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# Pre-service teachers' experiences of using social software applications for collaborative inquiry

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ABSTRACT

This case study focuses on the use of social software applications for supporting pre-service teachers' collaborative inquiry. Second year pre-service teachers ($N = 98$) were instructed to carry out an inquiry using a selection of suitable applications to support their work in a forest ecology field course. Although they were not specifically instructed on the use of the software applications, the assumption was that being 'digital natives' they would be familiar with them or would readily adopt them. The study reports the students' experiences of the course. Results show variations in their experiences: differences in the way they saw the adequacy of their ICT skills, the suitability of the software, and in their opinions about familiarizing themselves with the software applications as part of the inquiry process. The results also indicate that in future it is important to: (i) concretize and explain the pedagogical aspects of using social software applications as part of the learning process; (ii) highlight the reasons why software applications are used for supporting learning, i.e., the added value; and (iii) encourage students to explore and make use of different software applications for different learning purposes.



## 1. Introduction

The Finnish education system is currently highly praised globally. Finland is consistently well placed in international comparative studies on education systems such as PISA (OECD, 2010). Success has not been unnoticed by the international media and several newspapers and magazines have published articles outlining the factors behind the so-called 'Finnish miracle'. According to Sahlberg (2011), one reason for the success is the Finnish system of teacher training. In Finland, a qualified teacher holds a Master's degree and teacher training includes extensive research-based studies and practical training periods in schools.

Despite being internationally renowned, the education system in Finland also faces challenges. One of these is the use of ICT at different levels of education. In Finland, the needs of the 'knowledge society' and emphasis on different ICTs in teaching and learning are strongly reflected in national strategies and curricula (Finnish National Board of Education, 2003; Ministry of Education and Culture, 2010). ICT should be used in education throughout the school system; students should gain skills for further studies and working life. Despite these expectations, it seems that the use of ICT in teaching and learning has not progressed consistently in Finland (Kankaanranta & Puhakka, 2008). Contrary to success in international comparisons, it is perhaps surprising that Finland is less proficient in some aspects of the use of ICT in education (European Commission, 2013; Kankaanranta & Puhakka, 2008). This is reflected in teacher training. Despite big advances in ICT in Finnish society in general, newly qualified teacher may not be equipped with adequate skills to employ ICT for teaching and learning (Information Society Advisory Board, 2010). ICT skills necessary for teachers in the21st century skills include those associated with creative and critical thinking, collaboration and learning (cf. Binkley et al., 2010). The fact that some newly qualified Finnish teachers are at a loss to know how to use ICT in their work is of concern. Teacher training must prepare students for their professional obligations in using ICT.

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The role of ICT in teaching and learning aligns with current discussions about the needs of today's student generation i.e. 'digital natives'. According to Sadaf, Newby, and Ertmer (2012), today's pre-service teachers are familiar with ICT in general, especially social software for networking, and they have quite positive attitudes toward the use of ICT in teaching and learning. However, they seem to have rather limited skills to take advantage of ICT in teaching and learning and difficulties in seeing the value of different ICTs for supporting learning (Lei, 2009; Valtonen et al., 2011). These findings pose a challenge for developing teacher training to encourage students to build on of their familiarity with ICT and use it to good effect in teaching and learning.

This paper is part of a larger project aiming to improve the use of ICT and pedagogical methods in teacher training. According to Polly, Mims, Shepherd, and Inan (2010), to encourage students who will be future teachers to make use of ICT in teaching, it is important to provide them with authentic learning experiences with ICT in pedagogically meaningful ways, i.e., to provide them with real and inspiring experiences. This has been the guiding principle for the design and development of the case study that follows which introduces a way of using social software to support pre-service teachers' collaborative inquiry. The purpose was to provide pre-service teachers with examples, ideas and inspiring experiences of using ICT for teaching and learning and with concrete tools for their professional work. The study focuses on the experiences of the students and their descriptions on how they see the value of social software for collaborative inquiry.

## 2. Theory background

In this section, we first outline characteristics of learning as collaborative inquiry, then discuss the role of ICT and especially social software for collaborative aspects of learning, and finally outline factors affecting the use of ICT for teaching and learning.

### 2.1. Learning by collaborative inquiry

Inquiry learning has been described in different ways by different authors. According to Bell, Urhahne, Schanze, and Ploetzner (2010), the degree of concretization of the inquiry process varies. The 'knowledge building' approach provides students with possibilities and responsibilities in recognizing and defining how the inquiry process progresses (cf. Scardamalia & Bereiter, 1994). Järvelä, Veermans, and Leinonen (2008) outline features of collaborative inquiry that emphasize the active roles of students who are encouraged to ask questions, formulate hypotheses and test them through experimentation. Muukkonen, Hakkarainen, and Lakkala (1999) define progressive inquiry as a process starting from creating a context and setting up research questions to defining and evaluating working theories, after which students search further information and generate subordinate research questions and, eventually, form new working theories. Bell et al. (2010) define inquiry learning through nine different phases that align with a model of progressive inquiry starting from orientation, asking questions and defining a hypothesis and ending in conclusion and evaluation.

Descriptions by Bell et al. (2010), Järvelä et al. (2008) and Muukkonen et al. (1999) emphasize students' collaboration as part of the inquiry process. Collaborative learning theories are based on students' active participation. Each student has their own unique knowledge structures that direct their attention, actions and eventually, learning. An important aspect of collaborative learning is that students bring out and share these unique knowledge structures. In doing this, students become better aware of their own structures, how they understand the topic, what they do not understand, and what more they need to know (Dillenbourg, 1999; Weinberger, 2003, pp. 10–13). Collaborative learning practices allow students to share their unique ideas and provide opportunities for negotiating between different perspectives and meanings (Derry, 1996). In the best cases, this will lead to profound learning and even the building of new knowledge.

### 2.2. ICT and collaborative inquiry

Since the 1990s, numerous ICT environments for supporting students' collaborative inquiry have been developed. One of the first environments was the Computer-Supported Intentional Learning Environment (CSILE). The CSILE provided a platform for collaborative inquiry and contained tools for students to produce and save content, comment on each other's notes, and make links between content, i.e., to build knowledge together (Scardamalia & Bereiter, 1994). CSILE was followed by several similar environments such as Future Learning Environment (FLE) and Knowledge Forum. Environments evolved quickly to accommodate specific tools for inquiry (Bell et al., 2010). Co-Lab, for example, is an environment where students can conduct inquiries, making it easy to simulate the phenomena under investigation, make observations and analyses (Bell et al., 2010).

In the 2000s, with the increasing popularity of Web 2.0, i.e. social software applications, interest in them as an alternative for specifically designed learning environments increased. Web 2.0 refers to functional and interactive browser-based software and applications. These applications allow users to collaborate with each other in virtual communities through several features of social media. Typically, social software applications build on communication, networking, sharing and active participation. Examples of different types of these are collaborative environments, such as wikis and blogs, social networking sites, such as *Facebook* and content communities, such as *YouTube* (Kaplan & Haenlein, 2010). Common to all of these is the user's role as an active creator, sharer and exchanger of information and ideas.

It is easy, therefore, to see why Web 2.0 is seen to have important educational potential. Social software applications themselves provide tools for collaboration and interaction (Ferdig, 2007). In our case study described below, applications were used for specific purposes aimed for supporting collaborative inquiry. The online learning environment consisted of three applications: *Google Spreadsheet* (part of *Google Drive*), *Google Sites* and *Blogger*. *Google Spreadsheet* and *Blogger* were used in order to provide pre-service teachers with a shared knowledge base containing data in different forms, for example numeric 'raw data' (*Google Spreadsheet*) and pictures (*Blogger*). These applications also contain tools that can be used for analyzing and visualizing data. With *Blogger* and its tagging option it is possible to mark materials produced with keywords in order to see frequencies and to make searches. *Google Spreadsheet* allows saving and sharing the data and making calculations and visualizations of the data with graphs. *Google Sites* serve as environments for saving and publishing the materials and products created within the inquiry process and also enable separate environments to be linked together. These cross-linked environments provide working spaces for small groups and teachers. All-in-all, Web 2.0 offers myriad possibilities for education and particularly interesting resources for collaborative inquiry.

### 2.3. Pre-service teachers and social software applications

Despite the exciting possibilities of Web 2.0 for educational purposes, it is evident that the end-users, the students, are not quick to 'jump at the offer'. Interestingly, today's students, as technologically savvy as they are, seem to be hesitant about incorporating ICT into education (Lei, 2009). Pre-service teachers' beliefs about and acceptance of technologies have been studied from a number of theoretical perspectives. According to the Technology Acceptance Model (TAM) (Venkatesh, Morris, Davis, & Davis, 2003), people are more likely to use different technologies when they find them easy to use and useful for their purposes. Teo (2009) extended the TAM with factors such as self-efficacy and 'facilitating' conditions. Self-efficacy refers to ones' belief in one's own skills in using ICT; facilitating conditions refers to the availability of support and help with difficulties. Cheung and Vogel (2013) studied students' acceptance of collaborative technologies and extended the TAM with factors such as compatibility, i.e. compatibility with students' needs and other software used, and sharing, i.e. using knowledge from different sources and learning from each other. In the light of these studies, pre-service teachers are more likely to use ICT in education: (i) when it is easy to use and has a specific purpose; (ii) when they are confident that they are able to use it and know that help is available; (iii) when they feel that the software in question fills their needs and is similar to others they use; and (iv) when they are able to collaborate with other users.

In addition to the TAM, the factors that influence people's behavior have been studied using the theory of planned behavior (TPB) (Ajzen, 1991). Based on the theory of planned behavior, three elements determine an individual's behavioral intentions: attitudes, subjective norms and perceived behavioral control. Attitudes refer to a person's evaluation of certain behavior; whether it is positively or negatively valued. Subjective norms refer to the social aspect related to the behavior focusing on how it is viewed by important persons such as, e.g., friends, university teachers or colleagues. Perceived behavioral control refers to the extent to which people feel they are empowered to behave in certain ways, focusing especially on their skills (Ajzen, 1991).

Using the TPB for studying beliefs about Web 2.0 for teaching and learning, Sadaf et al. (2012) found that today's pre-service teachers have positive attitudes toward the use of Web 2.0.Students felt that using Web 2.0 improves interaction, communication and overall engagement in the learning experience. According to Sadaf et al. (2012), pre-service teachers are motivated and skilled at using Web 2.0 for their personal needs, but find it challenging to integrate Web 2.0 into their work as a teacher. The results also suggest that pre-service teachers find the expectations of their colleagues and administrators, and especially the needs of their digital age pupils, to be important factors in determining the use of Web 2.0 tools. Lei (2009) reports similar findings concerning digital native pre-service teachers' beliefs and attitudes toward ICT. These findings show that pre-service teachers reported quite positive beliefs in the potential of ICT for teaching and learning, but had rather reserved attitudes toward integrating it into their classrooms. Lei (2009) suggests that a reason for this is their lack of concrete experience of using ICT for teaching and learning.

In summary, social software applications provide tools for supporting teaching and learning, especially collaborative practices that emphasize students' active roles. These applications offer possibilities that are worth studying and testing as alternatives (not replacements) to the software specifically designed for supporting collaborative inquiry such as CSILE and FLE. This study provides insights into pre-service teachers' perspectives on using social software applications for collaborative inquiry. Based on previous studies, it seems that today's students are quite familiar with the possibilities of different ICT and particularly social software applications. What they lack are the skills to take advantage of these applications for teaching and learning in their work as teachers. They seem to appreciate the possibilities of ICT and social software applications mainly for leisure. In this case study, pre-service teachers were provided with an online learning environment consisting of the following social software applications: blogs *(Blogger)*, *Google Spreadsheets* (part of *Google Drive*) and *Google Sites*. The aim was to provide pre-service teachers with authentic and inspiring experiences of how social software applications can be used for supporting learning and in so doing provide an insight into their experiences of collaborative inquiry with social software applications.

## 3. Research questions and methods

### 3.1. Research questions

The aim of this research was to investigate pre-service teachers' experiences of using social software as a tool for inquiry. The research question was:

How do students experience using social software on a biology field course (i) in general, (ii) for interaction, and (iii) for collaboration.

These questions were addressed through (i) responses to a three part questionnaire analyzed quantitatively, and (ii) qualitative outcomes of students' reflective discussions.

### 3.2. Research context

The context of the study was a biology education field course for second year primary school pre-service teachers. On the four day long course, student teachers conducted inquires focusing on forest ecology and forest ecosystems. Students worked in groups making observations and collecting research data by taking pictures and sampling plants, invertebrates and soil.

Students were instructed to use social software applications for supporting their inquiry. For this purpose, they were presented with a selection of suitable applications, including a tool for presenting, tagging and sharing photographs (*Blogger*), a tool for collecting and processing quantitative data (*Google Spreadsheet*), and a tool for reporting and publishing their findings (*Google Sites*). Students were also allowed to use any other suitable application if they wished to do so.

In addition to students working in small groups, there were also short lectures within the course. Due to the strict timetable, the inquiry process was semi-structured. The four-day course proceeded as follows:

DAY 1. At the beginning of the course, pre-service teachers had a lecture on the main principles of forest ecology. They received training for making observations, identification and collecting data. Students were organized in groups of three to four and provided with topics for their inquiry.

The second phase was fieldwork. Students made observations and collected plant, soil and invertebrate samples. They took photographs and gathered baseline data on plant associations at particular study sites in the forest. They estimated percentage cover of ground flora in plots using a 1 × 1 m quadrate and they identified grasses, woody plants and non-woody plants (herbs, mosses, ferns). They listed species of surrounding trees and estimated their height, collected invertebrates and measured light intensity and temperature.

DAY 2. Students analyzed the data they gathered during fieldwork with the help of the social software applications. They analyzed plants by sorting them into families. They uploaded photographs of the plants to a shared blog with the tagging option. The shared picture blog showed frequencies of different tags, i.e., different plants and forest levels and provided possibilities for making searches of the shared database. They analyzed soil type, soil moisture and soil pH. All groups reported their results using *Google Spreadsheet* that functioned as a shared database enabling results of different groups to be compared. It also automatically calculated for example mean values. At the end of day two, student groups reported their findings using the shared databases (blogs and spreadsheets) and started building their research reports in *Google Sites*.

DAY 3. Students analyzed their invertebrate samples and identified the species. They reported their findings in a shared *Google Spreadsheet*, took photographs of the invertebrates and uploaded their tagged photographs to a shared invertebrate blog. At the end of the day, and as homework, they continued building their research report using the shared databases of plants, soil and invertebrates.

DAY 4. Each group had 30 min to present their work. Students used *Google Sites* including photographs, figures and models to present their main results and conclusions. They also discussed the limitations of their inquiries. Each group gave three or four peer evaluations on the reports and a self-evaluation.

### 3.3. Target group, research data and analysis

The target group consisted of a cohort of 98 primary school pre-service teachers. Most of the students were born during the 1980s ($n = 54$) and at the beginning of the 1990s ($n = 38$), from this perspective these 92 respondents can be seen as digital natives i.e. born after 1980 (Lei, 2009). The oldest participant was born in 1962 and youngest in 1991, while the majority of the students ($n = 53$) were born between 1989 and 1991. The majority of the students were female (Table 1).

As our study utilized both questionnaire and reflective data, it can be said to be a mixed method study (Creswell, 2003). The study aligns with Creswell's (2003) concurrent nested strategy, i.e., two different methods for collecting data were used simultaneously and one dataset was dominant. In this case, the data derived from reflective discussion was dominant and the questionnaire data were used to provide background information and statistical context.

Questionnaire data were collected through a three-part online questionnaire containing 1–5 Likert-type statements (1 = strongly disagree, 5 = strongly agree). The first part of the questionnaire contained statements measuring background statistics of the pre-service teachers: age, ICT skills, time spent with ICT daily, and familiarity with the social software applications used during the course. These statistics were examined from the perspective of different age groups. The second part addressed experiences of the different social software applications used to carry out the inquiry. These results were analyzed by calculating mean values and variations. The third part focused on the use of social software applications for supporting interaction and collaboration during the course. These results were analyzed using principal component analysis with varimax rotation (c.f. Afifi & Clark, 1996; Metsämuuronen, 2006). Principal component analysis is typically used for condensing several original variables into a few sub-scales (Afifi & Clark, 1996), a practice that has been adopted in this study. Results of the principal component analysis produced four sub-scales. These four sub-scales explained 62% of total variance. Coefficients of reliability for all sub-scales were satisfactory; Cronbach's alpha values were over .60 for each new variable (Metsämuuronen, 2006). Through these results, we are able to generate an overall picture of students' experiences of using ICT on the course.

The reflective discussion data was generated from students working in small groups ($n = 33$). Students were asked to outline their experiences of the course through the following questions:

- What did you learn during the course?
- What factors supported/disrupted your learning process?
- What was the role of the following software applications in your learning process: *Google Spreadsheet*, *Blogger* with tags and *Google Sites*?
- How would you describe the progress of the learning process in your group?
- How could you apply the content (e.g. biology, pedagogy, use of ICT) that you learned during this course in your future job as a teacher?

Discussions were arranged during the last meeting of the course and were held in the same groups that conducted the fieldwork. Discussions were recorded and transcribed. Content-based analysis was used to code the data (cf. Gibbs, 2007). Analysis proceeded in four phases. First, the transcripts were read several times in order to gain an overview. Second, transcripts were coded based on pre-defined negative or positive tendencies toward using ICT on the course. An analysis unit consisted of one experience or opinion, i.e., one unit could be a single comment from a student or it could be a longer discussion concerning one agreed topic. In the third phase, the codes from the previous phase were combined into new categories based on commonalities. This yielded 10 sub-categories. In the fourth phase, the 10 sub-categories were consolidated under three broader themes: '*ICT in the collaborative inquiry*', '*ICT skills*' and '*Learning to use ICT*' (Table 2). Frequencies in Table 2 refer to the number of group discussions in which the topic was mentioned.

**Table 1**
Demographics of participants.

| | | | |
|---|---|---|---|
| Born | Before 1980 | 1980s | 1990s |
| $n = 98$ | 6 | 54 | 38 |
| Gender | Female | Male | |
| $n = 98$ | 76 | 22 | |

**Table 2**
Sub-categories based on reflective data.

| ICT in the collaborative inquiry | ICT skills | Learning to use ICT |
|---|---|---|
| ICT as a practical tool ($n = 25$) | Easy to use ($n = 11$) | Meaningful learning context ($n = 7$) |
| Collaboration ($n = 15$) | Inadequate ICT skills ($n = 14$) | ICT learning as an extra burden ($n = 5$) |
| Technical restrictions ($n = 11$) | Frustration with ICT ($n = 12$) | ICT as a tool for teaching in the future ($n = 10$) |
| Unnecessary workload ($n = 13$) | | |

## 4. Results

This section reports the results, starting from the background information that characterized the participating pre-service teachers. After this, the questionnaire data is presented and lastly data from the reflective discussions.

### 4.1. Background information

Background information is given in Tables 3 and 4. Students self-evaluated their ICT skills using a five point scale (very weak, weak, moderate, strong, and very strong). Results indicate that students typically evaluated their ICT skills as moderate or strong (mean = 3.4). They also reported their average daily use of ICT using the five point scale corresponding to the number of hours. Only 10 students reported that they used ICT less than 1 h per day, and typically students reported using ICT 1–2 h per day ($n = 36$) or 2–3 h per day ($n = 34$). Five students reported that they used ICT over 4 h per day. When comparing the results for different age groups, we can see differences between students born during the 1980s and 1990s (mean 3.5 and 3.4) compared to students born before 1980. Students born before 1980 evaluate their ICT skills lower (mean = 2.3) and use less ICT daily (mean 2.2) than students born after 1980 (means 2.6 and 2.8). Due to the limited number of respondent in group 1 '*Born before 1980*' these comparisons are taken to be indicative rather than definitive.

For most of the students, *Google Sites* and *Google Spreadsheet* were unknown prior to the course. The blog (*Blogger*) was more familiar to students, the mean value being 3.2. Also, the differences between age groups were minimal, only blogs were slightly more familiar to students born after 1980 than to those born before 1980. But again, because of the limited number of respondent born before 1980 the comparison can only be seen as indicative.

### 4.2. Questionnaire analysis

Table 4 shows students' evaluation of the suitability of the software applications for studying on the course. Results suggest that the overall experience of the different software applications used on the course was positive. The mean values of the student's responses to the different applications (calculated against the 5 point scale 1 = strongly disagree, 5 = strongly agree) were close to, or exactly, four with *Google Spreadsheet* the only exception having a lower rating of 3.5. There is, however, variation among the responses, the standard deviation being 1.0 or 1.1 in all statements. Combining responses of different questions gives a clearer picture of the variation. Table 4 shows the percentage values for responses grouped [1&2], [3], [4 & 5]. The grouping places the emphasis on responses 4 and 5 (agree and strongly agree) with percentages varying from 48% to 79.6%. Not all the respondents found the software applications suitable for the purposes of the course: the percentage of negative responses varied from 8.2% to 16.3%.

In order to evaluate students' experiences of working in small groups and the role of ICT in collaborative work, sub-scales '*ICT and working in small groups*' and '*Functionality of small groups*' were built using principal component analysis (Table 5). Evaluating the general functionality of the group but leaving out ICT, the results were very positive, the mean value for *Functionality of small groups* was 4.7. Results concerning the effects of ICT for supporting the group work (sub-scale '*ICT and working in small groups*') were lower 3.8, although still indicating positive experience. It therefore seems that students were pleased with working in groups and that the role of ICT was evaluated positively. Nevertheless, some negative experiences of ICT for supporting collaboration were reported. The number of negative responses, i.e., values 1 and 2 varied between 10.2% and 13.2%.

The last phase of the questionnaire analysis focused on the effects that the software applications had on conversation activity and students' discussing their discoveries (Tables 6 and 7). Again two sub-scales were built using principal component analysis '*Interaction using tags and Google spreadsheets*' and '*Interaction using Google sites*'. The overall mean value 3.3 for sub-scale '*Interaction using tags and spreadsheets*' suggests that the students had slightly positive experiences. Of the software applications, *Google Sites* was evaluated as the most effective for launching conversations and bringing up different discoveries (3.9). Tagging photographs and working with *Google Spreadsheet* received lower values. Mean value of the sub-scale '*Interaction using tags and Google spreadsheets*' was only 3.1. It is also noteworthy that some negative evaluations of the software applications' effect on interactivity were reported.

**Table 3**
ICT skills and use of ICT daily.

| | Born before 1980 | Born during 1980s | Born during 1990s | Scale |
|---|---|---|---|---|
| **ICT skills**: $n = 98$, mean = 3.4, std. deviation = 0.8 | | | | 1 = very weak, 2 = weak, 3 = moderate, 4 = strong, 5 = very strong |
| Mean | 2.3 | 3.5 | 3.4 | |
| Std. deviation | 0.8 | 0.8 | 0.6 | |
| **Use of ICT daily**: $n = 98$, mean = 2.7, std. deviation = 1.0 | | | | 1 = less than 1 h, 2 = 1–2 h, 3 = 2–3 h, 4 = 3–4 h, 5 = over 4 h |
| Mean | 2.2 | 2.6 | 2.8 | |
| Std. deviation | 1.0 | 1.0 | 1.0 | |

**Table 4**
Familiarity of the software used.

| Software | Born before 1980 | Born during 1980s | Born during 1990s | |
|---|---|---|---|---|
| **Blog**: $n = 98$, mean = 3.2, std. deviation = 1.5 | | | | Software was familiar to me prior to the course (Scale 1: strongly disagree, 5: strongly agree) |
| Mean | 2.3 | 3.1 | 3.4 | |
| Std. deviation | 1.5 | 1.0 | 1.3 | |
| **Google Sites**: $n = 98$, mean = 1.9, std. deviation = 1.2 | | | | Software was familiar to me prior to the course (Scale 1: strongly disagree, 5: strongly agree) |
| Mean | 1.8 | 1.9 | 1.9 | |
| Std. deviation | 1.3 | 1.2 | 1.2 | |
| **Google spreadsheet**: $n = 98$, mean = 2.0, std. deviation = 1.1 | | | | Software was familiar to me prior to the course (Scale 1: strongly disagree, 5: strongly agree) |
| Mean | 2.0 | 2.0 | 2.0 | |
| Std. deviation | 1.1 | 1.1 | 1.0 | |

### 4.3. Analysis of reflective discussion

This section outlines the results from the data on reflective discussion. In the light of the questionnaire data, there is variation in the students' experiences of the usability of the different social software applications used on the course. With the data on reflective discussion, the aim is to provide deeper insight into the factors affecting the experiences. Next, the three themes that emerged from the data are discussed: (i) 'ICT in the collaborative inquiry; (ii) 'ICT skills'; and (iii) 'Learning to use ICT'.

#### 4.3.1. ICT in the collaborative inquiry

The first theme, 'ICT in the collaborative inquiry', contains four sub-categories formed in coding the data. The first of these, '*ICT as a practical tool*' ($n = 25$), focused on positive experiences of using different software applications for learning. The students saw ICT as a tool providing flexible opportunities for participating and working in small groups. In addition, ICT and particularly the social software applications used on the course were regarded as handy for collaborative inquiry; instructions, the materials produced and other useful material were easily collected and available in one place. All-in-all, these experiences indicate the role of ICT as a supportive tool for the group work, making it more easy and flexible. The quotations from students that follow are given with minor corrections to English.

> Students 3: it was really handy to collect all the work. Especially when you don't need any "memory sticks", it is all online…
> Students 1: it's much better this way than by using a Word document…(Group 2k)

> Student 1: … and most of all, that it wasn't... place dependent. You were able to do the task in university and also at home, you could continue the work you had done before. (Group 2h)

> Student 3: … and Google Sites it was quite practical, even though it was bit difficult to use, with Sites you could immediately see each other's work
> Student 2: Yes, you had to learn how to use it but you learnt it quickly (Group 6)

The second sub-category was '*Collaboration*' ($n = 15$). These comments referred to the meaning of social software for building a shared knowledge base. The comments within this category indicated that with the social software applications it was possible to become familiar with and make use of the content produced by other groups. Students could also compare their materials with the output of other groups, for example, samples that they had collected, and thus through cross-corroboration arrive at a more reliable result in their inquiry.

> Student 2: … and especially with the number of different species, how many had found some specific species, you we able to see the distribution.
> Students 3: Yes, even thought we were in a small area, each group had the one square metre area, you could still see and discover the difference there is, how the variation can be so strong within areas so close to each other (Group 2b)

> Student 2: I think the software used where each recorded their data was really good. The data just from our studies would not have told us much.
> Student1: That's true!
> Student 2: Like our result 8%, I think it wasn't really valid and especially when the other group had 90% from the same thing, based on the average values we can better draw conclusions… (Group 1b)

The third sub-category, '*Technical restrictions*' ($n = 11$), was the first category reflecting negative aspects of using ICT in collaborative inquiry. Within this category, the comments touched mainly on the deficiencies of the software applications. For example, students found it problematic that only one person at a time could edit the shared *Google Site*. They also felt that they were not always able to edit the materials in the ways they would have preferred. An important aspect is that even though students noticed deficiencies with the social

**Table 5**
Experiences of different software.

| | Mean | SD | Responses: 1 & 2 | Response: 3 | Responses: 4 & 5 |
|---|---|---|---|---|---|
| Shared blog suited well for studying the content | 4.0 | 1.0 | 9.1% | 11.2% | 79.6% |
| Tag defined to pictures suited well for studying the content | 3.9 | 1.1 | 11.2% | 19.4% | 69.4% |
| Google spreadsheet suited well for studying the content | 3.5 | 1.1 | 16.3% | 35.7% | 48% |
| Google Sites suited well for studying the content | 4.0 | 1.0 | 8.2% | 17.3% | 73.5% |
| *Mean percentage* | | | *11.2%* | *20.9%* | *67.6%* |

**Table 6**
Functionality of small groups and ICT

| | Mean | SD | Responses: 1 & 2 | Responses: 3 | Responses: 4 & 5 |
|---|---|---|---|---|---|
| **ICT and working in small groups** (Alpha .67, $n = 98$, mean = 3.8, SD = 0.8) | | | | | |
| lCTs used supported working of our group | 3.8 | .89 | 10.2% | 20.4% | 70.4% |
| lCTs used encouraged all the members of our group to participate | 3.8 | 1.0 | 13.2% | 19.4% | 67.4% |
| *Mean percentage* | | | *11.7%* | *19.9%* | *68.9%* |
| **Functionality of small groups** (Alpha .78, $n = 95$, mean = 4.7, SD = 0.5) | | | | | |
| Working of our group went well during the course | 4.7 | .61 | 0% | 7.1% | 92.9% |
| All the participants of our group participated actively in the work | 4.6 | .62 | 1% | 4.1% | 92.8% |
| The number of students per group was suitable | 4.7 | .52 | 0% | 3.1% | 95.9% |
| *Mean percentage* | | | *1%* | *4.8%* | *93.9%* |

software applications used they did not change the software, even though they were allowed to do so. The only change with the software was that students used *Microsoft Office Excel* and *Open Office Calc* along with *Google Spreadsheet* for making graphs because *Google Spreadsheet* was found difficult to use.

Students 1:…(talking about working from home) and about the Google Sites, it is problematic that you couldn't add materials simultaneously, so organizing the working of the group was difficult…
Student 2: Yes, you had to use Facebook to ask whether others are still editing the page or not, ask them to log out so that I can add the picture, and after that again you had to post messages to others that you are ready. (Group 2d)

Student 2: …and also you couldn't set the pictures where you wanted, with some other software you probably would had been able to design better layout for the page.
Students 4: Yes
Student 3: Yes, there are several different software for making web pages, the Google Sites is not the only one (Group 3d)

The last sub-category, '*Unnecessary workload*' ($n = 13$), refers to comments on social software applications being unnecessary and laborious for accomplishing the inquiry. These comments indicate that some students had not understood the reasons for having to use certain software applications on the course. Some software applications were seen of little value for learning processes.

Student 1: (talking about Blogger) I think it was a bit… Was there anything else than the pictures?
Students 2: I think it was a bit detached, bit separated
Student 3: Yes, I think it was waste of time, we just uploaded the pictures there… (Group 2l)

Student 2: (talking about Blogger) it was useless …

Student 3: (talking about Blogger) It wasn't really used, it was just a page online
Student 1: the pictures were just uploaded there without knowing who will use them, without knowing why.
Student 2: it should have been better taken advantage of… (Group 3d)

#### 4.3.2. ICT skills

The second theme, 'ICT skills', also includes four sub-categories. Comments within this theme varied from ease of use to difficulties related to the use of ICT. The number of comments referring to ease of use was rather small; it seems that students were more concerned with bringing up challenges related to the use of ICT. The first category, '*Easy to use*' ($n = 11$), indicates that the use of software applications did not cause any difficulties. Students felt that their ICT skills were sufficient to work with the different software and carry out the tasks. The software applications were either already familiar to the students or they were seen easy to learn.

Student 2: … after trying and learning you really learnt it so that it can be easily used next time (Group 2i)

Student 1: (talking about Blogger) it was familiar to me already, I have used it sometimes before, so it wasn't difficult to use for me. (Group 2c)

**Table 7**
Effects that the software applications had on conversation activity and discussion

| | Mean | SD | Responses: 1 & 2 | Responses: 3 | Responses: 4 & 5 |
|---|---|---|---|---|---|
| **Interaction using tags and Google spreadsheets** (Alpha .79, $n = 98$, mean = 3.1, SD .86) | | | | | |
| Tagging photographs launched active conversation | 2.8 | 1.1 | 37.8% | 38.8% | 23.4% |
| Working with the data using Google spreadsheet launched active conversation | 3.0 | 1.1 | 28.6% | 42.9% | 28.5% |
| Tagging photographs brought up students' different discoveries | 3.2 | 1.0 | 22.4% | 32.7% | 44.9% |
| Working with the data using Google spreadsheet brought up students' different discoveries | 3.3 | 1.2 | 21.4% | 31.6% | 47.0% |
| *Mean percentage* | | | *27.5%* | *36.5%* | *36.0%* |
| **Interaction using Google sites** (Alpha .62, $n = 97$, mean = 3.8, SD .83) | | | | | |
| Reporting findings to the Google Sites brought up students' different discoveries | 3.9 | 1.0 | 7.2% | 29.9% | 71.1% |
| Reporting findings to the Google Sites launched active conversation | 3.7 | 1.0 | 12.2% | 26.5% | 61.3% |
| *Mean percentage* | | | *9.7%* | *28.2%* | *66.2%* |

Student 3: …and also, I have learnt to use the Google Sites software that I haven't used before and it was surprisingly easy to use …
Student 2: Yes, this was really user friendly (Group 2l)

The sub-category '*Inadequate ICT skills*' ($n = 14$) relates to the difficulties with the use of ICT for collaborative inquiry. Students indicated that they did not have sufficient ICT skills for using the software applications as expected. Unfamiliar and challenging software meant extra effort and work. Within this category, there were comments about technical problems, such as malfunctioning computers or software.

Student 1: We had difficulties when we were writing the report
Student 2: Yes, the technical skills
Student 1: Yes, it was difficult
Student 4: But maybe it was mainly our own fault that we didn't know how to use them, but there were also real technical problems as well. (Group 3a)

Comments in this category also referred to the unreliability of the software applications. Students questioned the reliability of saving their work online, preferring, for example, memory sticks. Students also questioned the sustainability of the chosen software applications and felt that they might soon be replaced by new ones.

Student 3: it felt like, if we are going to write everything only online, then it is not very reliable, that if it disappears or you press some wrong button or don't remember to save it… (Group 1)

In addition, students specifically brought up that they had difficulties with *Google Spreadsheet*. These difficulties concerned mainly building graphs and embedding them in *Google Sites*. As *Google Spreadsheet* was found difficult to use, the students copied the data tables to *Microsoft Office Excel* or *Open Office Calc*.

The sub-category '*Frustration with ICT*' ($n = 12$) further opened up the problems related to ICT skills. Students' conversations show that lack of sufficient ICT skills caused frustration, anxiety and even fears. Insufficient ICT skills along with some technical problems lead to situations where students attempted to use different applications repeatedly without success. Some students felt they were left out of the group, unable make a contribution to collaborative work. Students were anxious doing certain things with ICT, they were afraid of destroying the shared work or they were afraid of violating the software policies.

Student 2: (talking about distractions) I must say it was the software
Student 3: frustrating, I could not write and do as much as I would have done if I had been able to do everything
Student 2: Yes, it was really the frustrating part of the study
Student 1: and especially when the computer didn't work (Group 2c)

Student 1: for me this was totally new, I could not use it and be a help to my peers (Group 3d)

Student 3: and believe me I was in panic, do I have the courage to do this, dare I click any button so that I don't destroy everything done.
Student 2: I was really afraid when there was the notion that the administrator of the page had violated the rules… I was in panic and called to my friend. (Group 3h)

#### *4.3.3. Learning to use ICT in connection with pedagogical practices*

Approximately half of the students had earlier experiences of using *Blogger* (mean 3.2), but *Google Sites* was new to most of them (mean 1.9). Therefore, they had to familiarize themselves with the software applications. Students' opinions were divided on the lack of instructions about the use of software applications. Some students criticized the course construction that assumed that they would be able to use the social software applications without orientation. Some students on the contrary found this not to be a problem but a welcome challenge.

The first sub-category in this theme was '*Meaningful learning context*' ($n = 7$). Comments in this category referred to very positive experiences concerning testing, trying and learning to use different software while carrying out an inquiry. Students' comments indicated that it is more meaningful to learn to use new software when there is a specific reason and context for it. The comments suggested that even though it took time and effort, it was worth it.

Student 2: it is much more meaningful to learn new ICTs in this way than in ICT class… It is much better this way when you are producing contents and data
Student 3: Yes, so that you do not have to just invent stuff from nothing

Student 2: it took a lot of time, there could have been faster ways
Student 3: but it (software) was also one thing that we learnt during the course. At the beginning, we were totally lost but at the end of the course, we knew how to do it
Student1: Like professional! (Group 2i)

Student4: … and I was so proud of myself that I had managed to use Excel software, I have never done that before. So in that way it was good that I had to. (Group 3b)

Within this sub-category, there are also positive comments concerning the use of ICT on the course in general. Students found it reasonable that ICT tools were used on the course and, in general, as part of teacher training.

The second sub-category within this theme was '*ICT as a tool for teaching in the future*' ($n = 10$). This category referred to a pedagogical perspective, learning to take advantage of ICT in future work. Comments revealed ideas for making use of ICT and the social software applications used on the course in a similar manner in their future work as teachers. Students outlined ways to use the tools with elementary school pupils. The conversations emphasized particularly the skills pupils need to use ICT. Students did not, however, touch much on the pedagogical aspect, i.e., the reasons for using ICT in their work.

Student 3: … and I think this blog thing was quite nice so that it could easily be used with bit older pupils to make this kind of blog with the whole class together … then we could see together what we have done. With photographs etc. I think the children would really like this.
Student 2: … and nowadays the pupils are using computers, even the youngest. (Group 2d)

Student 3: …(talking about Google Sites) it doesn't have to be sixth grade students with whom you can use this, you can use it with even the younger ones
Student 1: Yes, it is really easy to use and if you would do the blank pages ready for them, so that pupils would just click the edit-button and start writing
Student 3: They could show their work also for their parents at home

Student 1: Yes, that would be good. (Group 3g)

The third sub-category, '*ICT learning as an extra burden*' ($n = 5$), provided an opposite perspective to the '*Meaningful learning context*' category. These opinions suggested that most of the software applications used on the course were new to the students and that there was not enough time to familiarize themselves with them. What was challenging was that the course lasted only one week and students were in a hurry. Learning the functions of the software applications was seen as an extra burden that shifted the focus from the course content, biology. Students' comments suggested that they thought they ought to have been taught to use these software applications prior to the course, or that they ought to have been provided with more detailed instructions.

Student 2: … if we have a course that takes one week, then for me the whole time will be spent for training how to use these different software
Student3: That's true. It took too much time, like in our group we were wondering about where we can find different pages… (Group 1b)

Student 2: The Blogger was confusing, bit difficult. You don't know where to find different things and how to get back to the front page.
Student 3: Yes, there could have been a short moment for showing how they work
Student 4: Like showing for the whole class… (Group I)

## 5. Conclusion

Based on the background information provided by the students, it seems that as a group they correspond with the target groups in previous studies on digital native pre-service teachers (cf. Lei, 2009; Sadaf et al., 2012). Most of the students were born between 1980 and 1991 ($n = 92$), which according to Lei (2009), makes them digital natives. In general, the assumption is that that they are willing and able ICT users. Indeed, the background information reveals that the students were confident with their ICT skills and most of them ($n = 70$) used different ICTs between 1 and 3 h per day. Compared to the data for respondent students born before 1980 ($n = 6$) we can see that there are some differences: especially the self-evaluated ICT skills were higher with the digital native students. Also, the results show that most of the students were unfamiliar with social software applications that are suitable for different teaching and learning purposes, such as *Google Sites* and *Google Spreadsheet* (mean values 1.9 and 2.0). This is similar to the findings of Sadaf et al. (2012) and Lei (2009) who showed that today's pre-service teachers use Web 2.0 confidently for personal purposes but the number of familiar Web 2.0 tools is rather limited.

The results from the questionnaire data suggest that students' overall experience of different software applications used on the course was positive. Similarly, the overall experience of using ICT to enhance group work and interaction was positive. This generally positive outcome can be seen as supporting the assumption that for collaborative inquiry, social software applications may offer an alternative to, but not necessarily a replacement for, programs and software that are specifically designed for the purpose. Variation among responses showed, however, that not all students found these software applications suitable for their learning purposes. The results from the data derived from the reflective discussions brought up several factors related to this.

In general, the results align with the TAM model, suggesting that in order to achieve a positive outcome, the chosen ICT needs to be easy to use and useful for the purpose (see Teo, 2009; Venkatesh et al., 2003). On the one hand, the software applications were seen as practical tools that supported the course work. Moreover, the students were pleased with the possibility of seeing and benefiting from other groups' work. On the other hand, some students felt that ICT on the course meant extra work and that it did not benefit their learning. Some students felt that the functions of the software applications did not meet their needs.

Variation also existed in the students' perceptions of their skills in using ICT. On the one hand, they felt that the software applications were easy to use and did not cause any problems. On the other hand, they perceived their ICT skills inadequate for managing with the chosen software applications, and this led to frustration and some anxiety. Correspondingly, students' opinions varied on the ease of learning to use the software applications. Students felt that the course was a meaningful opportunity to learn to use different software applications in interesting and authentic learning contexts. At the same time, for some students it was challenging to try to learn how to use the software applications simultaneously with conducting an inquiry on forest ecology. They felt that it distracted them from the course work. The tight schedule of the course caused an extra challenge.

Even though students reported technical restrictions, deficiencies and shortcomings in the software applications, they were not eager to switch to alternative applications. In the instructions, they were encouraged to do so if they wanted to. The exception was *Google Spreadsheet*. Some groups changed to the easier to use *Microsoft Office Excel* or *Open Office Calc* for making graphs. There may be several reasons for this, such as the tight course schedule that left little time for negotiating for new tools. Another reason may be that students are not familiar with suitable alternatives. From the digital native perspective, this may be indicative of unfamiliarity and lack of experience in using social software applications as tools for teaching and learning.

The results also indicated that some of the students did not find the use of ICT meaningful for their collaborative inquiry. Different reasons may account for this. One is that even though the target group consisted of second year pre-service teachers who were assumed to have acquired theoretical knowledge of collaborative and inquiry based learning, they may not be familiar enough with the mechanisms of collaborative and inquiry based learning to apply that knowledge into practice (cf. Bell et al., 2010; Dillenbourg, 1999). This assumption

aligns with the TAM model in that for a meaningful experience, users of ICT must understand the actual purpose and benefit of the tools for their work (Venkatesh et al., 2003). Without understanding the reasons for using ICT and social software applications, having to learn to use them may appear as an unnecessary workload.

Lei (2009) has shown that while today's pre-service teachers might be considered to be digital-native *students*, they are not yet digital native *pre-service teachers*. According to Lei (2009), these students have yet to gain sufficient experiences of learning with ICT. Based on the studies of Polly et al. (2010) and Lei (2009), as well as our case study, it seems that models, practices and meaningful experiences of using ICT and social software applications for supporting teaching and learning are needed in teacher training. It is important that mechanisms of collaborative learning and collaborative inquiry are discussed and concretized in order to clarify the benefits of ICT for teaching and learning. Our assumption is that when students understand the reasons why certain activities with certain software are conducted, they are more willing to learn to use them and apply them in their studies. In addition, within the teacher training context, students need to be encouraged to try different software applications for their learning purposes. It may well be that without realizing it, students are already familiar with several software applications that would be suitable for teaching and learning.

Teacher training could be a platform for learning to integrate ICT with subject studies in a meaningful, tailored way. This would require active cooperation in integrating theory and practice of education, ICT and subject content. This way, pre-service teachers would be provided with opportunities and meaningful contexts to experience the possibilities of ICT for teaching and learning. We assume that this would also provide better possibilities for examining learning process with ICT as a whole and exploring the potential of different ICTs and software applications for different pedagogies and content. This view is supported by our case study where students, despite having difficulties, recognized that they had gained ideas and models that they could use as teachers in the future. This finding aligns with the assertions of Polly et al. (2010) that to encourage use of ICT in teaching and learning, pre-service teachers should be provided with actual experiences of learning with ICT in a pedagogically meaningful way.

The Finnish educational system has a good reputation globally and Finnish teacher training has been promoted as one reason for this success (Sahlberg, 2010). Nevertheless, more research on ICT use in teaching and learning is needed to guide the development of teacher training. We need better ways to support the development of pre-service teachers' ICT skills and attitudes toward the use of ICT for teaching and learning. In other words, we need ways to 'upgrade' the ICT experiences of our pre-service teachers to 'pre-service teachers 2.0'.

For future research, longitudinal studies following the development of pre-service teachers' ICT skills and attitudes toward using ICT in teaching and learning would allow combining the results of case studies such as the one reported here and the effects of the development of teacher training, particularly education on ICT in teaching and learning.

The respondent group represents a typical cohort of one year pre-service teachers, so the focus of our analysis was on students responses overall instead of comparing age or gender groups. In this study, there were only six students born before 1980 and they reported lower ICT skills and time spent with ICT daily. The small number of respondents in this age category precluded an exhaustive analysis of this factor. Thus, differences between age groups present an important topic for future research. A similar situation exists for gender differences which were not examined in this study for similar reasons to do with the nature of the cohort investigated.

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