Student-teachers’ use of Google Earth in problem-based geology learning
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Geographical Information Systems (GIS) are adequate for analyzing complex scientific and spatial phenomena in geography education. Google Earth is a geographic information tool for GIS-based learning. It allows students to engage in the lesson, explore the Earth, explain what they identify and evaluate the implications of what they are learning. This paper introduces one example of using Google Earth for problem-based learning processes in teacher education. Student-teachers’ geographical thinking was analyzed during the study process. We have found that although student-teachers have inadequate skills to use information and communication technology, the use of Google Earth improved student-teachers’ geographical thinking skills, even though they still have difficulties in interpreting maps and analyzing geological data.

Keywords: Google Earth; GIS; PBL; geographical thinking; geology

1. Introduction
Geography instruction in the upper secondary school in Finland contributes toward students’ understanding of global, regional and local phenomena and problems as well as finding potential solutions to such problems (FNBE, 2011). The courses also concern geological issues such as landscape; students will understand how and why natural landscapes change and through using images and maps know how to interpret the structures, origins and development of natural landscapes. Topography is also studied, including endogenous and exogenous processes shaping the Earth’s surface, as well as natural resources, raw materials, sources of energy, the location of industry and principles of sustainable industry and energy economy. The concept bedrock will be studied from different viewpoints, one of them being bedrock as a source of raw materials.

An elective course on regional studies in the upper secondary school is dedicated to Geographical Information Systems (GIS). The present national curriculum for upper secondary school makes it compulsory for Finnish schools to provide this elective geography course for any student wishing to participate in it. During this course, students will conduct small-scale research on a specific, selected region. Among other methods, GIS is used as a tool to collect regional data and produce thematic maps; students are also expected to learn the basics of cartography and GIS. This ambitious aim requires that students will understand the potentials of different GIS applications so that they will be able to process, interpret and visualize geographical data with GIS.

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The role of GIS in the upper secondary school will also meet the teaching and degree requirements stipulated by Finnish universities, particularly regarding teacher education. This means that as pedagogical approaches in the upper secondary school should also be developed, teachers will have to be educated in the use of GIS in instruction and schools should be equipped with adequate computers and programs.

With the aid of GIS, complex scientific phenomena can be analyzed both locally and globally and spatial and temporal aspects can be taken into account. GIS is one of the modern tools for decision-making because it allows the user to visualize and analyze spatial information by revealing hidden relationships, patterns and trends. Wiegand (2001, 2003) points out that if geographers fail to put GIS at the core of teaching geography, there is little confidence that school geography will survive in curriculum competition. In Germany, for example, learning with GIS has had an important role in curriculum development (Schubert & Uphues, 2009). However, as Lam, Lai, and Wong (2009) pointed out, there have been many barriers to the implementation of GIS in schools, one of the most critical being the availability of hardware and software all over the world (Baker, 2005; Ratinen & Johansson, 2005). Providing pedagogy, which will ensure the competency of students’ GIS skills, has also been one of the most important issues relating to the development of school GIS (Schubert & Uphues, 2009). Moreover, although it is known that GIS benefits students’ development of geographic knowledge and thinking skills (e.g. Favier & van der Schee, 2009) and many projects have been developed, for example, for the use of GIS in fieldwork, we still have a lack of knowledge as to how GIS really enhances students’ acquisition of quantitative data and improves their abilities to visualize, manipulate and analyze geographical data.

In this study, the GIS-based study module focuses on geological knowledge, which has been modified from the data of Geological Survey of Finland to be used in the upper secondary school with the aid of Google Earth. Data have been modified for this study module during the Northern Periphery Programme project – Northern Environmental Education Development (NEED; www.uef.fi/need). The project aimed to develop learning environments in science centers, introducing geological knowledge and planning respective study modules. The study modules included several tasks and emphasized problem-based learning (PBL).

This study clarifies how Google Earth could be used as an effective tool to enhance student-teachers’ learning of geology. Moreover, the study examines the challenges of using GIS in geological tasks related to Koli National Park, Finland. To achieve these purposes, the following questions frame the research:

1. How familiar are student-teachers with Google Earth?
2. How does the use of Google Earth improve student-teachers’ content knowledge of geology and geographical thinking?
3. How would student-teachers develop the GIS-based study module?

1.1. The pedagogical potential of GIS

Socioconstructivism forms the framework for GIS-based learning (Kerski, 2001; Schultz, Kerski, & Patterson, 2008). Socioconstructivism is primarily the assimilation of those processes by which humans interpret and explain their world (Gergen, 1991). It is an approach where interpersonal knowledge can only be achieved by social construction of it, therefore focusing on the learning process. After socioconstructivism, PBL and inquiry-based
learning (Minner, Levy, & Century, 2010) approaches have become more common instructional methods in schools, enabling students to change from passive recipients of geographical information to active members of an interacting group. Collaborative GIS-based learning improves students’ orientation for learning and leads to a deeper understanding of GIS. PBL or inquiry-based learning, together with cooperative learning, activates students’ spatial thinking and can be used as a teaching and learning approach when studying through GIS.

PBL is not only a tool for fostering thinking and active learning but also an instructional approach that has the potential to support many of the tenets of constructivist or sociocultural learning theories. Learners actively construct knowledge through interaction with the environment and social discussion. Chang and Weng (2002), when studying 10th-grade students in the context of Earth Science, have found support for earlier studies, which revealed that a problem-solving ability and science process skills are closely tied together. PBL is student-centered and self-directed, and addresses authentic problems. It takes place in small student groups, in which collaborative learning, sharing and negotiating information and knowledge is of prime importance. The teacher is the facilitator of the learning process, stimulating group discussions and monitoring the social group processes (see e.g. Dochy, Segers, Van den Bossche, & Struyven, 2005.) The characteristics of PBL are strongly reflected in the defining features of a powerful learning environment.

GIS has been shown to be an empowering tool for improving access to spatial data and providing a means to examine spatial relationships. GIS facilitates students’ spatial thinking (Sui, 1995). According to Sui (1995), GIS also offers strong connections to geography’s methodologically diverse intellectual core; GIS can serve constructivist pedagogy by developing students’ inquiry experience and their understanding of the constructed nature of research problems. Maddux, Johnson, and Willis (1997) pointed out that GIS

- present multiple representations of the world,
- offer real-life problem-solving tasks in a social context,
- support context- and content-dependent knowledge construction,
- enable collaborative knowledge construction,
- engage in reflective practice and
- provide open learning environments.

The upper secondary students working with GIS tasks in education have increased their use of maps as analytical tools more than when they worked without the implementation of GIS; this strengthens standard-based (NCGE, 2010) skills and encourages spatial analysis (e.g. Schultz, Kerski, & Patterson, 2008). GIS has therefore aided the learning of geographic principles in the secondary curriculum (Patterson, Reeve, & Page, 2003). On the basis of his findings, Wigglesworth (2003) suggests that GIS teaching and curriculum development strategies should begin with an assessment of student understanding of spatial relationships and should continue over time, with a progression that spirals according to the evolution of student cognitive mapping skills. Carlson (2007) has found that the GIS inquiry approach, together with field experience, engaged university students in positive learning outcomes. In their study combining fieldwork with GIS, Favier and Schnee (2009) argue that doing inquiry projects with GIS stimulates students’ research skills: skills for raising geographical research questions, skills in choosing data acquisition methods, skills in collecting data, skills in manipulating, visualizing and analyzing data, and skills in reporting and presenting. They also consider that regarding the learning of geographic thinking skills, higher order geographic thinking operations are predominantly applied in the assignment and discussion phase.
GIS has the potential of facilitating sociocognitive pedagogy through PBL, if, for example, the techniques are to be incorporated into the upper secondary school curriculum. Baker and Bednarz (2003) stated that scientific research on GIS in education supports the view that it helps the students to “do science”, especially when implementing PBL approaches. In this case, the objective of GIS would be to help students better analyze the maps they produce and to understand the meaning of the data included in them. According to Baker and White (2003), PBL unit and a collaborative GIS for supporting data analysis activities improved eighth graders’ attitudes toward technology, self-efficacy toward science and showed modest improvements in process skills, especially geographic data analysis activities. GIS motivates students and influences student ability to utilize higher level thinking skills (Aladağ, 2010). For adults too, PBL–GIS has been engaging when used on online course (King, 2008).

Although there have been numerous literary examples of the infusion of GIS in education (see also Milson & Earle, 2007), it has not been widely adopted by teachers (Kerski, 2003; Ratinen & Johansson, 2005). Barriers for its implementation are, among others, the lack of GIS preparation in teacher education and the high costs of geographical data and GIS software (Milson & Earle, 2009). Concrete evidence of the effectiveness of GIS in the curriculum is also still inadequate. The development of geographical thinking takes time, and even though GIS is based on sociocognitive pedagogy, one must ensure that students understand the phenomena behind their inquiry problems. Having understood the basic features of GIS, it is realistic to begin to use the GIS software. The importance of introducing GIS into schools is not in using it as a mechanical tool or in the technicalities of software design, innovation and modification, but in the scientific inquiry processes by which geographic phenomena are measured, generalized, analyzed and presented with GIS technologies.

Using GIS, different phenomena can be approached from the map layer point of view (superimposition), which enables the user to evaluate and seek similarities between what is already known and the unknown, the familiar and the unfamiliar. According to the theory of learning developed by Rumelhart and Norman (1981), new conceptual frames arise through either continuous development of already existing schemata or discontinuous reconstruction of already existing schemata in GIS-assisted lessons. Establishing an analogy between the familiar and the unfamiliar develops new conceptual frames in which the structures from the familiar are transferred to new domains (Duit, Roth, Komorek, & Wilbers, 2001). For example, by using GIS, it was possible to analyze the aspects of a local heritage landscape and study how students used thematic mapping for its future management (Summerby-Murray, 2001).

1.2. Google Earth as a tool for analyzing geological data

Google Earth, a cost-free software, can be implemented in classroom settings to help make spatial information relevant to students and teachers (Table 1). Google Earth can also be utilized to enable learners to meet challenges during their studies by helping them understand information in a spatial or geographic context; thus, Google Earth supports spatial thinking and also develops critical analytical skills. According to Cates, Price, and Bodzin (2003), the use of Google Earth allows students to engage in the lesson, explore the earth, explain what they identify and evaluate the implications of what they are learning. Google Earth allows students to explore the earth in a dynamic and interactive manner, helping them understand and learn the spatial context of their locale in relation to the global context, in a spatially oriented, entertaining and meaningful manner. Unlike many other
Table 1. GIS functions related to Google Earth.

<table>
<thead>
<tr>
<th>Function of GIS</th>
<th>Functional description</th>
<th>Google Earth’s capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Query</td>
<td>Question asked of a support system</td>
<td>No</td>
</tr>
<tr>
<td>Buffer</td>
<td>Area around an object of specific distance to constrain or contain details</td>
<td>No</td>
</tr>
<tr>
<td>Overlay</td>
<td>Use of multiple spatial data layer registered to all other data layers utilized</td>
<td>Yes</td>
</tr>
<tr>
<td>Proximity</td>
<td>Proximity of features to an object or area of interest</td>
<td>Marginal</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Inter-relatedness of locations</td>
<td>Marginal</td>
</tr>
<tr>
<td>Modeling</td>
<td>Analysis of processes, results, trends or projecting possible results of decisions</td>
<td>Marginal</td>
</tr>
</tbody>
</table>

Note: Modified after Patterson (2007).

commercial software, learners are not required to be at school in order to use Google Earth; its cost-free version can be installed by any user, thus allowing its use outside the classroom and educational environment.

Google Earth does, however, have some disadvantages, requiring a fast Internet connection and a computer that has a fast graphic chip (Patterson, 2007). It is also possible that the accuracy and authenticity of the data may not be easily available, which could have an effect on the educational value of the lesson. Users can themselves upload data to Google Earth, but during downloading would need to understand how to create their own account in order to search for it. Moreover, users have to be familiar with how to open the database once a desirable database has been identified. Google Earth’s capabilities and tools to support true spatial analytical operations are limited (Table 1) in that the tools are not capable of inquiry nor do they allow complex spatial operations.

2. Research design and rationale

The aim of the study was to survey the students’ ideas and skills to use Google Earth as a learning environment, as well as to study how problem-based tasks are suitable for learning with Google Earth. The results of the study were used in the development of assignments. The core of the subject-teacher (teachers in upper comprehensive and upper secondary school) education program in Finland includes one year of pedagogical studies that also include training courses. The data for this study were collected during one of the pedagogical courses. The main purpose of the course is to familiarize student-teachers with the pedagogical aspects of geography learning and teaching; so, PBL in relation to science teaching and systems thinking and geographical teaching methods such cartography and GIS were taught on this.

The study was designed and implemented using qualitative case study methodology. Case study is appropriate when the researcher seeks to develop an understanding of a curricular-instructional innovation such as GIS pedagogy (see Yin, 2003). The case study
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researcher is concerned with a defined system and collects data through purposeful sampling based upon specific criteria.

Participants in this study were 10 subject-teacher students \( (n = 10) \) who piloted the planned GIS assignments, which were related to the geology of Koli National Park. Sampling was gathered from every student who participated in the course in which GIS pedagogy was taught. When the number of students is small, they comment very freely on the course evaluation forms (Drennon, 2005). Piloting composed of \( 4 \times 45 \) -minute sessions and the piloted version of *Google Earth* was 5.0. At the onset of the study, the students filled in the questionnaire with background information: age, gender, studies and hobbies. Furthermore, the students were asked open questions about how, why and how much they had previously used *Google Earth* as well as how they would like to develop it. After the GIS studies, we surveyed the students’ perceptions on the assignments solved by *Google Earth* by asking: What was most advantageous in the GIS-based assignments? How could the assignments be developed? What kind of problems did you have in doing the assignments? What kind of problems did you have in using *Google Earth*?

Data were also collected by field notes on observations made during the lessons. The students’ work was observed during the piloting phase and, if necessary, support was given to help with problems concerning the GIS-based assignments. If students needed instructions to manage the assignments, an account was kept for further analysis of the students’ problem situations. Multiple sources of data (questionnaires and observation) ensure triangulation of data that can be analyzed using constant comparative analysis (Merriam, 1998).

The goal of the analysis is the development of themes and assertions that suggest implications for the field of GIS pedagogy, especially focusing on the use of *Google Earth*. Data analysis in qualitative research has been described as repeatable and dynamic (Merriam, 1998). The goal of our data analysis for this study was to develop illustrations that depict the state of GIS and *Google Earth* for solving geology-based problems. These illustrations were based on patterns in the data, which were revealed through an ongoing process of categorical aggregation. The categories were formed from respondents’ answers to the open questions that focused on continuously emerging issues or concepts. Data from the questionnaires were analyzed based on the students’ comments; answers were formulated into concept categories describing the phenomenon under examination.

### 2.1. Problem for students: Why radiation, magnetism or conductivity exists in some region?

In order to answer study questions, we prepared problem-based tasks for the student-teachers, which they solved during piloting of the study module. The assignments were designed in the context of geology, to help students along several educational purposes (see Patterson, 2007).

1. **Knowledge**: Memorizing, recognizing and recalling the geological aspect and phenomena in Koli National Park.
2. **Comprehension**: Organizing, describing and interpreting geological data.
3. **Application**: Applying geological information via *Google Earth* and solving geological problems with computer aided learning.
4. **Analysis of geological data**: *Google Earth* helps learners to find hidden geological structures and separate geological entity into components as minerals in the bedrock.
5. **Synthesis of geological aspects in Koli National Park**: the core issue in geographical thinking. The spatial aspect is also considered in these GIS-based assignments.
Table 2. Problem: Why radiation, magnetism or conductivity exists in some regions?

**Task description**
Rock and soil radiation, magnetism and conductivity of the soil are regionally studied by PBL learning. Geophysical material is combined with physical geography and GIS teaching. The tasks require for the knowledge of magnetism and radiation.

**Advance information for the tasks**
Magnetism is caused by the bedrock and soil, and their properties. Gamma radiation is mainly from the depth of a few centimeters. There are small amounts of uranium, which free the gamma radiation when weathering, particularly in granitic bedrock. The bedrock mainly accounts for the weak electric conductivity, but the soil too influences it. Magnetism occurs on the map as a “relief” figure. The stronger the radiation of the uranium, the redder it is seen on the map. The red color also refers to increased conductivity.

**Learning objective**
To understand the elementary knowledge of rock and soil (uranium) gamma radiation, magnetism, soil conductivity.

**Time required**
About 45 minutes.

**How to start?**
Activate the map levels by putting the barb to the screen on the front of the map level. When you examine several map levels simultaneously, you can adjust the transparency of the map levels with a slide. The map level to be examined must be active (it is seen shaded).

**Tasks**
- Get information from the address <http://stuk.fi/> and familiarize yourselves with bedrock and soil (uranium) gamma radiation in Koli National Park. After studying, examine how the uranium radiates from the bedrock and soil of the area? What do you perceive and how do you explain the phenomenon? (*Required materials: map of quaternary deposit, uranium gamma radiation*).
- Get information, for example, from the address <http://www.gtk.fi/geotieto/jokamies/ohjeita.html> and consider how magnetism, the minerals and rock-type radiation properties appear in the bedrock of Koli National Park. Study how the magnetism of the bedrock appears regionally. What do you perceive? (*Required materials: bedrock map, magnetism map*).

The study module was developed in the NEED project (see www.uef.fi/need) and contains problem-based GIS tasks for use in Koli National Park (see Kolin kansallispuisto, 2009). Table 2 gives an example of the assignments used in the piloting of this GIS-based study module and the data needed for it. This study module, which was developed to help illustrate the utility of *Google Earth* as an educational tool, was intended for upper secondary geography studies. Geological data are incorporated into a single KLM file. KLM is a grammar and file format for modeling and storing geographic features such as points, lines, images (raster data) and polygons, for display in *Google Earth*. Data in the KLM file are meant to illustrate both the breadth and depth of *Google Earth* as a potential educational tool. In this study, the geological data have been produced by the Geological Survey of Finland.

An example of data illustration in *Google Earth* is shown in Figure 1, in which the task involved using data in the KLM and base imagery data available directly through *Google Earth*. The original data were converted to the kmz-files, which were downloadable in *Google Earth*. 
3. Results

All 10 student-teachers were involved in the present study. Their responses to the questionnaire coupled with our fieldnotes of observation made it possible to answer the research questions aimed at developing PBL in a GIS-based learning environment.

3.1. How familiar are student-teachers with Google Earth?

Students’ familiarity with Google Earth was not very extensive, due to the fact that none of them had regularly used Google Earth (Table 3). The questionnaire indicated that 30% of the students had not used Google Earth at all before piloting. Typically, they had visited the site for studying, leisure purposes and just for exploring planet Earth (Table 3). Nobody expressed that the computer was one of their hobbies and not even photography as a hobby affected their evaluation of Google Earth. It was a student who had studied physics as her major who succeeded the best with the geophysical tasks.

In the questionnaire, when asked what is the most important feature of Google Earth, students emphasized the possibility of exploring rich geographical content, for example geology, vegetation and other features of Google Earth. At the same time, we also noticed during observation that students’ performance was deficient for university level because 30% of the students’ IT skills were unexpectedly insufficient. They could not, for example, manage to move from one file to another, and the same students with insufficient IT skills also, according to the questionnaire, experienced difficulty in using Google Earth.

Forty percent of the students wrote, as the following extract indicates, that Google Earth is quite complex and only two of them had had previous experience of software before piloting. This finding is quite peculiar because Google Earth has been said to be simple to use (e.g. Patterson, 2007).

There are too many menus and too many possibilities for adapting Google Earth. (Woman 1)
Table 3. Students’ background data.

<table>
<thead>
<tr>
<th>Gender (number)</th>
<th>Age</th>
<th>Studies</th>
<th>Hobbies</th>
<th>How much experience of GE?</th>
<th>Purpose for using GE?</th>
<th>Using GE has been</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woman (1)</td>
<td>23</td>
<td>Biology</td>
<td>–</td>
<td>Sometimes</td>
<td>For leisure, travel</td>
<td>Smooth</td>
</tr>
<tr>
<td>Woman (2)</td>
<td>26</td>
<td>Biology, special education, educational science</td>
<td>Photography, jogging</td>
<td>None</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Woman (3)</td>
<td>25</td>
<td>Biology, geography, health science</td>
<td>Thai boxing, keep-fit</td>
<td>None</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Woman (4)</td>
<td>24</td>
<td>Biology, geography, health science</td>
<td>Music, sport</td>
<td>Sometimes</td>
<td>For leisure, travel</td>
<td>Smooth</td>
</tr>
<tr>
<td>Woman (5)</td>
<td>33</td>
<td>Biology</td>
<td>–</td>
<td>Couple of times</td>
<td>For leisure, travel</td>
<td>Straggly</td>
</tr>
<tr>
<td>Woman (6)</td>
<td>29</td>
<td>Physics, maths, biology</td>
<td>Reading, horse management</td>
<td>Sometimes</td>
<td>Exploring the Earth</td>
<td>Easy</td>
</tr>
<tr>
<td>Woman (7)</td>
<td>26</td>
<td>Biology, geography</td>
<td>Travel, snow boarding</td>
<td>Looked just once</td>
<td>Exploring the Earth</td>
<td>Cannot say</td>
</tr>
<tr>
<td>Woman (8)</td>
<td>27</td>
<td>Biology, geography</td>
<td>–</td>
<td>Couple of times</td>
<td>For studying</td>
<td>–</td>
</tr>
<tr>
<td>Woman (9)</td>
<td>28</td>
<td>Biology, chemistry</td>
<td>Dancing</td>
<td>None</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Woman (10)</td>
<td>26</td>
<td>Biology, geography</td>
<td>–</td>
<td>Sometimes</td>
<td>For studying, exploring the Earth</td>
<td>Straggly</td>
</tr>
</tbody>
</table>
Two students indicated in the questionnaire that they had not had any difficulties in using *Google Earth*, as both of them had used software before piloting; moreover, two students experienced that their skills had developed during piloting. It would be good to know what the basic properties of a site should be to facilitate doing the tasks while concentrating on the essential matter in question. Familiarity with the use of *Google Earth* after practical training can be perceived from the following excerpt:

Problems, not actually. Relatively easy to use when I was allowed to play with the program for a little while. (Woman 4)

All in all, we observe that after 90 minutes of practice, the students were able to use *Google Earth* quite fluently, when taking into consideration the possibilities for its use in geology-based assignments.

### 3.2. How does the use of Google Earth improve student—teachers’ content knowledge of geology and geographical thinking?

When asked how GIS affects students’ learning achievements, 80% of the students wrote that GIS improved their geographical thinking. Students considered that different phenomena could be approached and compared with *Google Earth* from the map layer point of view. As the following extracts indicate, *Google Earth* enables the students to evaluate and seek similarities between what is already known and the unknown, the familiar and the unfamiliar.

It was very interesting to explore how the different phenomena are dependent on each other. (Woman 6)

It enables one to examine matters simultaneously at many levels. (Woman 10)

Students appreciated that *Google Earth* brings extra value to the learning of geology as a science. Nine students mentioned that *Google Earth* supports PBL, as well as the analysis and visualization of the information. Among other things, students found that it was interesting to examine connections between soil and vegetation, and furthermore, that with the help of *Google Earth*, it was possible to present scientific matters in an illustrative way.

During piloting, we observed the students’ learning strategies; we noticed that students solve problems relating to the assignments by trial and error. Quite a lot of support was also needed to solve the assignments because the students did not have even basic knowledge about the geophysical phenomena (except Woman 6). Due to this, students’ conversance with uranium gamma radiation and conductivity took time. Their understanding of geophysics was insufficient. Geographical thinking of uranium gamma radiation occurrence in some specific area was lacking, as too was an understanding of what that radiation is generated from. Even though issues such as soils and podzolization are the basic content of geography education in Finnish schools, the students’ working with the map of quaternary deposit was also relatively uncertain.

Forty percent of the students stated in the questionnaire that their map skills were insufficient. Our observations confirm their self-evaluation and revealed that students had particular difficulties in interpreting the geophysical symbols of maps, although there were no problems with the other map skills such as direction, scale and perceptive. The
following quotation reveals that map skills are particularly important in the development of GIS pedagogy.

Even though the separate soil had its own color, I did not get quite a clear picture of it. (Woman 4)

During piloting, the students (except Women 6 and 9) needed assistance in interpreting the colors of geophysical maps and the investigation of uranium gamma radiation also proved to be very complicated.

3.3. How would student-teachers develop the GIS-based study module?

In order to develop our GIS-based study module, with the aid of the questionnaire, we collected key themes of problems perceived in the assignments, which used Google Earth. We constituted three concept categories: technical problems (mentioned 11 times), insufficient map skills (mentioned four times) and instructions for tasks (mentioned twice).

When answering the questionnaire, students expressed that they had experienced crucial problems with the computer; they mentioned problems relating to computer function six times. Observation, however, revealed that the computer had worked properly, but in some cases, students had applied trial-and-error learning strategies, seizing up both the computer and web-based Google Earth. Six students indicated problems about the functionality of Google Earth, claiming that the zooming tool did not work smoothly and the fade-out glider backed up software.

Observation enabled us to analyze more accurately the functionality problem with Google Earth. We noticed that the data of some map layer such as the CORINE land cover and the bedrock map unexpectedly got mixed during layer analysis. Data from CORINE transferred to the bedrock map and the zooming of these layers simultaneously (CORINA land cover, bedrock map) did not work properly. However, these functionality problems were overcome by reloading the kmz-files to Google Earth. We also perceived that our piloted geological data needed at least version 5.0 of Google Earth for appropriate functionality.

Two students indicated in the questionnaire that the instructions given for tasks were confusing and there was also criticism about the clarity of the task (mentioned 10 times). In practice, students hoped for task instructions that would introduce the use of Google Earth step by step, and furthermore, they wanted simple, clear reasons about the purpose of the task and how the tasks would help to clarify the results. The students emphasized that pupil-centered tasks should not involve any extra technical problems and complex menus such as those which are located in “Places” in Google Earth. One suggestion concerning development was that GIS assignments could be solved in the IT class. Students experienced that most technical problems had arisen as a result of simultaneous examination of more than two map levels; therefore, the tasks should be drawn up to avoid this. As the following extract indicates, students emphasized the role of the teacher. They considered that the teacher’s role of introducing students to Google Earth and the content of GIS tasks would contribute toward helping learners to solve assignments.

In order for these tasks to be really advantageous to learning, one should command personal competence to ensure that the learners too can use Google Earth. (Woman 8)
4. Discussion

According to Schultz, Kerski, and Patterson (2008), geography is an integrating discipline that helps students understand the world around them. In the USA school system, a major drawback has been an educational system that does not value spatial thinking and geography education; GIS has been incorporated into schools to remedy this situation. Computer aided geography teaching and learning belongs to present-day school, as does GIS software too. Furthermore, although the Finnish school curriculum stipulates that GIS should be considered in teaching, there have been problems in this implementation: hardware and software costs, the complexity of the GIS tools, the lack of GIS-based lessons as well as other technological factors, which have blocked the widespread adoption of GIS in the classroom. Similar aspects have been apparent in Finland too (Ratinen & Johansson, 2005) and this study confirms earlier studies.

Moreover, the lack of teaching time is a key issue, which has been the obstacle in reforming teaching (Kerski, 2003). Virtual globes such as Google Earth are an exciting and powerful mechanism; they reinforce students’ understanding about connection between space and place and they remove obstacles created by classic GIS implementations in the classroom. According to Patterson (2007), Google Earth in the classroom helps to apply the national standards (NCGE, 2010) by (1) asking questions on how humans obtain and use Earth materials as resources; (2) requiring students to describe features of the Earth; (3) arguing how human behavior changes the Earth’s surface; (4) measuring distances; and (5) employing other thinking and analytical capacities. Nevertheless, GIS technology does not work wonders. As the present study pointed out, students have difficulties in using Google Earth for geographical thinking. In order for students to be able to apply GIS-based assignments in their learning, inquiry-based learning and teaching is required in which deductive logic promotes the development of analytical skills. GIS-based assignments should be at a suitable level for every learner, and as Google Earth requires written explanations of observations, its use also helps to develop literacy. This study supports earlier findings (e.g. Schultz, Kerski, & Patterson, 2008) that Google Earth inspires students who work with GIS. Developing teaching procedures in which a region can be studied through PBL would be of the greatest importance (see Drennon, 2005).

From the socioconstructive point of view, providing learners with the opportunity to share their ideas and examples stimulates suggestions for enhancing the learning environment. We recognized in our study that science student-teachers need support with both technical and content-specific issues. It is therefore essential that students and pupils collaborate when they solve GIS-based assignments. The students’ process of conceptual change would be interesting to study in relation to GIS pedagogy because it has been proven to be fruitful in science education where everyday views of phenomena are often incommensurable with canonical views.

McClurg and Buss (2007) pointed out three components that help to improve teachers’ professional development in relation to GIS teaching. According to the present study, those elements are also possible to apply in the context of students’ professional development. Firstly, professional development activities need time for the practice and application of new knowledge and skills; this includes an introduction to GIS and software such as Google Earth. Secondly, relevant, accessible datasets are needed and students’ file management must be supported. Thirdly, students need an array of support structures and personal aid at the motivation level. As Schubert and Uphues (2009) pointed out, we too support the argument that the clarification of competency development related to GIS requires more empirical evidence.
5. Conclusion

The purpose of our study was to pilot the GIS-based study module which had been developed in the NEED project. Data were collected during piloting in order to assess student-teachers’ familiarity with Google Earth, the role of Google Earth in improving student-teachers’ content knowledge of geology as well as their geographical thinking and finally to get student-teachers’ ideas and opinions about how best to develop the GIS-based study module.

Although Google Earth is a well-used, widely known computer program, the science student-teachers who participated in this study had little experience of it. They had occasionally visited some areas of Google Earth, but its wider adaption, for example, its use in studying, was limited. If the teacher students’ main subject had been geography, the results might have been different. On the basis of this study, students who have studied geography as their minor subject will have to improve their IT skills, in order to acquire fluency in teaching with Google Earth. The students’ uncertainty in using Google Earth made piloting more difficult, as about half the time that had been reserved for piloting was spent in becoming acquainted with Google Earth. This study showed that even though the students had little experience of Google Earth, they still estimated that it is possible to study many geographical and geologic phenomena with the program.

According to the students, GIS-based PBL and teaching helps to improve geographical content knowledge due to the fact that different phenomena can be approached with GIS from the map layer point of view. Observation during the GIS class also indicated that science student-teachers have a somewhat shallow knowledge of geology.

The students had some good ideas for developing GIS tasks. Clear instructions and simple tasks were most wanted in the development of student-centered tasks, but simultaneously, the teacher’s role as supervisor was also emphasized.

References


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