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e-ducation: research and practice

U. Nulden
Viktoria Institute and Department of Informatics, Goteborg University

Abstract This paper proposes an integrated approach for information technology in an educational context. The paper suggests a framework for the design of computer assisted learning activities — e-ducation. The framework captures three contemporary interrelated aspects of teaching and learning and is more pedagogical than it is analytical. The three aspects covered in the e-ducation framework are electronic, engaged and empowered. An implementation of the framework is used to illustrate how e-ducation can be applied in educational research and practice. The paper concludes that the e-ducation framework contributes to both educational research and educational practice.

Keywords: Assessment; Change; Collaboration; Constructivist; Experiential; Problem solving; Research paradigm; Undergraduate

Introduction

The modern educational system was developed to teach the skills necessary and the facts applicable to survive in the industrial society; facts that would be true and skills that would be useful throughout life. The factory was the model of choice; all students learned the same way and should learn the same things; all should be at the same place at the same time; and facts were transmitted to the students and later measured through instruments like written exams. But things have changed: '*Schools today are structured more for the industrial age . . . problem is, those factory jobs don't exist anymore*' (Soloway, 1993, p. 28).

While the most important objective of schools and education used to be the teaching of facts and skills, today there is an intention among many educators to put as much emphasis on the actual process of acquiring the knowledge as on the knowledge itself. Education needs to help students develop conceptual tools to become self-directed learners capable of learning new things and adopt to an increasingly dynamic, and also complex, work situation. Education has changed from teaching to learning with a change of roles and responsibilities in the learning process.

Additionally, there is another element which is changing education — computers. Computers or rather information technology (IT) have become a routine component of many aspects of education. But for the computer to bring about a real and substantial change, its introduction must be accompanied by improvements in the understanding of learning and teaching.

Today the culture of the educational system is challenged. IT has the power of

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Correspondence: Urban Nulden, Viktoria Institute and Department of Informatics, Goteborg University, PO Box 620, 405 30 Goteborg, Sweden Email: nulden@viktoria.se

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being both a catalyst and a main vehicle for implementing change and may help to bring about some important reforms (Barker & Dickson, 1996). But still, IT is used just as any other educational technology for fact or information transfer. If conventional models from the classroom with teacher-centred activities focusing transmitting information to passive learners continue to be re-implemented, only marginal improvement in the quality of teaching, if any improvement at all, can be expected. Just providing schools with an infrastructure, i.e. computers and networks, will not have the desired effect. This *push* action may actually result in a continuation of technology rejection. Teachers will begin the process of *pull* when they know for what, why and how technology should be used.

The area of educational technology and pedagogy is full of jargon, confusion and lack of structure. Various models and frameworks have been proposed to give some structure to the field (e.g. Ramsden, 1992; Laurillard, 1993; Leidner & Jarvenpaa, 1993; Harasim *et al*., 1995; Leidner & Jarvenpaa, 1995; Duffy & Cunningham, 1996). These, and many others, provide guidelines for how IT can be introduced and used to improve the teaching and learning processes in higher education. Clearly, in the absence of fundamental changes to the teaching and learning process, IT will do little but speed up ineffective processes and methods of teaching. Whereas the models and frameworks discussed above come from a learning perspective, the e-ducation framework has its roots in informatics.

The methodological and practical guidelines in this paper originate from informatics, which is the '*design oriented study of IT use with the intention to contribute to the development of both the use and the technology itself*' (Dahlbom, 1996). The central interest of informatics is to intervene and contribute to the process of change rather than just to observe and describe it.

The remainder of the paper is divided in the following sections. In the first section the paper gives a review of the theories applied in the research. The following section is a brief discussion about educational technology. In the third section the e-ducation framework is outlined. This is followed by a description of how the research study was designed. In the fifth section the e-ducation framework in practice is discussed, and the paper ends with some conclusions.

Theoretical background

Everyone who teaches has some theory of learning. A learning theory is a systematic and integrated understanding of the process whereby people relate to their environment in such way as to enhance their abilities to employ both themselves and their environment effectively (Bigge & Shermis, 1999; p. 3). Educators may, or may not, be able to describe their theories in explicit terms, but their practice is always exemplifying a theory of learning. The ways in which the educator designs and conducts learning activities reveals how the educator understands the process of learning (Kaplan & Kies, 1995).

Duffy & Cunningham (1996) propose that grounding assumptions are '*the fundamental assumptions underlying the conception of the teaching-learning process*'. The e-ducation framework embeds five such assumptions:

- understanding learning as the individual construction of knowledge, i.e. constructivism;
- insight on how both individual learning and collective learning can be supported by the group, i.e. collaborative learning;

- problem- based learning as a model for designing educational activities;
- experiential learning to initiate learning activities, and finally,
- the notion of formative assessment as an alternative to summative examination, which is a support of the learning process rather than control of the outcome.

Constructivistic learning

A great deal of education builds on an objectivist model, e.g. the lecture method (Leidner & Jarvenpaa, 1995; p. 267), or the transfer model (Lave, 1988). The objectivist approach is criticised for stimulating surface learning (O'Neil, 1995), knowledge reproduction and being a knowledge telling strategy (Schank, 1997), instead of knowledge building (Scardamalia & Bereiter, 1993; p. 37). A knowledge building strategy sees the learner as an active participant, interacting with the environment. In this view, learning is '*the active struggling by the learner with issues*' (Duffy & Cunningham, 1996; p. 174). The constructivist model stresses the crucial relationship between new experience and what is already known, since people can only understand what they construct themselves (Leidner & Jarvenpaa, 1995). Learning develops through encounters with new information that is different enough to be stimulating, but not so alien that it cannot be assimilated into learners' mental structures that constitute their present state of understanding (Watson, 1996).

Constructivism covers a wide diversity of perspectives, which have the following in common: '*learning is an active process of constructing rather than acquiring knowledge and instruction is a process of supporting that construction rather than communicating knowledge.'*(Duffy & Cunningham, 1996; p. 171)

Writings on constructivistic learning have altered in their perspective over the last 20 years to include more than the mental activity of individuals in learning (Watson, 1996). Social interaction among the learners is added to the constructivist model and it becomes collaborative (Slavin, 1990).

Collaborative learning

Collaborative learning consists of peer interaction, peer evaluation and peer cooperation, with some structuring and monitoring by the teacher. The basic premise is that learning emerges through the shared understanding of multiple learners (Leidner & Jarvenpaa, 1993). The essence of collaborative learning is that active participation is critical in the learning process and that learners have knowledge valuable to other learners. Learning is sharing and the more that is shared, the more is learned. It is assumed that students are likely to learn as much from each other as from course material or from the tutor. It is even claimed that the most powerful and sustainable learning process occurs among peers who *pull* each other rather than being *pushed* by experts. This way, collaborative learning is a creative process of articulating ideas, '*having them criticised or expanded, and getting the chance to reshape them or abandon them, all in the light of peer-discussion*' (Rowntree, 1995; p. 207).

Collaborative learning can be understood in terms of distributed cognition, which is about sharing information and building knowledge. It implies collaboration as people are interacting and learning together using technology (Roschelle & Teasley, 1995), but also collectiveness, when people are successful in building a shared representation and, to some extent, a shared cognitive system (Dillenbourg *et al*., 1996). Distributed cognition extends beyond an individual's mental activity to

include everything in that individual's environment; it comprises the individual, peers and tools. Hence, it is the interaction among these that ensure individual as well as collective knowledge building.

Problem-based learning

Problems that are real, that might arise in the learner's life or that are known to the learner, have enormous potential for learning (Guzdial *et al*., 1996). Problem-based learning is not just another way of teaching since it builds on a fundamentally different understanding of learning than conventional teaching. Problem-based learning represents a significant challenge to orthodox beliefs about learning (Margretson, 1991). Boud & Feletti (1991) describe problem-based learning as:

> '. . . a way of constructing and teaching courses using problems as the stimulus and focus for student activity. It is not simply the addition of problem-solving activities to otherwise discipline centred curricula, but a way of conceiving of the curriculum which is centered around key problems in professional practice'. (p. 14)

The problem-based learning process can be more or less structured or open for the students (Harden & Davis, 1998). Two end points of a continuum can be distinguished (Ellis *et al*., 1998; p. 46b). First, in a guided problem-based learning approach, the students face a problem (usually one that is defined by the teacher) to solve as a group. While this drives the students' needs for knowledge construction, both the nature of the student (e.g. less experienced in self-directed learning) and the nature of the subject require guidance and some sequencing of the learning events (i.e. the acquisition of knowledge).

Second, full problem-based learning, where the nature of the problem guides and drives the whole learning experience. There are no formal expositions of knowledge from the expert, and the students develop resources based on requirements they determine. While some resources for both the support of the process and the subject content may be predefined and developed, the students also develop appropriate resources to assist in their learning. In fact, the students themselves become a resource in the collaborative process.

Often problem-based learning (PBL) attempts have failed because what the educator has chosen as a problem has actually not been a problem in a psychological sense, since a learning problem in a PBL context must create psychological tension in the learner (Bigge & Shermis, 1999; p. 280). Ownership of the problem is essential. If the students do not own the problem, they will spend their time finding out what the teacher wants and wait for extrinsic cues from the teacher.

Experiential learning

In classroom learning, the emphasis is on the assimilation of information and the steps involved are: receiving knowledge, assimilating and organising information to ensure the understanding of the principles, inferring a particular application from the general principle, and lastly applying the knowledge. In contrast the steps involved with experiential learning are: concrete experience, observation and reflection, formulation of abstract concepts and generalisations and lastly the testing of the implications of the concepts in new situations (Kolb, 1984).

Various terms have been used to label the process of learning from experience. Learning by doing was introduced by Dewey and used by for instance Graf & Kellogg (1990). Others have discussed this in terms of experience-based learning,

trial and error and applied experiential learning (Gentry, 1990), reflection in action (Senge, 1995), and action learning (Marsick & O'Neil, 1999). Pedler (1997) defines action learning as: '*an approach to the development of people in organisations that takes the task as the vehicle for learning. It is based on the premise that there is no learning without action and no sober and deliberate action without learning*'. Action learning activities help people to learn from risk taking and errors (Marsick & O'Neil, 1999).

Experiential learning is meant to be a relatively safe laboratory for learning in which concrete experiences are subjected to individual and group reflections (referred to as process evaluation), as well as attempts to generalise in order to be able to experiment with new behaviour. But, experience alone does not automatically lead to learning. An experience must be accompanied by reflection on the experience. Reflection is a conceptual tool for understanding the ambiguous and inexhaustible. Rosenørn & Busk Kofoed (1998) distinguish three forms of reflection, or reflection periods. First reflection-in-action, which is similar to Senge's notion (1995), second, reflection-on-action, which takes place after the learning activity, and third, reflection-for-action, where participants in an learning activity reflect on which types of problems they hope to solve more successfully in the future than in the past.

Assessment of learning

While assessment of learning and examinations of different types are used throughout the education system, there are many competing, and sometimes conflicting, understandings of the meaning and purpose of assessment and examination (e.g. Kvale, 1975; Rowntree, 1977; Ramsden, 1992). 'Examination as control' is the dominating conception, i.e. summative assessment. It is necessary to control if the students have learned, or rather remembered, what they are expected to. The instrument of choice is a written exam or a term paper. Understanding and analytical abilities are not really asked for in a conventional examination as they are difficult to judge. Both students and educators are more comfortable if answers can be considered as objectively right or wrong. The way a student is assessed in a course will determine the approach the student takes during the course. Students are rational and will apply a strategy that is aligned with the assessment.

Educators may encourage critical thinking when they are teaching, but examine their students according to conformity in ideas and detailed knowledge about facts.

Critique of the current control perspective of assessment has led to an exploration of alternatives. Assessment is relativistic as it is about several things at once. Assessment is:

> '. . . about reporting on students' achievements and about teaching them better through expressing to them more clearly the goals of our curricula. It is about measuring student learning and it is about diagnosing specific misunderstandings in order to help students learn more effectively. It concerns the quality of teaching as well as the quality of learning: it involves us in learning from our students' experiences, and it is about changing ourselves as well as our students. It is not only about what a student can do; it is also about what it means he or she can do.' (Ramsden, 1992)

If assessment is viewed as helping students to learn and educators to learn about how best to teach them, in other words formative assessment, it is clear that learners often require extra support to engage in unfamiliar tasks. Students are a diverse population, they vary in knowledge, skills, interests, and learning styles. To meet this

diversity, one understanding of formative assessment is scaffolding which is the support provided so that learners can engage in activities that would otherwise be beyond their abilities (Jackson *et al*., 1996; Jackson *et al*., 1998). Formative assessment and summative assessment have also been discussed in other terms as there continues to be a raging debate over the relationship between assistance and assessment. It is generally agreed that assistance promotes learning, growth and development.

However, grading and categorising should not, as many people seem to think, be viewed as a 'bad thing' (Ramsden, 1992; p. 182). Exams are stimulating to many students, and they are also efforts that are tangible. It is very clear that educators face a dilemma, since they are many times responsible for both helping students to learn, but also responsible for grading the students.

Technological background

Information technology is a powerful tool (Pea, 1993), which can '*facilitate the development of knowledge building communities*' (Scardamalia & Bereiter, 1993; Scardamalia & Bereiter, 1994, p. 6). The importance of understanding the underlying pedagogical assumptions when designing IT for education is emphasised by Laurillard (1993); Leidner & Jarvenpaa (1993) and Leidner & Jarvenpaa (1995).

The use of IT in an educational setting will reflect, either intentionally or inadvertently, a theory of learning as discussed above. Much of the use has suffered from a lack of a sound educational perspective. Hawkins (1993) is among those who stress that computer technology has been brought into the education system in the wrong way. It has been integrated with conventional teaching, which, as discussed above, emphasises active transmission and passive absorption of factual information. Traditional teaching may not be viable for the contemporary technological environment and new teaching approaches will be needed to exploit recent technological advances (Leidner & Jarvenpaa, 1993).

The earliest attempts to use instructional technology date back to the first quarter of this century when the first teaching machine was introduced. Individ-ualised education became possible with self-instructing and self-assessing computer programs. This detailed and systematic potential has seemed irresistibly attractive to over 30 years of computer experts who have worked in the area of computer-based instruction (CBI) or computer-based training (CBT). Of course there are applications and areas where CBI and CBT is very useful. Examples are computer literacy and instructions for learner drivers.

Communication technologies such as electronic mail, bulletin board services, computer conference systems, world-wide web, etc. have a profound effect on education as they create environments suitable for learning. The asynchronous learning network (ALN) is commonly used as a notion to integrate these technologies with an explicit pedagogical idea (Hiltz, 1994; Bourne *et al*., 1997). The asynchronous learning network is supporting 'anytime, anyplace' learning (Wegerif, 1998).

In an ALN, learners form a community engaged in collaborative learning at the time and place of the individual learner's convenience (Bourne *et al*., 1997). By slowing down interaction, learners are given time for reflection. Ideas, questions, comments, etc. can grow and mature before being shared with other learners. Online course material is provided as well as areas for submission of individual and group

assignments. Learning processes and the role of educators and learners in ALNs are radically different from conventional classrooms (Harasim *et al.* 1995). A discussion of participation vs. presence highlights some strengths of ALNs over conventional classrooms. To be present is simply to passively attend group sessions, and to participate is to actively contribute to group sessions. Attendance does not imply active participation and this is where conventional classrooms are weak. In a conventional classroom, learners can attend and seemingly participate. In an ALN, those who just attend are considered lurkers and they are invisible. For a more thorough discussion of asynchronous learning networks see (e.g. Harasim *et al.*, 1995; or visit http://www.aln.org).

A framework: e-ducation

The e-ducation framework is motivated by the assumption that information technology adds dimensions to teaching and learning. The framework differs from conventional models explaining and supporting design of educational activities since the IT perspective is informatics rather than the educational technology perspective. This way the framework is technology driven and also practice oriented. e-ducation is a framework with three interrelated aspects of teaching and learning:

- *engaged*, which refers to an understanding of the process of learning, i.e. that engagement is crucial for learning,
- *empowered*, which refers to the distribution of responsibility among all participants, students and teachers, in educational activity, and,
- *electronic*, which refers to the use of information technology in educational activities.

A model or a framework such as e-ducation is a simplification since it reduces much of the complexity it aims to model. e-ducation is of course a play with words.

Engaged

No matter how much is attempted to be taught, it is the learner who influences what is actually learned. Therefore, in e-ducation, *engaged* refers to the core of learning. For learning to take place, the learner has to be not only active in the learning process, but also engaged. Development and internalisation of knowledge, whatever its form, is an active and truly engaged process. Individuals actively construct their knowledge by relating incoming information to a previously acquired frame of reference.

While engagement is necessary, there is a kind of 'golden mean' in learner engagement, somewhere between apathy and wild excitement, for which the educator should strive. Bruner (1960) suggests that '*frenzied activity fostered by the competitive project may leave no pause for reflection, for evaluation, for generalisation, while excessive orderliness, with each student waiting passively for his turn, produces boredom and ultimately apathy*' (p.72).

Empowered

The teachers who are choosing to be a 'guide on the side' are empowering the students by establishing an educational climate that contributes to a feeling of student empowerment. Empowered is about those educational activities where the learners share at least some of the responsibility for what to learn and how to learn (Bagley & Hunter, 1992; p.23). Confrontation with material and practice in being

explorers, problem-finders and problem-solvers permit learners to become partners in determining when they are right and when they are wrong as well as when, and to what extent, material and information are relevant. Empowered, as it is used here, should not be confused with the teacher who has the attitude: 'It is up to you, I am not responsible for your learning, you are.' Instead, in empowered education, teachers and students share the process of learning.

But empowerment can also take other turns that are quite different than discussed above. The author participated in a working group on the theme of problem-based learning in programming education. After a couple of days working in this group an American colleague highlighted one issue. She said that students were waving literally the receipt from paying the tuition fees and saying 'Now I've paid, and I expect you to teach me.'

Electronic

One resource that is not lacking in educational institutions today is the access to computers and networks. Computers are now so commonplace in educational institutions that their absence is more noteworthy than their presence (Bigum, 1998, p. 587). The number of students with access to computers has increased substantially during the last few years.

However, there is a shared understanding that information technologies such as electronic mail, bulletin board services, computer conference systems, world-wide web, etc. have a profound effect on education as they create environments suitable for learning.

Research approach

Educational research is a thorough and systematic attempt to bring about a better understanding of the educational process with the purpose of improving the efficiency of educational practice. The aim for the researcher is to describe how 'learning' occurs and to suggest how different educational activities can influence the quality of the learning (Entwistle, 1986).

In this paper, the term *design* is used to describe the activity of analysing the needs, or the possibilities, for the implementation of form and functionality (e.g. Dahlbom & Mathiassen, 1993). Current research approaches applied to contribute to both the development of technology and the design of its use is guided by variations of the scientific methods: ethnography and action research. Ethnography aims at describing the culture of a specific domain by observing and participating in this culture. Often, but not necessarily, ethnographic studies involve longer periods of study to assure the researcher of a deep understanding of the culture. However, ethnographic research in short time periods is also advocated, i.e. 'quick and dirty ethnography' (Ljungberg, 1997).

Action research has two aims: to contribute to solving practical problems, and some specific research goal, such as the development of an approach, a method or a conceptual framework (Patton, 1990). A key assumption in action research is that science can be used by people themselves, in collaboration with researchers, to solve their problems of practice. The combination, and focus, of the two is delicate, '*Those involved [in action research] are either doing research with little action, or action with little research*' (Foster, 1972, p. 529).

Ethnography and action research, are suggested as fruitful in reaching the aim of

designing IT use in education. The researchers' relation to the educational activity determines the approach. There are basically two alternatives. An ethnographic approach is suggested when the researcher acts as an observer and does not participate as a teacher. This allows the researcher to observe and understand. Teachers conducting research on their own courses are not able to be outside observers and, in this case, an action research approach is suggested.

The overall research approach proposed in e-ducation is action research since the aim is to experiment with education through intervention and to evaluate and reflect on the effects of the intervention. The aim is also to discuss implications on the theoretical foundations. Inspired by the pedagogical ideas discussed in the previous section and the possibilities to enhance them with information technology, e-ducation focuses on the design of prototype applications and the use of them in educational activities.

The importance of experimentation and providing examples of IT use in education is advocated: '*computer-based teaching methods might be encouraged as a means of enhancing classroom learning, although it may require trial-and-error or experimentation to determine the most effective uses of the technology*' (Leidner & Jarvenpaa, 1993 p. 51). The evaluation of the effects on different aspects of education is therefore less emphasised than it would be in other educational research. The reason for this is that there is a need for concrete examples of how information technology can be used in different educational activities. Of course, there is also a need for extensive evaluation of the effects, but it is probably more urgent to experiment with a variety of ideas to open up a dialogue among teachers concerning the use of information technology. The web is a valuable resource for knowledge and discussion concerning IT and education, see for instance (http://www.aln.org and http://www.aace.org).

Applying e-ducation

The e-ducation approach is not understanding IT as an add-on to conventional teaching. Rather it is a tentative approach where IT is an interrelated and integrated part. This section illustrates one implementation of a learning activity based on an e-ducation framework with the asynchronous use of a computer-based conferencing system to facilitate group discussions guided by the methodology of thematic modules and the notion of *mandatory participation as examination* (MPE).

Thematic modules and mandatory participation as examination

There needs to be a balance between the pedagogical intentions, examination formats and the learning environment. There is a good 'fit' between collaborative learning, mandatory participation and ALN since the focus is on active participation. MPE is an examination format that promotes active participation in online discussions. Mandatory participation in ALN-based learning offers integration between examination and learning, and supports the belief that it is not possible to separate examinations from learning. ALN-based courses without mandatory participation commonly encounter problems; Almeda (1998) found limited group interaction in the absence of requiring such interaction as part of the students' course grades.

MPE is a continuous format of examination in which students must be reasonably active throughout the course. Learning activities should be evenly spread out over the duration of the course. This way students can choose to be more active during

some periods and less active in others. Examination outcome is determined by the total participation, not, as in most conventional educational settings, by large assignments at the end of the course. To achieve this flexibility in participation the course can be structured as *thematic modules* (TM).

Thematic modules is a structuring philosophy that divides the course into several self-contained, uniformly structured units (Nuldén, 1999). This is different from conventional modular structuring where a large topic area is divided into subtopics small enough for learners to digest and is presented in a sequence. In TM, each module introduces a separate issue or problem, like tiny islands in a vast ocean of knowledge. The individual construction of knowledge and of 'bridges' between the islands is facilitated through collaborative activities. Collaboration takes place in smaller groups and provides formative assessment. Every module has a well-defined beginning and end and since each module is self-contained, students can be more or less active in different modules as long as the total participation is 'satisfactory.'

Results and discussion

The e-ducation framework was used implicitly rather than explicitly in the design of a course. The course was 'Thematic modules and mandatory participation as examination' implemented and evaluated in an information systems development course at a Swedish University with 210 first-year undergraduate students. The course was divide into 10 thematic modules according to the principles described in the previous section. The complete results of the evaluation will be published later. However, the main results are summarised here.

The results from the evaluation are based on three sources of data: student activity in online discussions, active participation as a teacher in the course and a 2-page questionnaire with both Likert-scale questions and open-ended questions. The questionnaire was handed out during one of the last lectures and 74 complete surveys were handed in. The overall reaction to the course was clearly above average compared to other courses in the department. Both female and male students were clearly positive about the experience, but the opinions of the females varied more. During an analysis of the course and its outcomes, the following was apparent.

Electronic
A computer-based conference system, in which the author contributed to the design, was used. The pedagogical and methodological assumptions built into the system, such as the terminology and the functionality is therefore consistent with the e-ducation framework.

Engaged
The main goal of the course was to push the students to react and relate collaboratively to the issues raised in each module. The examination format forced the students to be active and open in the computer-based conference system. The visibility of the comments made to all participants in the course were better articulated than when only submitted to the teacher.

Empowered
The topic introduced in each module was a real and relevant problem in contemporary organisations, many of which were introduced by practitioners

themselves, which emphasised the relevance of the problem. The aim was not to force the students into a specific and predefined discussion with definite answers and end but rather to support them in their discussion of issues related to the problems they found puzzling. They decided what was important and how to discuss the issues.

Conclusions

In this paper it is suggested that there is a need for a more integrated approach when using IT in an educational context. The e-ducation framework was suggested as a model to understand and design educational activities, and as a way to conduct research in education.

The e-ducation framework was exemplified through 'Thematic modules and mandatory participation as examination.' In this activity, apart from electronic, the two aspects of engagement and empowerment were emphasised through the balance of mandatory participation and unconstrained discussion among the students. It was mandatory since the students had to participate, and it was unconstrained since the aim was not to control the direction of the discussion.

New educational activities supported by information technology are replacing the older. e-ducation is one example where research becomes practice and the other way round. Still, the design and use of information technology in educational activities must be pedagogically well grounded. Information technology in itself will not solve the perceived problems in education.

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