Innovative pedagogical practice with ICT in three Nordic countries – differences and similarities

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Abstract
Three Nordic countries, Denmark, Finland and Norway, participated in the IEA SITES 2006 study. All the three countries have launched huge policy and investment programmes to promote digital literacy and readiness for the information age. In relation to the remarkable Finnish Programme for International Student Assessment (PISA) results, it is interesting to see if the Finnish school system may be better suited to ground and contextualize pedagogical practice with Information and Communication Technologies (ICT) than the Danish and Norwegian counterparts. One main difference is that the Finnish system seems to anchor decisions about and interpretations on how ICT should be utilized stronger at the local level than the two other systems. One of the general goals in the policy programmes is to get teachers to innovate with ICT in the classrooms. The Second Information Technology in Education Study (SITES) 2006 indicators for two innovative pedagogical orientations, lifelong learning orientation and connectedness are utilized to compare teachers from the three nations. The main findings is that Finnish teachers are either not differing or they are scoring significantly lower on the two indicators than teachers from Denmark or Norway. The exception is Finnish science teachers who are more inclined towards using ICT in lifelong learning practices than their Danish and Norwegian counterparts. Generally, the Finnish teachers seem to be more autonomous in their pedagogical choices but may also be more conservative than the Danish and Norwegian teachers in making use of ICT.

Keywords

Introduction: differences in pedagogical practices with ICT
There is a global trend in both educational policy and research to recognize the need to reform education from traditional paradigms of teaching and learning into more innovative forms of pedagogical practice. These areas of practice and change are often described with concepts such as information or knowledge society, emerging pedagogy and 21st century skills. The close link to use of ICT and ICT as an instrument for change and innovation is also prevalent in these discussions (Law et al. 2008; Anderson 2009; Anderson & Plomp 2009). Teachers play a crucial role in redeveloping schools into modern, technology-enhanced educational institutions. Implicitly, many major policy goals carry initiatives for teachers to adopt new pedagogical practices and to utilize new technologies to support their practices.

Three Nordic countries, Denmark, Finland and Norway, participated in the The International Association...
for the Evaluation of Educational Achievement (IEA) SITES 2006 study. The educational systems of the three countries share similarities as well as differences, but common to all three is a profound policy interest in pedagogical use of ICT to provide desired learning outcomes for the 21st century.

Former studies of teachers’ practice with ICT in the three countries have either been country-specific, oriented on teachers’ and students’ attitudes or towards describing the state of equipment levels (Arnseth et al. 2007). One overarching study, the E-learning Nordic 2006 study (Pedersen et al. 2006) looked at students’ and teachers’ practices and self-reported competency levels in Finland, Sweden, Norway and Denmark. An underlying notion in the study was the understanding that ‘[t]he Nordic countries in many respects share the same basic educational philosophy and the same framework in the educational systems’ (p. 3). Following this, the study did not undertake a comparative analysis between the four countries but tended to treat the participating teachers as one group with quite similar working conditions, leaving out valuable information about nuances in the teachers’ practices.

This paper seeks to clarify in what respect ICT policy in education in the three countries overlap, and if teachers’ visions and pedagogical practice with respect to ICT differ substantially. In the SITES 2006 study, indicators for three pedagogical orientations were developed, viz for traditional orientation, lifelong learning orientation and connectedness (Law & Pelgrum 2008). In this paper, the three indicators serve as the main framework for a comparison of the pedagogical visions and practices of Finnish, Danish and Norwegian teachers in the SITES 2006 data set.

Practices that belong within the categories lifelong learning orientation and connectedness are thought to be supportive of the development of 21st century skills, and are conceptually considered innovative (Law & Pelgrum 2008). Such innovative practices are clearly promoted as desirable in policy documents and policy initiatives in all three countries. Arguably, a secondary analysis of data from SITES 2006 can be utilized to comprehend if and how differences in the Nordic teachers’ innovative practice manifest themselves and how any differences can be understood in relation to policy goals.

The connection between policy and pedagogical use of ICT is also interesting with respect to the Organisation for Economic Co-operation and Development (OECD) PISA studies (OECD 2004a,b, 2007), which all show a remarkable difference in student performance. Finnish students are outperforming most other participants, which has led to heated debates in the other Nordic countries on how the Finnish school system differs (Beck 2008). For the purpose of this paper, it is then interesting to see if the Finnish school system may be better suited to ground and contextualize pedagogical practice with ICT than the Danish and Norwegian counterparts. This may in turn enable the Finnish teachers to use ICT more in coherence with the fostering of 21st century skills.

From this, the main research question can be formulated: when measured with the indicators distinguished in the SITES 2006 framework for 21st century skills and visions, are Finnish teachers scoring higher on these indicators than Norwegian or Danish teachers?

The paper presents a short description of the features of the three Nordic countries’ educational systems, followed by a brief discussion of relevant literature. After a methods section, the research question will be discussed in light of two sets of variables describing teachers’ visions and specific practices within the three pedagogical orientations (traditional, lifelong learning and connectedness).

System differences with respect to curriculum and ICT policy initiatives in Norway, Finland and Denmark

In terms of investments and attention to the issue of ICT in education, all three countries have invested quite heavily in hardware and infrastructure as well as in a range of other initiatives and staff training. However, whereas the Finnish government has included and embedded a strategy and initiatives for ICT in schools in a comprehensive plan to prepare the nation for the information society (Kiesi & Nieminen 2008; Kankaanranta 2009), in Denmark and Norway such initiatives appear to be largely restricted to the educational sector alone (Erstad & Quale 2009; Larson 2009).

In regard to policy concerning school and curriculum development, all three countries have made profound efforts to integrate the pedagogical use of ICT into the formal framework for their school systems (Arvedsen 2008; Helland 2008; Kankaanranta 2009). Norway has perhaps taken the most explicit steps through the connection of the use of ICT and basic skills (UFD 2004;
Norwegian Directorate for Education and Training 2008). This seems to put some stress on teachers in general as professional development within the domain are, at best, rudimentary (Erstad & Quale 2009; OECD 2009). Furthermore, intended policy goals in Norway remain largely unmet (ABELIA 2009).

Finland has placed development of pedagogical use of ICT into a large coherent strategy for the Finnish information society (Kiesi & Nieminen 2008; Kankaanranta 2009). Finnish teachers also enjoy strong municipality-based opportunities to engage in professional development (Sahlberg 2007; Tuovinen 2008). Nevertheless, it seems that the application of pedagogical use of ICT is left to each school and each teacher to a greater extent than in the other two countries, where more centralized efforts to define a common framework appear.

Denmark has integrated the use of ICT in all subjects in the curriculum, but a recent study shows that ICT has been used as a supplementary rather than as an integrated part of pedagogical practice (Sahlberg 2007; Tuovinen 2008). Danish teachers also report low levels of professional development in general (OECD 2009).

The last issue to be investigated is the teachers’ general access to ICT equipment and the percentage of teachers that report using ICT in their teaching and learning practices. Arguably, access to ICT equipment provided for teaching and learning is crucial in order to stimulate pedagogical practice and innovation with ICT. Schools in the three Nordic countries are quite well provided for. For example, the average number of computers available to students at secondary school was quite favourable for all three countries when the survey was conducted: Finland had 6.1 students per computer, Denmark had 4.9 and Norway had 3.2. These figures placed the countries among the top six countries participating in the SITES 2006 study (Ottestad & Quale 2009).

The SITES 2006 study established that teachers’ use of ICT differs in the three countries with respect to the amount of time used with ICT and on specific pedagogical practices (Law & Chow 2008). Most Norwegian teachers reported that they had used ICT in teaching and learning activities (72% math/64% science) followed by Danish teachers (69%/62%) and Finnish teachers (46%/57%) (Ottestad 2008). Further, more than 75% of all Norwegian and Danish teachers reported the use of ICT in class on a weekly basis or more often compared with only about 58% of Finnish science teachers and about 23% of Finnish mathematics teachers. Most ICT-using teachers in all three countries are only using ICT for limited periods of time (i.e. project work), and not in the daily pedagogical practice (Voogt 2008b). According to the study data, pedagogical use of ICT is more widespread among Danish and Norwegian teachers than among Finnish teachers.

From these data, a preliminary sketch was made of the policies regarding pedagogy and ICT and the mechanisms deployed to implement them. On the national level, there seems to be a distinction between national strategies and sector-bound initiatives. Finland has placed the use of ICT in schools in its master plan for societal development, while Norway and Denmark have developed policies mostly within the education sector. Prescriptions for how ICT is to be utilized in pedagogical practice range from the national curriculum prescription in Norway via the national strategic initiatives in Denmark to the school – or even teacher – control in Finland. Professional development in the pedagogical use of ICT can be understood as a key initiative to deploy central parts of these policies. Here, Denmark and Norway have a few uncoordinated initiatives and lack a clear culture for professional development, while Finland has placed the responsibility for these initiatives at the local level.

System-wide innovation in a school is more likely to take place when it is grounded in support from principals’ vision and motivation, formal school policy and structured teacher training (Forkosh-Baruch et al. 2005). It seems that the Finnish school system is better able to implement these features than the Norwegian or Danish systems. The Finnish school system places greater responsibility on each teacher and school to both prescribe what the pedagogical use of ICT should be similar to, and to identify and develop professional competencies for support.

The general conclusions for this section are that the Finnish system seems to anchor decisions about and interpretations of how ICT should be utilized more firmly at the local level than the two other systems and Finnish teachers are reporting fewer ICT users than Danish and Norwegian teachers. One very tentative interpretation from these two conditions is that Finnish teachers seem to be more autonomous in their pedagogical choices but also may be more conservative than Danish and Norwegian teachers in making use of ICT.
Further analyses of goals and practices within a 21st century skills framework could elaborate upon these differences.

Relevant dimensions concerning pedagogical visions and practice

To obtain a better understanding of teachers’ visions and practices, it may be useful to examine relevant system-level and school-level characteristics. Voogt and Knezek (2008) state that the school provides the organizational structure for the learning process and that educational policies affect how teaching and learning take place and are organized. This implies that it is useful to view the practices of teachers and students in a larger context to comprehend how innovative practices are best fostered. A number of relevant dimensions concerning this context could be investigated. In the further discussions, attention will be given to policy and curriculum, school conditions and professional development.

Policy and curriculum

To achieve inclusion of ICT in regular pedagogical practice, reasonably explicit requirements should be included in the schools’ curriculum, or in the framework for the curriculum. Voogt and Pelgrum (2005) found that, generally, the change towards the information society entails changes in the design and implementation of educational curricula, addressing an understanding of the need to develop novel competencies and lifelong learning capabilities that are not addressed in the traditional curricula. Here, Norway seems to have taken a firm stand through its efforts to establish a national curriculum that supports the use of ICT as a basic skill in all subjects.

Generally, when it comes to ‘translating’ such policy initiatives into new system-wide patterns of actual pedagogical practices, local frameworks play an important role. Voogt (2008a) argues that ‘[i]n IT-supported teaching and learning content, goals, pedagogy and assessment need to be attuned to bridge the current gap between the intended, the implemented and the attained curriculum’ (p. 129). A successful translation from the policy and curriculum levels to actual practice then rests largely on conditions at school level. As pointed out in the earlier section, the Finnish system seems to assign a clearer responsibility to schools and teachers for this translation to happen than is the case in Denmark and Norway.

School conditions

School leadership is crucial for the climate of innovation at a school. Arnseth et al. (2007) found that by systematic planning and anchoring the ICT implementations in the faculty, school leaders can manage to systematize the work and focus broadly on several decisive measures concerning the pedagogical use of ICT (e.g. professional development or flexible time planning). Further, in the SITES 2006 main study, Law (2008a) reports that the principals’ leadership and vision with respect to the pedagogical use of ICT is largely realized by means of the influence these principals have on support (both pedagogical and technical) and the technology infrastructure and that these factors are crucial for fostering teachers’ pedagogical practices with ICT.

Tondeur et al. (2008) are more directly concerned with the teachers’ working conditions. They argue that differences in school-level variables can be used to explain differences in teachers’ use of computers. Even when teachers’ adoption of the different computer uses is checked for gender, experience with computers and current teacher beliefs, structural variables at school-level, especially the availability of computers within classrooms, seem to have a profound effect. Similarly, Pelgrum (2008) documented huge variations between school systems in terms of access to ICT infrastructure and perceived need for ICT-related resources (i.e. interactive whiteboards, email accounts for students) in the SITES 2006 main study.

Ten Brummelhuis and Kuiper (2008) introduced individual characteristics of teachers when they identified four driving forces for the use of ICT in learning: the teacher, the learner, the learning content and the learning materials. They described a learning process as ‘the result of both structural conditions (of content and materials) and individual characteristics (of teacher and learner)’ (p. 97). From this, one might argue that if the learning process is central to the use of ICT, the teachers’ motivations and capabilities are key when the actual choice of procedures, learning material and practices is made. This in turn puts the focus on professional development as a means to build capacity for such informed choices among the faculty.
Professional development

The need to develop novel competencies and lifelong learning capabilities suitable for the 21st century is arguably closely linked to teachers’ professional development. The OECD Teaching and Learning International Survey (TALIS) study indicates that feedback structures, strategic leadership and clear notions of what competencies are required to meet different needs are crucial to raise the quality of professional development (OECD 2009). As pointed out in the earlier section, Norway and Denmark have rather weak systems for building effective systems of professional development, particularly regarding the use of ICT in educational practice.

Findings from SITES 2006 indicate that a majority of schools did not require any form of professional development with regard to pedagogical use of ICT to be undertaken by their teachers, and the availability of courses varied to a great extent (Pelgrum 2008). Furthermore, the school leaders differed greatly with regard to how they tried to influence the teachers’ pedagogical and assessment practices, and their cooperative activities (Law 2008b). This finding could be crucial as several studies establish school leadership and change management (Kozma 2003; Kirkland & Sutch 2009) as two important dimensions at the meso level that make teachers implement and innovate with ICT.

Methodological framework

In order to clearly understand how concepts of pedagogical orientations were constructed and how these concepts were linked to the larger concept of 21st century pedagogy, a closer inspection of pedagogical vision indicators and pedagogical practice indicators is necessary. A short presentation of other analytical techniques used follows. In general, a weighting procedure was used for all calculations to correct for the different sample sizes of teachers in the countries participating in the study (Carstens & Pelgrum 2009).

Indicators for pedagogical visions

The teachers’ vision was measured in terms of support to various statements concerning pedagogical goals. The main question was phrased this way: ‘In your teaching of the target class in this school year, how important is it for you to achieve the following goals?’ Table 1 presents the 10 items that were found to comprise the three constructs for the teachers’ espoused curriculum goals.

Some compromises were made in the SITES 2006 study when the three constructs were established. For example, among the original 12 items, only 10 were found to hold satisfactory explanatory power and reliability across all 21 educational systems (countries) to

<table>
<thead>
<tr>
<th>Table 1. Items for 10 curriculum goals used to generate the three constructs of pedagogical goal orientation.</th>
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<tbody>
<tr>
<td><strong>Curriculum-goal orientation</strong></td>
</tr>
</tbody>
</table>
| Traditionally important | • To prepare students for upper secondary education and beyond  
• To improve students’ performance in assessment/examinations  
• To satisfy parental and community expectations |
| Lifelong learning | • To provide activities that incorporate real-world examples/settings/applications for student learning  
• To individualize student learning experiences in order to address different learning needs  
• To foster students’ ability and readiness to set their own learning goals and to plan, monitor and evaluate their own progress  
• To foster students’ collaborative and organizational skills for working in teams |
| Connectedness | • To provide opportunities for students to learn from experts and peers from other schools/countries  
• To foster students’ communication skills in face-to-face and/or online situations  
• To prepare students for responsible Internet behaviour |

The items are measured on a four-point Likert-scale (1 = not at all, 2 = a little, 3 = somewhat, 4 = very much). Source: Law (2008a, p. 124).
be included (Law & Chow 2008; Carstens & Pelgrum 2009).

Further, one might argue that the choice of items and their assignment into three factors is partly theoretically grounded. Lifelong learning and connectedness denote practices ‘considered conducive to developing learning outcomes important for the knowledge society, such as undertaking autonomous learning, collaborative inquiry, and communication through use of appropriate digital technology’ (Law & Chow 2008). The method chosen in the SITES 2006 main study was to calculate the arithmetic means across the pre-assigned items rather than to calculate factor-score variables for each educational system, which would have created incomparable variables.

From this, one can hypothesize that the indicators for lifelong learning and connectedness will be more strongly correlated with each other than with the indicator for the traditional orientation. Table 2 supports this assumption, showing consistently higher correlations between the indicators assigned to describe the traits of a 21st century pedagogy than with the indicator for traditional pedagogy. This supports an understanding of the teachers’ visions for their pedagogy as influenced both by traditions and by more recent paradigms.

Even if unexplained variance is included in the indicators by summing the items, we were still given an opportunity to compare countries by means of calculating the arithmetic means for the three indicators. This consideration was given priority in this paper as well as in the SITES 2006 main study (Carstens & Pelgrum 2009).

### Indicators for pedagogical practice orientations

Data concerning the teachers’ use of ICT in specific pedagogical practices were gathered in the SITES 2006 study. Twelve specific practices were analysed, where the logic of organizing the items into indicators is similar to that discussed for pedagogical visions.

The means calculated for these orientations were based on a four-point Likert scale that specifies how often the practice is conducted (‘never’, ‘sometimes’, ‘often’, ‘nearly always’). Note that the difference in response alternatives makes it impossible to test the differences in means between visions and practice. In addition, the responding teachers were also asked to indicate if they used ICT or not with the specific practices (yes/no). See Table 3 for a complete list of items, clustered by pedagogical orientation.

In general, Table 3 shows that there are relatively more Norwegian teachers in both subjects reporting use

<table>
<thead>
<tr>
<th>Table 2. Correlations of indicators for pedagogical orientations.</th>
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<tbody>
<tr>
<td><strong>Mathematics teachers</strong></td>
</tr>
<tr>
<td>Life-long learning</td>
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<tr>
<td><strong>Dk (N = 392)</strong></td>
</tr>
<tr>
<td>Traditional vision</td>
</tr>
<tr>
<td>Lifelong learning</td>
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<td>Connectedness</td>
</tr>
<tr>
<td><strong>Science teachers</strong></td>
</tr>
<tr>
<td>Life-long learning</td>
</tr>
<tr>
<td><strong>Dk (N = 454)</strong></td>
</tr>
<tr>
<td>Traditional vision</td>
</tr>
<tr>
<td>Lifelong learning</td>
</tr>
<tr>
<td>Connectedness</td>
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</tbody>
</table>

*p < 0.05, **p < 0.01.
Table 3. Valid percentage (N) of mathematics and science teachers in Denmark, Finland and Norway reporting utilization of ICT in specific practices.

<table>
<thead>
<tr>
<th>Traditional orientation</th>
<th>Denmark Math</th>
<th>Science</th>
<th>Finland Math</th>
<th>Science</th>
<th>Norway Math</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present information/demonstrations and/or give class instructions</td>
<td>38.2 (374)</td>
<td>39.3 (436)</td>
<td>22.7 (556)</td>
<td>31.0 (565)</td>
<td>57.2 (298)</td>
<td>52.3 (279)</td>
</tr>
<tr>
<td>Assess students’ learning through tests/quizzes</td>
<td>24.2 (375)</td>
<td>31.7 (437)</td>
<td>18.4 (556)</td>
<td>25.7 (564)</td>
<td>36.4 (296)</td>
<td>37.7 (278)</td>
</tr>
<tr>
<td>Use classroom management to ensure an orderly, attentive classroom</td>
<td>4.0 (368)</td>
<td>5.1 (425)</td>
<td>1.6 (543)</td>
<td>1.6 (559)</td>
<td>13.7 (282)</td>
<td>9.7 (273)</td>
</tr>
<tr>
<td>Lifelong learning</td>
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<td></td>
</tr>
<tr>
<td>Provide remedial or enrichment instruction to individual students and/or small groups of students</td>
<td>24.9 (372)</td>
<td>25.5 (432)</td>
<td>16.7 (557)</td>
<td>11.4 (537)</td>
<td>43.5 (293)</td>
<td>28.9 (271)</td>
</tr>
<tr>
<td>Provide feedback to individuals and/or small groups of students</td>
<td>11.5 (369)</td>
<td>13.2 (434)</td>
<td>6.9 (551)</td>
<td>7.9 (555)</td>
<td>19.1 (291)</td>
<td>22.5 (275)</td>
</tr>
<tr>
<td>Provide counselling to individual students</td>
<td>15.1 (366)</td>
<td>18.3 (420)</td>
<td>13.2 (544)</td>
<td>9.4 (556)</td>
<td>26.3 (279)</td>
<td>22.6 (272)</td>
</tr>
<tr>
<td>Help/advise students in exploratory and inquiry activities</td>
<td>28.5 (364)</td>
<td>40.4 (429)</td>
<td>39.5 (512)</td>
<td>60.4 (544)</td>
<td>44.2 (289)</td>
<td>50.5 (270)</td>
</tr>
<tr>
<td>Organize, monitor and support team building and collaboration among students</td>
<td>4.5 (360)</td>
<td>4.6 (423)</td>
<td>3.3 (536)</td>
<td>2.5 (550)</td>
<td>8.7 (280)</td>
<td>9.9 (271)</td>
</tr>
<tr>
<td>Organize, observe or monitor student-led whole-class discussions, demonstrations, presentations</td>
<td>24.7 (354)</td>
<td>29.0 (428)</td>
<td>7.7 (512)</td>
<td>15.7 (544)</td>
<td>20.6 (289)</td>
<td>18.4 (270)</td>
</tr>
<tr>
<td>Connectedness</td>
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<td></td>
</tr>
<tr>
<td>Organize and/or mediate communication between students and experts/external mentors</td>
<td>19.0 (342)</td>
<td>24.6 (406)</td>
<td>5.6 (501)</td>
<td>12.1 (528)</td>
<td>19.7 (266)</td>
<td>19.0 (264)</td>
</tr>
<tr>
<td>Liaise with collaborators (within or outside school) for student collaborative activities</td>
<td>22.2 (344)</td>
<td>24.8 (408)</td>
<td>16.4 (515)</td>
<td>18.0 (526)</td>
<td>27.9 (263)</td>
<td>21.1 (257)</td>
</tr>
<tr>
<td>Collaborate with parents/guardians/caretakers in supporting/monitoring students’ learning and/or in providing counselling</td>
<td>26.2 (359)</td>
<td>20.4 (402)</td>
<td>39.3 (543)</td>
<td>35.7 (541)</td>
<td>34.1 (273)</td>
<td>28.6 (267)</td>
</tr>
</tbody>
</table>

Clustered by pedagogical orientation. Dichotomous variable.
of ICT in most practices compared with Danish or Finnish teachers. Some exceptions were also found, e.g. that it is more common for Finnish teachers to use ICT to collaborate with parents or guardians or that more Danish science teachers utilize ICT to organize and support team building and collaboration among the students. However, the overall picture is that Norwegian teachers are relatively the largest group reporting pedagogical use of ICT in a broad sample of practices.

Other analytical techniques

All analyses of SITES 2006 data were conducted in spss 16 (SPSS Inc., Chicago, Ill., USA), with additional software provided from the IEA Data Processing Centre. To compare means, one-way analysis of variance (ANOVA) was used, and pairwise comparisons were provided through Bonferroni post hoc tests. To test the strength of significant differences between pairs of countries, the effect size measure $\eta^2$ is reported. The analyses will use the guidelines for interpreting effect sizes provided by Vacha-Haase and Thompson (2004). Effect sizes $\eta^2 = 1\%$ should be considered small, $\eta^2 = 10\%$ medium and $\eta^2 = 25\%$ large.

Findings

In this section, findings from a comparison of the three indicators for visions and practice are presented, each in their own subsection. Analyses of pairwise differences between countries are used to answer the main research question.

Differences in visions

As described earlier, 10 items describing espoused curriculum goals (i.e. visions) were found to fit within three pedagogical orientations. Figure 1 shows the difference in mean scores on the pedagogical orientations for teachers in the three countries.

From Fig 1, it can be suggested that Norwegian teachers tend to favour goals within the lifelong learning category more strongly than do Danish and Finnish teachers. Furthermore, the similarities between how the teachers rank their support of the three goal orientations are strong and at a first glance, appear not to yield differences. Teachers in both subjects in all countries favour goals within the lifelong learning indicator over traditional goals and rank goals within the connectedness indicator lowest.

Testing for differences in mean for visions, the ANOVA test is significant for all three countries in both subjects on both 21st century indicators:

- Lifelong-learning orientation: mathematics: $[F_{(2, 717)} = 220.4, P < 0.001]$; science: $[F_{(2, 953)} = 132.4, P < 0.001]$
- Connectedness orientation: mathematics: $[F_{(2, 717)} = 3.486, P < 0.031]$; science: $[F_{(2, 953)} = 76.7, P < 0.001]$. 

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When comparing countries with respect to the mean results for all teachers on the indicators for lifelong learning and connectedness visions, it is interesting to see whether the differences in means lie between all countries or just two. Table 4 shows the mean (SD) of pairwise differences for Denmark (DK), Finland (FIN) and Norway (NOR).

Table 4. Bonferroni post hoc test and effect size ($\eta^2$) for support of indicator for lifelong-learning curriculum goals (visions) and connectedness curriculum goals (visions). Mean (SD) of pairwise differences for Denmark (DK), Finland (FIN) and Norway (NOR).

<table>
<thead>
<tr>
<th>Lifelong-learning</th>
<th>Math</th>
<th>Finland (N = 585)</th>
<th>DK (N = 392)</th>
<th>NOR (N = 326)</th>
<th>FIN (N = 585)</th>
<th>NOR (N = 326)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>$\eta^2$</td>
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</tr>
<tr>
<td>Lifelong-learning</td>
<td>Science</td>
<td>DK (N = 454)</td>
<td>-0.07* (0.01)</td>
<td></td>
<td>-0.04* (0.01)</td>
<td></td>
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<tr>
<td></td>
<td>$\eta^2$</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connectedness</td>
<td>Math</td>
<td>DK (N = 392)</td>
<td>0.06* (0.01)</td>
<td></td>
<td>0.02 (0.01)</td>
<td>-0.04* (0.01)</td>
</tr>
<tr>
<td></td>
<td>$\eta^2$</td>
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</tr>
<tr>
<td>Connectedness</td>
<td>Science</td>
<td>DK (N = 454)</td>
<td>0.000</td>
<td></td>
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</tbody>
</table>

*The mean difference is significant at the 0.05 level.

See in light of the research question, the Finnish science teachers are promoting the indicator for connectedness vision a little stronger compared with the other teachers.

**Difference in practice orientations**

As described earlier, 12 items describing specific practices were found to fit within the three pedagogical orientations. Figure 2 shows the difference in mean scores for the three indicators for practice orientations, for teachers in the three countries.

It is noteworthy compared with Fig 1 that the mean scores for the two innovative indicators, lifelong learning orientation and connectedness, are much lower in Fig 2, compared both with the mean scores for traditional practices and with the two corresponding indicators for vision in Fig 1. However, as noted earlier, this comparison can be only read as indicative.

Testing for differences in mean for the pedagogical practice orientation, the ANOVA test is significant for all three countries in both subjects on both 21st century indicators:

- Lifelong learning orientation: mathematics: $[F_{2, 7042}] = 340.3, P < 0.001$; science: $[F_{2, 9415}] = 413.4, P < 0.001$
- Connectedness orientation: mathematics: $[F_{2, 7015}] = 372.9, P < 0.001$; science: $[F_{2, 9369}] = 178.8, P < 0.001$. 

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Table 5 shows that when pairwise differences are considered, teachers from the three countries differ significantly on the mean score for the indicator of lifelong learning practice. Even if Danish and Norwegian math teachers come out significantly different in the pairwise comparison, they are still closer to each other than to the Finnish teachers. The Finnish math teachers score on average significantly lower on the lifelong learning practice indicator compared with both Danish and Norwegian teachers, but the Finnish science teachers are scoring on average significantly higher than their Danish and Norwegian counterparts. All effect sizes between Finnish teachers and the others could be considered to be in a range from small to medium. This gives another partial answer to the research question. When considering lifelong learning practices, Finnish math teachers score lower than the others, but the Finnish science teachers score higher.

For connectedness, Table 5 shows that both the Finnish math and science teachers are scoring significantly lower on average for the practice indicator when compared pairwise with the Danish and Norwegian teachers. Effect sizes here also range from small to medium, which indicates that the differences should not be neglected. In light of the research question, this means that the Finnish teachers are scoring lower on the connectedness practice indicator than the other teachers when compared.
To summarize the answer to the research question: Finnish teachers are either not scoring differently on the indicators for 21st century pedagogical visions and practices from teachers from Denmark or Norway or they are scoring significantly lower, with the exception of the lifelong learning practice where Finnish science teachers’ scores are significantly higher.

Discussion

Apart from the differences in pairwise comparisons, Norwegian, Finnish and Danish mathematics and science teachers, in general, promote a vision of their pedagogical orientation where lifelong learning goals are ranked highest. However, when the same teachers report on their practice, traditional orientated practice prevails.

This might corroborate the conclusion in the earlier section, i.e. that the Finnish teachers seem to be more autonomous in their didactic choices but more conservative in making use of ICT than the Danish and the Norwegian teachers. However, as the discussion earlier indicated, Finnish teachers might have an advance in using ICT in specific pedagogical practices where the impact on learning scaffolding and subject understanding is high. Univariate differences between the countries on two of the practices reported could reveal valuable information on this question.

Table 3 shows that, in general, fewer of the Finnish teachers reported use of ICT in the 12 practices, with some very interesting exceptions. First, both groups of teachers in Finland that are using ICT to collaborate with parents or guardians are relatively larger than in Denmark and Norway. A good relationship between home and school is important to strengthen children’s learning (Fan & Chen 2001; Hattie 2009) and extending this relationship using ICT could open for closer collaboration.

Second, more than 60% of the Finnish science teachers used ICT to ‘help/advice students in exploratory and inquiry activities’ compared with 50.5% in Norway and 40.4% in Denmark. This item is of particular interest as it points directly to the debate on how the extraordinary Finnish science results in PISA were achieved. It is claimed that Finnish teachers through their education are focusing on experimenting and modelling in the subjects. The national curriculum also separates the subject science into the disciplines physics, chemistry and biology from grade 7 onwards. This combination of curricular and pedagogical priorities makes for two (of many) important factors to explain the Finnish success (Pehkonen et al. 2007). The aforementioned data from SITES 2006 seems to support the argument of Pehkonen et al. by pointing to how Finnish teachers purposely are utilizing ICT pedagogically to teach and support learning the very process of scientific reasoning.

To contrast this, a recent secondary analysis of the OECD PISA 2006 results found that in the case of school use, more computer use does not mean better results in the subject-based standardized tests in PISA 2006 (OECD 2010). Even if it is plausible to assume that more, and more regular, time with computers at school should increase learning outcomes, one should clearly not read the extent of ICT use as an indicator of the quality of the learning processes.

Concluding remarks

We have so far seen that all the three countries have launched huge policy and investment programmes to promote digital literacy and readiness for the information age and that teachers’ pedagogical use of ICT in the three countries do not differ very much from each other. Finnish teachers are reporting less use of ICT, but the Finnish teachers may be in the lead when the uses of ICT specifically concur with their strong tendency to promote an inquiry-based pedagogy. This fact could be related to teachers’ relatively more autonomous position in Finland, which in turn could partly be due to their higher education levels (Pehkonen et al. 2007), partly to a school system that is anchored in a systematic culture of knowledge building where an example could be the implementation of national information strategy goals (Kankaanranta 2009). It is also characteristic of the Finnish school system that decisions on curriculum and instruction are made by local schools and teachers (Kankaanranta 2009). Parallel to this, Ottestad and Quale (2009) show that close ownership (i.e. at schools) of investment decisions regarding the procurement of ICT equipment correlates with increased investment in such equipment.

Most ICT-using teachers in all three countries are using ICT in their practice just in confined periods of time and not on a daily basis. This is contrary to the policy statements and goals of all three countries and
serves as a reminder of the complexity of the reforms schools are facing.

As an example, the greatest novelty by far in the Norwegian reform ‘knowledge promotion’ is the inclusion of use of ICT as a basic skill. This inclusion seems to put stress on teachers and school leaders as they now are responsible for the students’ training in this new field. However, as Erstad and Quale (2009) stated, they are ‘(…) faced with a frustrating dilemma: they are required by statute to use ICT extensively in their practice, but no one tells them how they should do this’ (p. 565). The apparent drop from a prevalence of innovative 21st century visions to a relative lack of 21st century practices could be interpreted as corroborative of the existence of this dilemma. Another perspective is to understand the teachers as lacking resources or meeting other structural constrictions to put their visions into action.

From the arguments in this paper, two recommendations to stimulate innovative pedagogical practice with ICT are emerging. First, the Finnish case arguably show that autonomy and local ownership of definitions of important interpretations of curricula together with influence on professional development can provide better structures for pedagogical innovation with ICT. Second, despite this, the Finnish teachers are the least likely to utilize ICT in their pedagogical practice. Here, the Norwegian implementation of ICT in the curriculum seems to yield results in the proportion of teachers that are starting to use ICT in their practice.

References


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