to teach with GIS, the resources and administrative support for incorporating GIS into the classroom, and the future of GIS. The survey also asked teachers how they had heard about the NGEC program to provide potential techniques to facilitate teachers' access to this kind of in-service education in the future. Figure 1 presents the research design. More detailed information of participants, procedures, and analyses follows.

1) Participants

Three types of subjects were included in this study: 1) active participants, 2) passive participants, and 3) non-participants. As noted previously, "active participants" are teachers who voluntarily took part in the staff-development

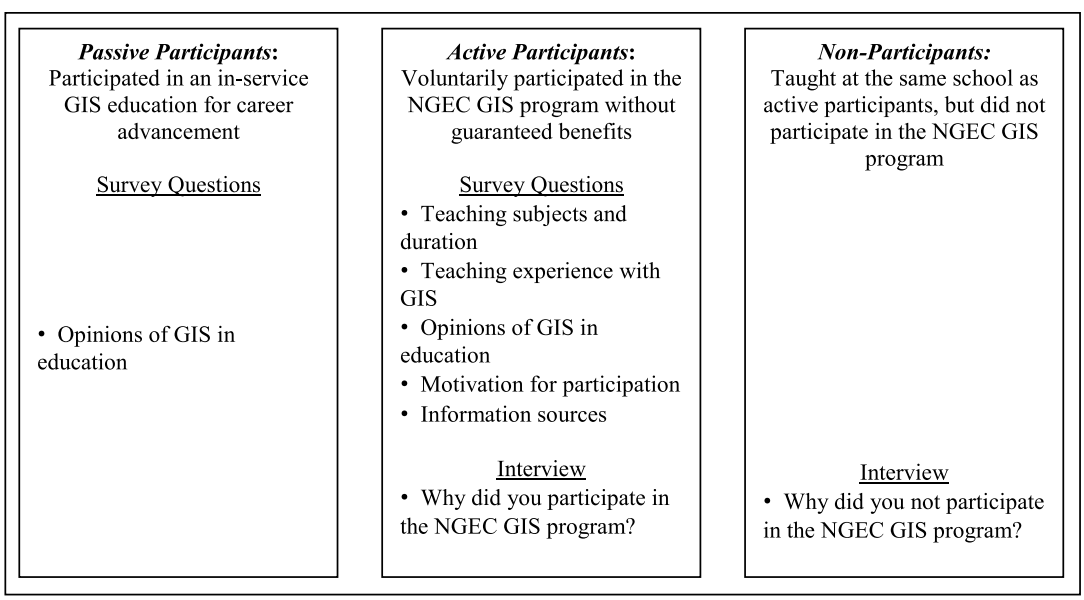

Figure 1. Research Design

program by the NGEC without guaranteed benefits (n=20). "Passive participants" are those who participated in a different in-service program required for career advancement (n=52). Finally, "non-participants" are teachers who taught in the same school as active teachers but did not participate in the NGEC GIS program (n=6).

2) Procedures

A survey was administered to active participants upon completion of the GIS education program offered by the NGEC (Figure 2). Even though the program was designed as in-service teacher education, some pre-service teachers were allowed to attend. Of 37 participants, 20 were in-service teachers, the remaining 17 participants were pre-service teachers. A similar questionnaire was given to passive teachers who participated in a different in-service program (Figure 2). The questionnaire for this group included a question asking whether he/she had voluntarily participated in another GIS in-service education. This question was used to eliminate teachers from the passive group who had voluntarily participated in teacher GIS education before their "passive" participation. Questions that are specifically related to the NGEC program were not included in this group's questionnaire. Fifty-two participants from this second program were included in the analysis.

In-depth telephone interviews with eight active teachers were conducted to supplement and confirm the survey findings. In addition, six peer teachers who worked in the same school as active teachers, but did not participate in the GIS staff-development program (non-participants), were interviewed. We assumed that these teachers faced circumstances similar to active participants, but did not participate. Thus, the

This questionnaire aims to determine why some teachers participate in GIS education. The survey results will be used only for academic purposes. Your sincere responses will contribute to enhancing GIS education. Thank you.

National GIS Education Center (NGEC)

- What subject do you teach in your school? (Please indicate whether you teach in middle school or high school)
- Where is your school located?
- How long have you taught?
- Have you ever used GIS in your class? #

  o If you have, what kind of tools or software did you use?
  o If you have not, why have you not incorporated GIS in class?

- How did you hear about this teacher GIS education program? (multiple selection allowed) #
  1. Internet
  2. Official Document
  3. Peer Teacher
  4. Miscellaneous (Please specify your source of information):

- What is the reason you chose to participate in this teacher GIS program? (multiple selection allowed) #
  1. To get points for promotion
  2. Because it is required by school
  3. To get knowledge for applying GIS to teaching
  4. To know more about what GIS is
  5. Because participation is free of charge
  6. Miscellaneous (Please specify your motivation):

- Have you previously participated in a voluntary teacher GIS program? If so, when and what education program was that? ##

- Do you have any issues or suggestions concerning GIS in-service education or GIS implementation in your class? If so, please provide them.

- The following asks your opinions of GIS in education.

Please select one response for each item below	SD: Strongly Disagree D: Disagree U: Undecided A: Agree SA: Strongly Agree				
	SD	D	U	A	SA
GIS can support geography learning					
Project-based activities are a good way for students to learn GIS					
Use of GIS will increase in the geography curriculum					
I have adequate resources (e.g., computer, software, IT support) to incorporate GIS in class					
GIS enhances students' problem solving ability					
Administrators will support me if I use GIS in my class					
GIS can help improve students' exam scores					
I am likely to incorporate GIS in class in the future					
GIS can support interdisciplinary thinking					

Note: # This question was given to active participants only.
This question was given to passive participants only.

Figure 2. Survey Instrument

reasons they stated for failing to participate in the program might provide insight about the difficulties teachers perceive concerning the use of GIS. A semi-structured interview method was employed. The major question for active participants was "What motivated you to participate in the GIS education program?" and for the non-participants was "Why did you not participate in the GIS staff development?"

3) Analyses

Research findings from the questionnaire surveys and interviews are described in the next section. Opinions of the value of GIS in education of passive and active participants are compared using the data from the surveys. The Mann-Whitney U-test, a nonparametric counterpart of the t-test (Huck, 2008), is computed to investigate whether statistically significant differences exist between these two groups. Differences between active participants and non-participants are revealed by comparing interview responses. This comparison is strengthened and contextualized because non-participants teach in the same school as active teachers.

3. Questionnaire Findings

1) Who Participated in the GIS Education Program?

To understand who the "active" teachers were, participants were asked what subjects and how many years they had taught. Most of the participants were middle school social studies teachers (n=10) or high school geography teachers (n=9). One participant was a high school teacher who taught measurement and computer-aided design (CAD). Because none of the participants taught science, it appears that science teachers in South Korea have not yet become aware of or interested in GIS.

Most participants (80 percent) had fewer than 10 years of teaching experience (Figure 3). Teachers with experience between 1 and 5 years accounted for 60 percent of all participants. The preponderance of young teachers actively participating in the GIS education program may be because GIS-related education has only recently been incorporated into higher education in South Korea, so only younger teachers are likely to have been exposed to GIS education during pre-service training. This situation is similar to that reported for other Asian regions such as Hong Kong (Lam *et al*., 2009). We expect that previous GIS education experience might affect active teachers' interest in GIS. Teachers without exposure to GIS-related education may have difficulty recognizing how GIS can be applied to their classes. In addition, young teachers are probably more accustomed to using computers, thus increasing their interest in GIS or other state-of-the-art technology. Interestingly, however, in the United States (Kerski, 2003) and Australia (Wheeler *et al*., 2010), more experienced teachers are attending GIS in-service education. Kerski (2003, 130) describes this situation as follows:

> The fact that most of these teachers have been in the profession at least 20 years adds significance to this finding: they are more likely to carefully consider the advantages and disadvantages to GIS, rather than "jumping on the bandwagon" of technology. Their acceptance of the tool encourages others to adopt it, rather than to dismiss it as a fad.

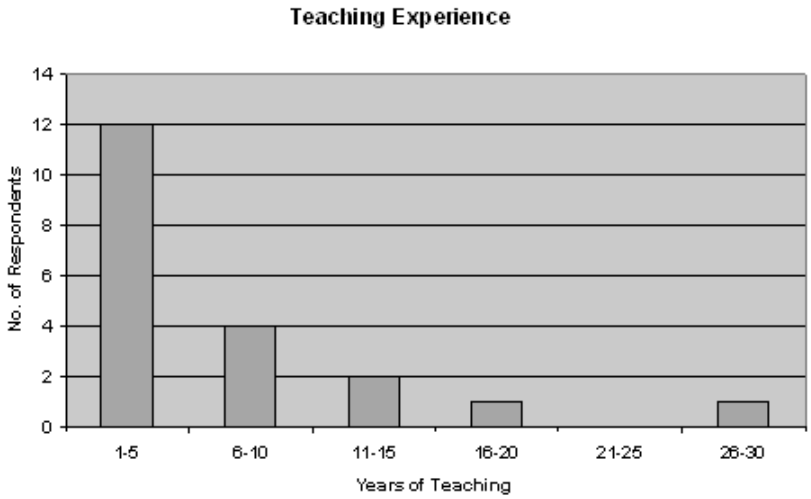

Figure 3. Years of Teaching Experience of Active Teachers

2) What GIS-related Teaching Experience Do Active Participants Have?

Of 20 active participants, eight had used some type of GIS in their classrooms. In general, these teachers did not use desktop GIS software or other sophisticated technology. Most GIS teaching used Internet or web-based software and data or Google Earth. The participants who had not used GIS responded that they could not incorporate GIS in their classes because they did not know enough about it to use it effectively. Whether they had used GIS or not, the teachers' GIS experience was limited.

3) What Are the Participants' Opinions of GIS in Education?

Questions that addressed teachers' opinions about the value, teaching method, support, and future of GIS in education were answered via a Likert scale from 1 to 5 (1 - strongly disagree, 2 - disagree, 3 - undecided, 4 - agree, 5 - strongly agree). Table 1 presents mean scores of active and passive teachers. In general, the opinions of the two groups were similar. Both groups acknowledge the potential of GIS as an effective educational tool and both think that GIS is beneficial for enhancing geography learning, interdisciplinary thinking, and problem solving ability. As is true of teachers in other countries, Korean teachers see project-based activities as an effective way of teaching GIS. Although teachers see the potential of GIS, they also worry about several issues. Teachers do not think that GIS can improve students' exam scores within the monolithic Korean exam system, and this definitely hinders implementation or introduction of GIS. Furthermore, teachers do not believe that they have the necessary resources or sufficient administrative support to incorporate GIS into the classroom. Mean scores of the responses to these questions are mostly less than 3. Thus, teachers in South Korea see both the potential and the obstacles of incorporating GIS into education. When teachers predict whether GIS will become more common in future geography curricula, teachers are neither strongly positive nor negative. Nonetheless, most teachers reveal a positive attitude regarding incorporation of GIS in

Table 1. Participants' Opinions of GIS in Education

Category	Questionnaire Items	Mean Score(Likert Scale 1 to 5)	
		Active (n=20)	Passive(n=52)
Value of GIS	GIS can support geography learning	4.50	4.23
	GIS can support interdisciplinary thinking	4.20	4.10
	GIS can help improve students' exam scores	2.85	3.23
	GIS enhances students' problem solving ability*	4.55	4.17
Ways of GIS education	Project-based activities are a good way for students to learn GIS	4.25	4.12
Support related to GIS education	I have adequate resources (e.g., computer, software, IT support) to incorporate GIS in class*	2.85	2.31
	Administrators will support me if I use GIS in my class	2.45	2.73
Future of GIS education	Use of GIS will increase in the geography curriculum	3.70	3.56
	I am likely to incorporate GIS in class in the future	4.20	4.02

* $p<.05$

their classrooms in the future.

It is interesting that both active and passive participants have similar perspectives about GIS in education. For each of the nine questions, Mann-Whitney U tests were employed to examine whether there is a statistically significant difference between the two groups. The results indicate that statistically significant differences exist for only two items: "GIS enhances students' problem solving ability" (U=367.00, p=.03) and "I have adequate resources to incorporate GIS in my class" (U=345.50, p=.02). More active teachers than passive teachers believe that GIS can improve students' problem solving skills. Active teachers are also more positive concerning the resources that exist for GIS education, even though both groups' absolute scores were quite low. However, no statistically significant differences between the two groups' responses to the other seven questions exist. These results suggest that passive teachers may not be literally "passive," but in fact are "potentially active teachers." Depending on efforts to support GIS in education, these passive teachers could become active teachers.

4) What Motivated Active Participants to Attend the GIS Education Program?

The active teachers' reasons for attending the staff-development program are presented in Table 2. Among the reasons listed by the participants, two, incorporating GIS into teaching and learning more about GIS, stand out. Career advancement was not a concern, and in fact, there was no guaranteed benefit to teachers who took part, nor were teachers required to participate in the program. The lack of a fee for the staff-development program was not a

Table 2. Motivation to Participate

Reasons of participation	Number of Responses
Career Advancement	0
Requirement	0
Incorporation of GIS into the Classroom	18
Academic Curiosity	12
No Charge	1
Miscellaneous	1

Note: Multiple selections were allowed.

significant factor, either. Active teachers were those who eagerly wanted to incorporate GIS in their teaching and those who enthusiastically wanted to learn more about GIS.

5) How Did Active Participants Acquire Information about the GIS Education Program?

Because many teachers complained that they did not know a professional development program associated with GIS existed, the survey asked the participants how they learned about the program (Table 3). Many participants learned about the program through an advertisement on a website where teachers share teaching materials. Although an official document was sent to each school, more teachers obtained information from a conference they attended or from a friend studying at a graduate program. However, no single source of information dominated; teachers learned about the in-service program from various sources. Therefore, a variety of announcements should be created and disseminated to facilitate teachers' interest and participation in GIS education programs.

Table 3. Sources of Information about the GIS Program

Sources of Information	Number of Responses
Internet	6
Official Document	3
Peer Teacher	4
Miscellaneous (e.g., conference, other in-service programs, friend of graduate student)	8

Note: Multiple selections were allowed.

4. Interview Findings

This section compares the interview responses of active participants and non-participants. The reasons active teachers took part in the NGEC program are reported first, followed by non-participants' difficulties in participating in the program.

1) Why Did Some Teachers Participate?

In-depth interviews with the participants confirmed the questionnaire findings and interpretations. Most teachers voluntarily participated in the GIS training because they wanted to incorporate GIS into their teaching and/or they had interest in finding out more about GIS. Almost every interview converged on these two points. For example, one teacher answered that she participated in the in-service program because she thought GIS could be a good tool for teaching geography:

> As you know, there is GIS content in the geography curriculum. Even though it does not cover much about GIS now, I believe GIS is likely to be an interesting topic for today's students who are familiar with computers. GIS could be a powerful weapon for geography to compete with other subjects. But it is indeed difficult to develop educational materials by myself. I do not have enough understanding of GIS tools. I have wanted to get a chance to be educated about GIS. So, I decided to participate in the program.

Another participant's response is related to his academic curiosity about GIS. The participant indicated that he felt he should know more about GIS as a geography teacher:

> I don't think I learned about GIS sufficiently in my undergraduate days. Recently, I find a lot of GIS content ranging from newspapers to geography books, but as a geography teacher, I did not think I knew enough about GIS. I felt I should learn more about GIS. I was curious why GIS is so popular and widespread nowadays. This made me attend this GIS professional development program.

Many teachers participated in the program without any funding. It is not certain whether this is the case for all the participants, but none of the interviewees received support. One teacher who traveled a long distance to attend the program replied to a question about monetary support as follows:

> Never. I do not have any support from my school. I just individually participated in this program. My participation was possible because the in-service program was offered during vacation. I paid everything including transportation, lodging, etc. I stayed at a hotel in Seoul with my friends who also took part in the training, splitting the cost.

In summary, active teachers participated in the GIS staff development because they wanted to get help in incorporating GIS into their classroom. Moreover, they were motivated by academic curiosity to learn more about GIS. These two reasons strongly motivated teachers to participate in the GIS in-service program even without financial support.

2) Why Did Other Teachers Not Participate?

Some teachers teaching in the same school as active teachers did not participate in the GIS program. The interviewer asked why they did not participate even though their peer teachers took part. Their reasons fell into three categories: 1) a lack of GIS content in the geography curriculum, 2) location of the staff-development program, and 3) inaccessibility to information about the program. The teachers who did not participate pointed to the small amount of GIS content in the geography curriculum. They did not feel an urgent need to attend the session. The following response exemplifies this attitude:

> Currently, you know, content about GIS in geography textbooks is just a small portion. I believe you also know about Korean education. If certain content does not appear in textbooks, it subsequently does not appear in the exam much, and I do not have a time to teach it. GIS content in the geography textbook can be taught by simply explaining it verbally. We do not have time to teach it in detail. Moreover, we do not have any hardware or software to incorporate GIS in education. That is definitely related to the fact that GIS is not an important part of the current geography curriculum. I did not feel the need to take part in the program.

For teachers who worked in a region distant from Seoul, the location of the program was an obstacle. Without any funding, it was not easy to attend:

> In actuality, it is not easy for me to be in Seoul for one week without any support. I do not have a friend or a relative in Seoul. This makes me hesitate to attend the program. As you know, the program is not mandatory. I think really enthusiastic teachers would decide to participate.

Furthermore, there were teachers who did not know that the NGEC offered a GIS program for teachers:

I did not even know such a program is offered. I usually do not go to conferences and I have no graduate student friend who can give me information like that. It was my fault for not paying attention to such information, but more advertisements from various sources could be helpful for teachers like me.

5. Discussion and Suggestion

Without teachers' acceptance and recognition of GIS as an effective instructional tool, GIS cannot find its way into secondary education. In this regard, understanding teachers' attitudes is essential. Recommendations based on the surveys and interviews follow. Similar recommendations have been made by other researchers regarding the educational situations in other countries (e.g., Bednarz and Ludwig, 1997; Bednarz and Audet, 1999; Bednarz, 2004; Milson *et al*., 2005; Bednarz and van der Schee, 2006; Aladağ, 2010; Wheeler *et al*., 2010). We believe that our results reinforce the validity of the recommendations and provide another cultural context.

First, it is critical to develop educational resources to help teachers use GIS. Active teachers are interested in incorporating GIS into their teaching and believe in the potential of GIS as an educational tool. To support those teachers, educational materials related to GIS must be developed and provided to them. It is very difficult for an individual teacher to collect data and develop educational materials on his or her own. Active teachers and passive teachers expressed concerns about the lack of teaching materials and modules using GIS. Without solving this problem, even active teachers are likely to lose their passion for GIS and give up. Therefore, systematic and collaborative efforts to develop educational GIS materials are required.

Second, it is necessary to provide a variety of pre- and in-service education about GIS. It would be ideal for pre-service teachers to be given opportunities to learn about GIS. It is difficult to be motivated about something without exposure to and basic knowledge of it. If pre-service teachers are not given opportunities to learn about GIS, it is unlikely they will be interested in GIS. The results of this study showed that most active participants were young teachers who had some GIS experience during their pre-service education, and thus had an awareness of GIS. In-service education is also critical. Active teachers are those who are academically motivated to know more about GIS. A lack of in-service GIS programs that satisfy their academic curiosity can discourage active teachers. Sustained in-service education is crucial to guarantee teaching that enhances students' learning with GIS (McClurg and Buss, 2007). The most frequent response by both active and passive teachers was that more opportunities to learn GIS were necessary. Of course, information about these programs must be widely accessible.

Third, an explicit and rigorous curriculum for GIS in geography is required. The geography curriculum is the fundamental guide for geography teachers. If GIS is not explicitly included in the curriculum, simply expecting teachers to conduct effective GIS education does not make sense. It is not likely that teachers will incorporate GIS if it is not an important part of the curriculum. The interviews support this assertion - the lack of GIS content in the curriculum was identified as a major obstacle in incorporating GIS into the classroom. This is especially true in a country such as South Korea where high-stakes exams are emphasized. The National Geography Standards, *Geography for Life,* (Geography Education Standards Project, 1994) provides a good lesson. The Standards

were written with GIS in mind (Geography Education Standards Project, 1994; Bednarz and Audet, 1999), and more emphasis is given to geospatial technologies in the revised version (Stoltman *et al*., 2008). When explicit guidance about using GIS in education is offered within the geography curriculum, teachers are more likely to use GIS effectively in their classrooms. Linking GIS education to the curriculum has been a long-running and critical problem for GIS education (Bednarz and Ludwig, 1997; Bednarz, 2004).

Fourth, GIS resources such as computers, software, and IT support are important. The history of GIS education in South Korea is much shorter than in the USA or Europe. Only a few teachers are beginning to show an interest in GIS. Even though this study did not explicitly investigate how well secondary schools in South Korea were equipped, it is clear that more investment in GIS resources is necessary (Kim, 2010). Both active and passive participants' opinions identified numerous problems in this area. Therefore, before GIS can be introduced into most secondary classrooms in South Korea, significant improvements in the resources available to geography teachers must occur.

6. Conclusion

This study investigated who participated in the GIS in-service program offered by the NGEC and why. Active teachers who voluntarily took part in the program were young teachers who are expected to have had experiences with GIS during pre-service education. Participating teachers' primary motivation was to learn enough about GIS to incorporate it into their teaching. Non-participating teachers indicated that they did not participate in the program because of the lack of GIS content in the geography curriculum, the location of training, and insufficient access to information regarding in-service program.

Teachers in South Korea appear to believe in the potential of GIS in education, but several issues must be resolved to implement GIS into secondary education. We suggested developing diverse educational GIS resources, providing a variety of pre- and in-service education about GIS, including GIS content explicitly in the geography curriculum, and removing barriers involving computers, software, and IT support.

Educators all over the world have tried to infuse GIS into secondary education. It remains to be seen whether GIS will be actively used in secondary education in South Korea. However, we are certain that the future of GIS in South Korea depends on whether appropriate support is given to active teachers and subsequently more active teachers appear.

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