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The Fifth Basic Skill – ICT – as a Learning Resource

Abstract

It has been of great importance for us to study ICT as a tool for learning in a holistic perspective. Accordingly – the article presents students' actual use of PC related to the atmosphere in the classroom, to social relations, to the teacher´s role, to work processes and to the conception of learning and learning outcome.

Besides stressing the context, the article stresses the teacher's positioning, namely: allowing the students *time* to search for and construct new skills and understanding, allowing the students *time* for reflectiveness and insight into what one does and why, i.e. cognitive activity, metacompetence and additional learning. The article underlines understanding for learning, processes for the end product. We claim that the teacher´s role to focus learning atmosphere and to guide suitable process-strategies is a decisive condition for success with ICT.

Key words: *holistic perspective – teacher's positioning – processes surpass end product.*

Preface

The 2006 Norwegian school reform, labelled "Knowledge Promotion", presents ICT as one of five basic skills. It is important to better understand the pedagogical potential and challenges of using ICT in schools, and each research project shows a new aspect of this field. I give thanks to Åretta Lower Secondary School and the pupils of grade 9b, whom I was able to observe in their mathematics class. Furthermore, I would like to thank the teacher, Bueie, who was very positive and forthcoming and provided knowledge and support for this study.

I. Background

ICT at schools

In 2006 the Norwegian government presented a teaching plan for the school reform project *Knowledge Promotion*[1]; in the teaching plan the use of digital tools is characterized as one of five basic skills, and ICT is supposed to play a central role in the subject of mathematics. The international DeSeCo[2] project of the OECD stresses that there is international agreement in terms of ICT-use; in the discussion of "key competencies" one of the three vital competences is that pupils "use technology interactively" (pp. 10–11).

Åretta Lower Secondary School is one of ten demonstration schools in Norway, and the school promotes the use of digital tools in teaching. The school's teachers stress that pupils are more motivated when they work with digital tools and that weak pupils are better able to follow class. The mathematics teachers point out that pupils who have fine-motor difficulties are better able to use the keyboard than they are to use pencils, dividers, and rulers in the geometry class. At an international level Åretta school participates in the ENIS (European Network of Innovative Schools) project, and there are plans to send the school's teachers to exchange visits and to receive visiting teachers from other European countries.

II. Sketch

Observation as a method

This classroom study is a case study (cf. Nunan 1992:74f.) since it is limited to a single classroom and has a limited duration. The study analyzes, interprets and describes a limited phenomenon in a social context. The study is based on observation of selected classroomactivities, verbal interaction and partly based on what is called "stimulated recall" (op.cit:94f.), i.e. the teacher´s comments on the previous classroom events under study. The observations are carried out in a natural, i.e. not experimental setting (op.cit:102f.). The study is *qualitative*; the overall goal is holistic understanding and seeing connections as different from fragmentary knowledge (op.cit:231 and Patel & Davidson 1995). The personal based, subjective

[1] *Knowledge Promotion,* cf. Nilsen, H. (2006A). School for the future; a critical view on the Norwegian School Reform 2006, Knowledge Promotion. In: *The New Educational Review*, 2006, *10(3–4)*, and Nilsen, H. (2007). Norweska reforma edukacji: *Promocja wiedzy* 2006. (forthcoming September 2007).

[2] DeSeCo: Definition and Selection of Competences. Available on-line.

perspective of interpretation (cf. "Forståelseshorisont"; "horizon of understanding", Føllesdal et al. 1990:101) interferes with the validation of results. The subjective perspective is enhanced by the mode of observation where "open" observation was used rather than a pre-prepared observation form. Nevertheless, the observations had a clear focus on work modes, social interaction, and learning objectives, and can therefore be classified as "semi-structured" (Nunan 1992:91–114, Patel & Davidson 1995:67).

The classroom is an arena for diverse activities (cf. Ellis 2006). Children and young adults are generally active, and in the classroom the teacher organizes physical, verbal, and mental activities that are meant to generate learning and understanding; during my time as an observer in the 9th grade of Åretta school I experienced such a setting. It is impossible to describe the diversity of activities, and I had to be selective (see above). However, selection and focus on something implies that some things can be overlooked. Therefore this study is not going to present "heavy" conclusions but is meant to prepare and motivate further more detailed studies in this field.

Learning = understanding

The new teaching plan, *Knowledge Promotion*, discusses the pedagogical challenges and changes in the wake of the new focus on information and communication technology. The changes have at least two aspects, changes of the actual teaching methods and changes regarding the general view on learning. With the computer as a tool in the classroom, changes regarding the way of learning or the teaching design have become obvious, and we think that changes in design should have consequences for general views on learning such as asking what the defined learning objectives and what the objectives of the so-called concomitant learning are. Another important aspect is to define the concepts that are used for describing learning objectives. In this observational study it became clear for Bueie as a teacher and for me as a researcher that we should talk about *understanding* rather than about learning. The term understanding provides a user perspective for the subject of mathematics, and in this perspective there is a harmonious relationship between understanding and an interactive (or rather symbolic-interactive, Blumer 1969) view of learning and between understanding and the pupils' investigative way of solving problems. Understanding appeals more than learning to the idea that pupils should be able to reflect upon and do something with what they have learned, in other words, understanding is linked to cognitive competence. The DeSeCo-report calls cognitive competence "reflectiveness", which is "the heart of key competences" (net-address).

It can be argued that understanding in the subject of mathematics is equally relevant for ICT, that the idea of understanding links the students' PC to a user-

context and links it to a holistic, cognitive process ("reflectiveness"). Bueie understands his role in the process as "constructing understanding", and in this role he is able to improve the quality of the teaching process.

ICT in context[3]

In order to study a subject, learning and understanding, activities, and tools in a holistic perspective,[4] the whole school environment as a learning arena has to be included. The learning environment functions at least at three levels: school, classroom, and a third level where pupils/teachers *realize* their environment and their relations; this is the symbolic level ("symbolic interaction", Blumer 1969). The latter exceeds the aim of this study and is therefore not taken up explicitly.

Åretta – a demonstration school

Åretta school consciously aims at realizing a result-oriented culture. The areas the school focuses on are evaluation, net-based learning and models for ICT-use, flexible work forms with access to basic classrooms, large classrooms, and group rooms, and last but not least, the pupil's constructive participation. A 10th grade pupil states that the best aspect of the school is that "the pupils' opinions are heard and are taken seriously" (quoted in the newspaper *Gudbrandsdalen/Dagningen* 02.02.06) and that "now we can, to some degree, participate in determining what and how to learn."[5] In the same article two girls state about the "good school" that "the teachers saw every single one of us" and furthermore think that good teachers are those who understand the pupils' world and take them seriously. The statements from a log book in the 8th grade, where the task was to describe what was good about the school, include many answers such as "good/very good learning environment", "freedom", and "smart teachers"(brochure *Åretta School*).

The classroom

More important than the physical space as such is the atmosphere created by human beings who act and interact in that space. The pupils' verbal and body language demonstrates security. Both inside and outside the classroom there is

[3] About ICT and context: Nilsen, H. (2006). ICT jako narzędzie w edukacji na odległość w świetle perspektywy ekologicznej. In: K. Wenta & E. Perzycka (Ed.). (2006). *Edukacja informacyjna*. Szczecin: Szczecin University.

[4] On perspectivism; Hundeiede referred to in: Hoel Løkensgard T. (1998). *Læring som sosial praksis*. NTNU – Program for lærerutdanning.

[5] These pupils' statements are documented and seen in a larger context in Nilsen, H. (2006). School for the Future: A Critical View… *The New Educational Review*, *10(3–4)*.

much talking, but no unpleasant noise, the situation could be labelled an "ordinary" conversation culture of 15-year-olds.

The teacher positioned himself in an anonymous way and appeared to be neutral and friendly; nevertheless, he was always physically and visibly present. Being both anonymous and visibly present may appear to be a paradox, and this point is discussed later in the study. The pupils thought that the teacher was present for them. That the teacher was present for the pupils could be seen in the way they addressed the teacher openly, securely, and "naturally", in contrast to a memorized routine. This is what the teacher has to say about the situation:

> I perceive the social order and structure in the learning situation as calm and relaxed. We are organized in a way where I do not have to show myself to be authoritarian, and I can function as a genuine partner in conversation and cooperation with the pupils.

One may ask what the positioning of the teacher has to do with the use of digital tools, and here it could be argued that the way of the teacher to position himself as both discreet and present, as patient and daring to wait is a good investment for preparing an attitude of investigation and challenge that pupils need in their dialogue with the computer.

The roles of computers and of teachers

Before the class "really" started, the computer had taken over the role of the teacher; it structured the transition from break to the formal learning situation. It took 2 – 4 minutes until the pupils routinely had fetched their computers from the store room, placed them on their desks, opened them, and split their attention between the screen, other pupils, or other things and appeared to ask "what now?" Although the opening minutes invited much freedom, the process was marked by routine, in other words, order. Here the teacher was physically clearly present and placed himself in the front of the classroom; however, his presence was quite wordless and he appeared to be patiently waiting – but waiting for whom or for what?

As I see it, the anonymity of the teacher invited a "wait and listen" attitude among pupils, a "now we are going to learn" atmosphere. It was not the teacher who at that moment was concerned about creating silence for work (a learning environment) during the class, but it were the pupils who took the initiative. The computer was present, and the machine in itself was interesting for the pupils, opened up possibilities such as individual or collectively organized free investigation. However, the pupils understood that if there should be a *progression* in their learning, they needed the teacher. This is what Bueie says about the use of ICT:

> In my view the learning situation has changed after we started to use ICT. The focus has shifted from teaching to learning, from the teacher to the pupil. This means that pupils themselves must be more active in knowledge acquisition. Through their interaction with the computer, pupils control their own progression. They navigate through net pages, investigate, try out things, and the learning process is circular and recurrent rather than linear; cognition research has too long seen learning as a linear transfer of knowledge and knowledge as a storeroom of mental representation.

The fact that the computer offers and invites investigation and experimental activities should have consequences for the role of the teacher, according to Bueie: "The computer liberates time that can be used for supervising pupils individually in a conversation and guide them through a process. The more pupils discover and understand without my explanation, the better the learning situation. ICT clearly opens up possibilities for investigation and a dialogic learning, for example when one works with geometrical figures".

Pupil – teacher – relations

As a collective the pupils of the class wanted to use their freedom in a responsible manner. I have mentioned that the computer invited the formation of routines, a type of seriousness in contrast to play and irresponsibility. Furthermore, the cautious authority of the teacher appeared to have precipitated in an attitude that could be paraphrased as "we are here to learn" or "the teacher is here for us". Another important point was that the pupils appeared to respect each other for what they were, in contrast to a ranking according to smartness or popularity. However, this does not mean that pupils were not interested in being smart in their subject. They demonstrated to be conscious about the fact that some were smarter than others when they said that "he is smart", "she is smarter than…." or asked "could you help me?" The teacher did not press the class to present results during an established frame of time, nevertheless, the pupils were used to a "certain" time frame. The most interesting aspect in the relationship between teacher and pupils was that the teacher invited the pupils to be investigative and experimental in their routines. The positioning of the teacher is a signal to manage and to "find out things" independently, in contrast to a positioning where the teacher checks wrong and correct answers.

The teacher is convinced that ICT has a motivational effect and refers to his experiences in teaching mathematics in classes without computers. Here we come to the central point, namely the motivation to work with a subject. To learn means to "do" something, either physically or mentally. In this context it was obvious that the pupils were diligent and even enthusiastic in their dialogue with the computer. Above all, they appeared to be relaxed because the computer was a benevolent

partner that did not demand anything but functioned more or less in a cooperative way and as a useful tool to them.

I experienced the importance of the computer for motivation when one of the five observation classes were computer-free. During this class there was so much loud talking and physical restlessness that it affected the learning environment, and the teacher had to calm down the class, though respectfully.

III. Learning and Learning Objectives

Dynamic geometry with Cabri

"Data technology has opened up many new options in regard to how we understand geometry. Among other things there are construction programmes that enable us to perform the constructions that were traditionally done with dividers and aruler. Cabri is an example of such a construction programme. The screen image of Cabri looks like a blank page, but we are able to choose the basic geometrical figures that we want to construct from a menu. When a figure is constructed, we are able to change the basic elements of the of the figure form or placement." (Bueie 2005)

Learning objectives and learning activities class by class

February 14th

- Tasks: With the help of the computer and Cabri, the pupils are going to construct "basic" angles (60 and 90 degrees), divide the angles in half, rise and lower normals, construct parallels, and try out simple triangle and quadrilateral functions.
- Work form: Pair work, each pupil with his or her computer. Free engagement with the computer until the aim is reached.
- Learning objective: To construct (= skill) according to instruction/guidance (= understanding).
- Atmosphere: Relaxed, safe, "talk culture", balanced, a social climate.
- Role of the teacher: Introduces the tasks briefly: "where are we, where shall we go?" Functions as an aid in the pupils' work processes.
- Learning gain: cf. report from February 21.

February 21st

- Tasks: With the help of Cabri the pupils are going to construct triangles and write a construction explanation.
- Work form: In pairs, and the class is organized into two groups, A and B. During sequence 1 (ca. 20 min) each group is going to construct "their" tri-

angle and write a construction explanation. Now the pupils erase their geometrical figure but leave the explanation on the screen. Group A and B swap computers and construct new triangles in accordance with the explanations that are left on the screen.

- Learning objectives: To construct according to an objective/instruction and create a functional construction explanation.[6]
- Atmosphere: Relaxed, secure interaction pupil-pupil and pupil-teacher.
- Role of the teacher: (i) Introduces the class with providing a perspective (= the "why" of didactics) and (ii) problematizes the criteria for "good" construction explanations.
- Learning gain: Bueie explains that he changed his view on learning gains after data technology had been introduced to the math class:

> Earlier, when we used dividers and a ruler, I first presented a "model" solution, and the task was in some way a confirmation whether or not the pupils were able to follow my presentation. Learning meant to memorize my presentation. With ICT there is a new focus on the pupil as an explorer, and the pupils' learning is linked to the quality of the process rather than to how many tasks they can solve during a given time. The process is interactive because the pupils have the option to receive "real time" feedback rather than a response on the quality of their final product. In summary one can say that the focus has shifted from the aim itself to the process towards the aim.

See report from March 12th, item 3 on skill and understanding as learning gains.

March 7th – computer-free class.

For me as an observer it was interesting to see what a computer-free class meant for the working conditions.

- Tasks: To construct quadrilaterals and to make a construction explanation. Tools: paper, pencil, protractor.
- Work form: Pupils work in pairs. Each pupil constructs his or her quadrilateral and makes a construction explanation (15 – 20 min). Pupil A explains the construction explanation to his or her counterpart who is going to construct according to the guidance of A. Then roles are switched so that B explains his or her construction explanation to A.
- Learning objectives: Becoming an observer meaning that one has to provide

[6] A "functional explanation" in this context means an explanation that another person can use to reproduce an object.

precise explanations, practise to transmit and to receive information (communicative skill).
- Atmosphere: Relaxed, but with the absence of computers there was more agitation, more obviously uncontrolled talking, less time for work and for formal learning objectives. Generally I perceived less motivation for working with the tasks.

March 12th
- Tasks: Revision as preparation for the test on March 21st. Construction of triangles and quadrilaterals, with an increasing degree of difficulty.
- Work form: Placement in pairs, individual work.
- Learning objectives: Skill to "manage" Cabri (carry out constructions). Understanding/reading skills, i.e. to grasp the instruction of the task and interpret the context between instruction and tool.
- Atmosphere: Clear motivation (to "want" to present). No pressure, some degree of cooperation (the good helpers).
- Role of the teacher: Introduces the tasks: (i) Provides a perspective, (ii) indicates where to find help on the Internet, and (iii) acts as an aide for current activities. The role of the teacher in this context was much more visible than during other classes; he had a form where he ticked off items as "done", he was willingly accessible for questions from the pupils asking questions such as "can you come here" or "I don't get it". His role was to sympathetically monitor the work contract which consisted of individual work.

March 21st (test)
- Tasks: To demonstrate skills and understanding for the solution of geometrical tasks with Cabri.
- Work form: As on March 12th. Pupils present a finished product (four constructions, one construction with construction explanation).
- Learning objective: See March 12th.
- Atmosphere: Usual work climate, relaxed, the pupils appear to be positive that they can "show" what they can do. Also freedom/acceptance to show that one is "not so smart". Absence of presentation fright.
- Role of the teacher: Delineates the rules for the test, is present and to affirm the work situation, creates silence, signals through body language that the situation is OK, "tactically" helps individual pupils.

Test result:

The teacher points out the concepts *skills* and *understanding*, and the test is designed to demonstrate both aspects. Bueie states about the relation between skills and understanding that a skill comes from understanding. Understanding is the

motivation behind the skill to "use" a tool. One can nevertheless add that a certain technical skill is also the prerequisite for understanding, i.e. a *cognitive process*. Understanding and skill are qualities that reinforce each other in an endless process. Through the test the pupils demonstrate their understanding in terms of being able to interpret the text of the task and to grasp the relation between the text of the task and the tools, and in terms of showing the skill to construct angles, divide angles in half, construct parallels, or calculate a denominator. Pupils should provide a construction explanation for one of the tasks. The teacher comments that the regular and the good pupils solve the tasks in a way that he thinks they would manage without the programme (Cabri). However, in his opinion the so-called "weaker" pupils have better results with the programme.

Concomitant learning

Concomitant learning is a learning gain that is not specifically aimed at and is therefore not evaluated formally. The *way* the teacher organized the classes motivated reflection about the informal learning gains. In a conversation with four pupils I asked what it meant for them to use the computer during the maths class. Their answers contained terms such as "easier", "revise", "exact" and explain: "it is somehow easier, we can revise and delete and get it done more exactly than by using a pencil, dividers, and an exercise book–there were so many things to take care of. When we use the computer we have everything, we remember where things are placed, and there is order." One girl expresses it so: "the challenge is to remember and to think, because we know that everything is there".

Learning strategies:

The pupils' comments indicate something about learning strategies, about learning as *cognition*. This means that the computer invites or demands a way to think, remember, and investigate, in other words, invites and demands attention and concentration. In conversations we come across the term "smart", and the pupils say that everybody keeps up initially, but that after a while some become smarter because they remember better, "those are smartest who remember where things are", as one pupil points out.

The pupils' statements can be described in terms of both a cognitive and a process view of learning. What the pupils pointed out is that what was important was not "smartness" in terms of getting many correct answers, but they talked about the conditions for learning, to remember what was where, to remember/think/understand what one needed, in other words, learning strategies. Indirectly they demonstrated that the *process* was more important than the final product. This is

in accordance with Bueie's view; he talks about "navigating" the web pages, investigating, trying out. This point needs to be elaborated.

Relational pedagogy and identity:

The subject is mathematics, the tool is the computer, the teacher is a "conductor", and the framework is relational pedagogy. It is the role of the conductor to "see" everybody, everybody is seen. To be seen means to feel included, and this describes the situation in class 9b. Furthermore, it appeared that the pupils were equal, independent of any measurable "smartness". The teacher gave them time to try things out, to make mistakes, to succeed, to succeed "eventually". This practice appeared to create secure pupils, and feeling secure is a prerequisite for being a learning pupil. The pupils did not only learn a subject and learning strategies, they furthermore learned *identity*. Of course, visible external behaviour is no reliable indicator for identity or someone's self-image. However, it appeared that the use of computers in the classroom, the seeking and trying pushing of the keys in combination with the teacher's accepting patience formed the foundation for a type of security in terms of equality and the feeling that one is going to achieve something. Non-segregating relational pedagogy provides a good basis for reinforcing human value, which is the basis for a positive identity.

IV. Summary

This study presents ICT as a pedagogical tool in a holistic perspective. Åretta school is a demonstration school whose official programme includes a result-oriented culture, a good learning environment, flexible learning strategies, and testing of models for the use of ICT. In this study there is a focus on the atmosphere in the classroom, social relations, the role of the teacher, and how the teacher and pupils use the computer as a pedagogical tool. The positioning of the teacher is a decisive factor, as Bueie expresses: "After we started using ICT, the focus in the classroom was shifted from the teacher-pupil dialogue to a dialogue between the individual pupil and his or her computer. Pupils must be more active and *search* for new knowledge, navigate net pages, check and try things out. My role is that of an aide, directing a learning community". Experiences from this study show that the positioning of the teacher is an important prerequisite for the experience of the computer as an inspiring tool. Pupils must have sufficient *time, freedom, and acceptance for a learning strategy marked by inquiry and investigation*.

In regard to learning gains, this report stresses the importance of skills and understanding. Skills mean the ability to navigate with one's own computer and to solve problems, and understanding means insight into *what* one does and *why* one does what one does. The computer is a tool in an investigative process towards a final product. Bueie stresses the importance of quality in the process and thinks that the process itself must receive as much attention and priority as the final result. The process or learning strategies can be related both to an individual-cognitive and to a social-cognitive view of learning, which both correspond to the 2006 school reform "Knowledge Promotion" (cf. Dysthe, 2006). Bueie talks about smartness that "smart" pupils are smart regardless of tools and methods. However, "weaker" pupils perform better with a computer than without, and this is related to the computer's motivational effect and the function as a tool to improve learning gains.

Part of the study deals with the phenomenon of "concomitant learning", also called informal learning, i.e. a type of learning that is not included in formal assessment (grading). Pupils gain practice in investigating learning strategies. In both a dialogue with the computer and a multilogue with classmates and the teacher they "construct" knowledge and insight (individual constructivism and social constructivism). The pupils are knowledge producers, in contrast to knowledge consumers. The article furthermore analyses the learning of identity: who am I as a pupil in general and as a pupil in a mathematics class in particular? The classroom structure of class 9b, the relations between the pupils and between the pupil(s) and teacher classifies the situation as guided by relational pedagogy. The atmosphere, cooperation, and focus on the subject provided the pupils of grade 9b with a positive self-image. However, this is not primarily caused by the use of computers but by the teacher's arrangement of the "right" use of it.

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Sketch of Metodology

Subject: Mathematics – program *Cabri*[7]

Type of study: Study of classroom-activities, small-scale case study
Method: Observation, talk, documents
Subject: Mathematics, 9th grade, spring 2007. Topic: Geometry with the program Cabri
Grade 9b, *Åretta Lower Secondary School*, Lillehammer, 25 pupils
Period: Observation period February 14. – March 21, 2007.

[7] Cabri(Cahier de Brouillon Informatique) see this article part II. Cabri Geometre is developed at the University of Grenoble, France.

PROBLEM: Main goal for the study has been (i): to register classroom-activities and human behaviour – that means *processes*; what is going on? – and (ii): gain closer *understanding* about factors that *interact* – that means to see relations that one does not yet know.

- What impact does the use of PC have on the learning situation in the classroom?
- What is the connection between student's use of PC and the teacher's role?
- What impact does the use of PC have on the pupil's cognitive behaviour?
- Does the student's use of PC affect the interplay between students and teacher?
- Does the student's use of PC affect our notion of what learning in fact is?