eleed
e-learning
& education

Issue 1
2005

Pedagogical quality in e-learning

Designing e-learning from a learning theoretical approach

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urn:nbn:de:0009-5-785

Abstract

The article is concerned with design and use of e-learning technology to develop education qualitatively. The purpose is to develop a framework for a pedagogical evaluation of e-learning technology. The approach is that evaluation and design must be grounded in a learning theoretical approach, and it is argued that it is necessary to make a reflection of technology in relation to activities, learning principles, and a learning theory in order to qualitatively develop education. The article presents three frameworks developed on the basis of cognitivism, radical constructivism and activity theory. Finally, on the basis of the frameworks, the article discusses e-learning technology and, more specifically, design of virtual learning environments and learning objects. It is argued that e-learning technology is not pedagogically neutral, and that it is therefore necessary to focus on design of technology that explicitly supports a certain pedagogical approach. Further, it is argued that design should direct its focus away from organisation of content and towards design of activities.

Keywords: e-learning technology, learning theory, virtual learning environments, learning objects, evaluation, design.

Introduction

E-learning technology offers a wide range of new opportunities for development of education, and the advantages of the use of e-learning are numerous. The advantages cover administrative, financial, societal as well as pedagogical areas. The major advantages of and arguments for using e-learning technology are:

- Independence of time and space
  - students can follow a course from any place in the world and at any given time
  - courses can be offered to a world-wide audience

- Individuality
  - courses can be adapted to the individual student
  - course materials can be reused and rearranged

These advantages are often mentioned in connection with e-learning and more specifically in connection with the use of virtual learning environments (VLE) and learning objects. The advantages can be summed up in the word *flexibility* which is made possible by VLE and learning objects. VLE offer opportunities for teachers to give online lectures and for students to follow courses and collaborate online. Learning objects provide the opportunity for teachers and students to (re)use and (re)arrange learning materials in different orders - thereby creating different courses or course units (see Wiley (2002) for a definition of learning objects).

The advantages of flexibility in education are unquestionable. However, the discussions of design and use of e-learning suffer from a too narrow focus on the potentials of the technology itself. Concerning design of learning objects, Orrill (2002) writes:

”While there are undoubtedly advantages to the development of these learning objects, we have, as a field, overlooked the most important aspect of the tools - how they support student learning. The discussion on learning objects thus far has focused largely on their design and technical development.”

In other words, a discussion of the pedagogical quality of e-learning is, to a large extent, missing. This is partly due to a belief that e-learning technology is pedagogically neutral; a belief that a technical solution to flexibility can be used in relation to different pedagogical approaches. This article will discuss design and use of e-learning from a pedagogical perspective. I will present a framework for the evaluation of e-learning technology in relation to different concepts of learning. By using the framework to evaluate e-learning technology, it is argued that the technology is not pedagogically neutral. Further, the framework provides criteria for a purposeful design and use of e-learning technology to support learning, and it helps create a consciousness about the pedagogical consequences of using e-learning technology. Instead of attempting to achieve pedagogical neutrality, it is argued that it is necessary to focus on design of technology that explicitly supports a certain learning theoretical approach.

Theoretically grounded evaluation

How can we design and use e-learning to better the pedagogical quality of education? In *From change to renewal*, Koper (2000, p. 7) writes:

”I think that in education quite a lot of energy is wasted on chasing solutions that have everything to do with chance technical possibilities, and nothing to do with fundamental renewal.”

Koper believes it is necessary to create a fundamental renewal of the educational system, and not only to make small adjustments to the existing system. The purpose of the framework developed in this article is not only to support design and use of e-learning to change education but to fundamentally develop and renew education pedagogically. The

argument of Koper (2001) and his colleagues behind the development of Educational Modelling Language (EML) is a modelling or design of technology which makes explicit use of pedagogical models.

In line with Hannafin et al. (1997; 1999), I argue that design and use of e-learning must be grounded in a theoretical approach. First, as Hannafin et al. (1997, p. 102) write, the argument is that: ”Learning environments are routinely mismatched with their espoused epistemological roots”. It means that the specific solutions of practice are not congruent with advocated underlying theoretical principles. Second, besides the problems concerning a potential mismatch between practice and theoretical roots, I further argue that a theoretical grounding is necessary in order to develop the educational practice qualitatively. If an educational practice is developed strictly on the basis of an existing practice, the implementation of new technologies will result in a remediation of the existing learning activities; i.e. a transfer of the existing learning activities from physical locations to a virtual environment. A remediation *maintains* but does not *improve* the quality of the educational practice. In order to develop the use of e-learning from a pedagogical point of view, it is therefore not enough to study the existing practice. Instead, it is necessary to have an understanding of theoretical principles of the learning process and of the ideal learning environment. It means that the use and design of e-learning should be grounded in a learning theoretical approach and cannot be based on an existing practice.

The concept in Hannafin et al. (1997) of grounded design is ”defined as the systematic implementation of processes and procedures that are rooted in established theory and research in human learning” (p. 102). The framework presented in this article attempts to provide a learning theoretical grounding for design and use of e-learning. It is therefore necessary to create a link between theory and practice to ensure that the solutions of practice are congruent with the learning theory. The approach to a theoretically grounded design and use of e-learning is based on the following relations:

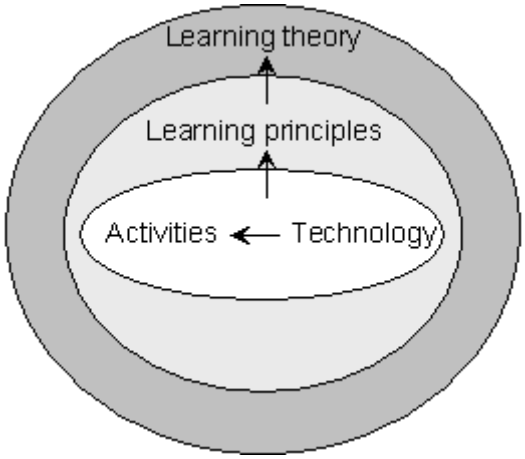

Figure 1 - Theoretically grounded evaluation of technology

Together, the concepts of figure 1 can be termed a pedagogical approach; it is characterised by a learning theory, learning principles, and by the use of technology (and other materials) in different activities in the learning environment. E-learning consists in different *technologies* such as discussion forums, e-mail, file sharing, shared white board, video conferencing and chat. In a learning environment these technologies are used in

support of different *activities*. The structure of the activities of a course or a course unit is determined by *learning principles* which provide a model of the learning environment. Finally, the learning principles are founded in a *learning theory* which describes the human learning process.

Figure 1 suggests a link between theory and practice; a link between learning theory and activities. Learning theory, learning principles and activities (including the use of technology) represent three different levels of abstraction. A learning theory is considered an abstraction or generalisation of learning principles which means that it does not prescribe the creation of learning principles. Similarly, learning principles do not prescribe creation of activities and use of technology. It means that there is no direct link between the three levels of abstraction, meaning that learning principles cannot be *derived from* learning theory, and that activities cannot be derived from learning principles.

However, it is possible to view learning principles *in light of* a learning theory, and similarly view activities in light of learning principles; it is possible to see whether or not an activity supports given learning principles. Thus, it is not a question of transforming the learning theory into learning principles, but instead a question of creating learning principles which support the learning theory - and, correspondingly, designing activities and technology in support of the learning principles.

In the development of e-learning technology to create new learning activities, the approach of this article suggests that the designer *reflects* the use of technology in relation to activities, learning principles and learning theories. As Bednar, Cunningham, Duffy, and Perry write, ”effective instructional design is possible only if the developer has reflexive awareness of the theoretical basis underlying the design” (cited from Hannafin et al., 1997, p. 102). In a critique of an empirical approach to instructional design manifested in the use of prescriptions in the design process, Winn (1989; 1997) similarly calls for what he terms reasoning from first principles. The term describes the designer’s reflection on problems on the basis of a theory:

”Reflection on problems, enabled by knowledge of underlying theory whose greater abstraction gives you more room for thought, is an expedient way to find new and creative solutions.” (Winn, 1997, p. 36)

According to the approach of this article, reflection takes place on the three levels of abstraction. As Winn (1997) writes, the use of abstractions implicate that the framework guides rather than prescribes the activities of the designer or user. The arrows of figure 1 suggest a connection between theory and practice. They indicate an orientation from practice to theory - from technology and activity towards learning principles and finally towards learning theory. First, technology is evaluated in practice by reflecting the technology in relation to different activities. Second, an activity is reflected in relation to learning principles which are finally reflected in relation to learning theory.

The framework for a theoretically grounded evaluation of e-learning, presented below, consists of learning theories and learning principles which means that it deals only with two of the three levels of evaluation. Activities and use of technology take place in connection with a specific learning environment, and it is out of the scope of this article to develop activities and discuss the specific use of e-learning technology. Instead some illustrative examples will be given.

A framework for evaluation

It is not possible to construct one universal framework, because it must be founded in a specific learning theoretical approach. Below, three frameworks will be developed on the basis of three different learning theoretical approaches; a cognitivist approach, radical constructivism and activity theory, respectively. The presentations of the three approaches are not substantial descriptions, and they do not describe the nuances of the theories and the different strands within the approaches.

A learning theoretical approach is developed on the basis of a philosophical understanding of knowledge and learning. A learning theory can be defined as *a conception of the individual, the world, the individual's relation to the world, and knowledge*. Analytically, learning principles can be divided into the form, content and relations of a learning environment. The concept of form describes the organisation of the students' work; *how* do the students work with the subject matter? Content describes organisation of the subject matter; *what* are the students working with? Finally, the concept of relations describes the relationship between the participants (teachers and students) in the learning environment and their respective roles. Learning principles can be defined as *an approach to form, content and relations of the learning environment*.

Cognitivism

Central to a cognitivist learning theory are the human cognitive, mental or intellectual abilities. A cognitivist approach is based on the belief that there is a structure in the way we perceive and understand the world. Gardner's (1983; 1986) theory of multiple intelligences is based on a cognitivist approach. According to Gardner (1983, p. 56) "a mind consists of a number of fairly specific and fairly independent computational mechanisms". The mind consists of cognitive structures which enable the individual to process information. The world consists of objective information, and the individual's knowledge is based on information from the external world. The individual receives information through the senses and then processes the information into knowledge. In other words, learning is understood as information processing. This means that knowledge cannot be transmitted to a passive individual. Instead, the individual learns by active, mental information processing. However, since knowledge of the world is an objective processing of objective information of the world, knowledge is objective. It means that the individual is passive in the determination or construction of knowledge; the individual does not contribute to the character of knowledge. Knowledge is about an external world, and knowledge exists isolated from the individual - in principle, a computer would be able to process information in the exact same way as a human. The individual's perception of information from the external world means that there is a direction in the learning process from the world towards the individual.

The foundation of learning principles developed in support of a cognitivist approach is the students' information processing. Information from the world has an objective structure which correlates to the structure of the information processing. This implies that the organisation of the content should be based on an identification of the structure of the

information processing. It is possible to structure the information for the students which means that the content should be organised in accordance with the inner structure of the objective information. Gardner (1983, p. 302) writes:

”If one has indeed specified the nature of human intelligences - the raw materials for cognition - on the one hand, and the range of human cultural roles and functions, on the other, one ought to be able to generate a list of all possible symbol systems and, if you like, all the domains in which human beings can become intellectually engaged.”

This also means that it is possible to structure the work process of the students. The learning process is a training of mental abilities or intelligences which is accomplished by the students' work on predetermined exercises. Therefore, the students' work should be based on a curriculum divided into predetermined and isolated units which means that is it possible to structure the activities of the learning environment. The activities should be structured on the basis of the inner structure of the subject matter and are controlled by the teacher. The role of the teacher is teaching and instruction whereas the role of the students is individual training.

Schematically, the cognitivist approach is illustrated in table 2 on the basis of the concepts of a learning theory and learning principles.

Cognitivism	
Learning theory	
Individual	*Passive*
World	*Objective information*
Individual and world	*From the world*
Knowledge	*Objective*
Learning principles	
Form	*Controlled* - structured - individual
Content	*On the basis of an inner structure of the subject matter* - curriculum - predetermined units
Relations	*Teacher instruction and student training* - controlled by subject matter and the teacher - communication from teacher to the students

Table 1 - The learning theory and learning principles of cognitivism

Radical constructivism

Radical constructivism is Glasersfeld's interpretation and development of the psychology of Piaget. This learning theory focuses on cognition, but unlike a cognitivist approach it does not consider learning as information processing. Basic to a constructivist line of thought is the belief that the individual is active in the construction of knowledge. According to radical constructivism, the individual learns through cognition in the sense that a cognitive structure constructs knowledge. The world exists as a world only in relation to the individual which means that the individual does not process information, but interprets a situation. Knowledge is therefore only determined by the cognitive structure of the individual which means that knowledge is not placed in the external world, but is individually constructed by the individual. Knowledge is the individual's subjective understanding or interpretation of the world. Therefore, according to Glasersfeld (1981), it does not make sense to speak of true or false knowledge; instead Glasersfeld (1983; 1989) talks about the usefulness of knowledge in the interpretation of situations. When the cognitive structure of the individual makes a viable interpretation of the situation, the individual is in a state of equilibrium. However, an unknown situation disturbs the equilibrium and initiates a mental process in order to adapt the cognitive structures to the new situation. Unknown situations which the individual is unable to interpret are therefore the basis of human learning.

This means that a problem which places the individual in a state of imbalance or uncertainty is at the centre of learning principles which support the theoretical foundation of radical constructivism. The learning environment should consist of situations which provide problems, in the sense that they are problematic *for the students*. As Glasersfeld (2000) writes: "The teacher presents a situation in which the students' network of explanatory concepts clearly turns out to be unsatisfactory". In the learning environment the students should work with problematic situations concerned with specific isolated topics. Independent student work supports the radical constructivist notion of learning as an individual and subjective construction of knowledge. The students should primarily work individually with problematic situations, but they might also help each other in groups. Since the work is based on the students' independent exploration, the students determine the work process. The role of the teacher is to guide and help the students in this process. It means that it is necessary to organise a flexible learning environment where activities are not pre-structured.

Table 2 provides a schematic overview of the learning theoretical approach and learning principles of radical constructivism.

Radical constructivism	
Learning theory	
Individual	*Cognition*
World	*Individual construction*
Individual and world	*Interpretation*
Knowledge	*Cognitive structure*
Learning principles	
Form	*Independent* - flexible - individual or group
Content	*On the basis of student problems* - problematic situations - isolated topics
Relations	*Teacher guidance (and coordination) and student work* - controlled by the students and the teacher - communication between the students and the teacher

Table 2 - The learning theory and learning principles of radical constructivism

Activity theory

According to activity theory the individual's actions in social and practical situations in the physical world form the basis of knowledge and learning. It means that the individual does not exist in separation from the world. The individual acts in the world, and the actions form the basis of knowledge and learning. According to Leont'ev (1978) human activity is directed at an object in the external world. The object represents a need which motivates and directs the actions of the individual. In an effort to reach the object, the individual uses the world as instruments for his/her object-oriented actions (Vygotsky, 1978; Leont'ev, 1978; Engeström, 1987). This means that the relation between the individual and the world consists in interactions between the individual and the physical world. Through the interactions, the individual creates the world by the creation of instruments. Knowledge is instruments used in object-oriented actions. Knowledge can also be described as the mediation between the individual and the world. In other words, knowledge is relative to the use of the world. It means that the world has no meaning in itself, but is a social and practical construction, a culture of instruments created by humans. This implies that knowledge is neither objective nor subjective. Knowledge is constructed in the relation between the actions of the individual and the consequences of the world (see also Dewey, 1916, p. 139-149). Learning is the construction of instruments, and the individual learns by

using instruments to mediate new actions. The individual is always situated in a social context which means that knowledge is dependent on the collective activity of the social practice. Therefore, knowledge is a social construction.

Fundamental to learning principles which support activity theory is a problem which orients the actions of the individual towards an object. It is important that the problems are understood by the students, meaning that they constitute problems *for the students*. The students' active and independent work with the problems supports the activity theoretical approach that learning is an active construction of knowledge. As Davydov and Markova (1983) write:

"[...] for human action to be endowed with the properties of activity, it is essential that the subjects formulates and accept the goals toward which his actions are directed. Translated roughly in Deweyian terms, this means that discovery of the goals is essential to true activity."

The independent work of students means that the work process should be flexibly organised and cannot be pre-structured. The work of students should be situated in a social and practical context which implies a broad subject matter. This means that it is not possible to narrow down the problems and divide them into small, isolated topics. Instead, content should be organised in large-scale projects. It is possible to determine the overall topic or theme of the content, but the specific problems should be made in collaboration with the individual student. The students' work on the project necessitates an authentic context in which the materials of the particular social and practical situation are made available. In other words, the content consists of different materials which are made available to students in their independent work. Independent work should be understood in contrast with controlled work which means that independent work is not necessarily individual. It is, however, possible for the students to work individually on their projects, but since the students are situated in a social context, collaboration with other students is often implied. The work is to a large extent controlled by students which means that the teacher's role is to coordinate and guide the students' work.

Finally, table 3 provides an overview of the learning theory and learning principles of activity theory.

Activity theory	
Learning theory	
Individual	*Activity*
World	*Social and practical construction*
Individual and world	*Construction*
Knowledge	*Instruments*
Learning principles	
Form	*Independent and social* - flexible - collaboration
Content	*On the basis of student projects* - problems - projects
Relations	*Student work and teacher coordination (and guidance)* - controlled by the students - communication between students

Table 3 - The learning theory and learning principles of activity theory

Evaluation criteria

The learning theories and learning principles of the three pedagogical approaches describe different approaches to the principles behind an ideal learning environment. It means that they describe the demands that technology should meet in order to support the different approaches. By viewing different technologies in relation to the learning theories and learning principles, it is possible to see what pedagogical approach they support. Rewriting the learning theories and learning principles into questions, creates evaluation criteria. Evaluation criteria are questions which the designer and implementer ask during design and use of e-learning technology. Criteria formed on the basis of learning theories support reflection and evaluation of learning principles in relation to learning theories (see figure 1). Criteria formed on the basis of learning principles support reflection and evaluation of activities (which the technology supports) in relation to learning principles (see figure 1). Table 4 shows the evaluation criteria formed on the basis of the three learning theoretical approaches.

Learning theory	
What conception of the individual do the learning principles support?	*A passive individual?* *A thinking individual?* *An acting individual?*
What conception of the world do the learning principles envision?	*Objective information?* *An individual construction?* *A social and practical construction?*
What conception of the Individual's relation to the world do the learning principles reflect?	*Knowledge is transmitted from the world to the individual?* *The individual interprets the world subjectively?* *The individual constructs the world?*
What conception of knowledge do the learning principles support?	*Objective?* *A cognitive structure?* *Instruments?*
Learning principles	
How is the course or course unit organised?	*A controlled course?* *An independent course?* *A social course?* *- a structured or a flexible course?* *- individual work, group work, or collaboration?*
How is the content organised?	*On the basis of an inner structure of the subject matter?* *On the basis of students problems?* *On the basis of student projects?* *- based on a curriculum, problematic situations, or problems?* *- consisting of predetermined units, isolated topics, or projects?*
How is the relationship between the participants?	*Teacher instruction and student training?* *Teacher guidance and student work?* *Student work and teacher coordination?* *- controlled by the subject matter and the teacher, the students and the teacher, or the students?* *- communication from teacher to students, between teacher and students, or between students?*

Table 4 - Evaluation criteria

These evaluation criteria make it possible to evaluate e-learning technology in relation to the three different pedagogical approaches and thereby to determine the (implicit) theoretical foundation of the technology.

Designing VLE and learning objects

According to the approach of this article, the first step in the design process is reflection of technology in relation to different activities. Below, I will argue that it is necessary to focus on design of activities that explicitly support a certain learning theory. Central to the approach of this article is that design of technology first of all should be directed at activities (see figure 1). This should be understood in contrast to a focus solely on the organisation of content. There is a tendency in the field of instructional design - especially concerning design of learning objects - to focus on the organisation of content:

”In distance education and in the classic instructional-design approach it happens fairly often that instructional materials and the media, rather than the learning activities, are central.” (Koper, 2000, p. 12)

As mentioned, an important objective of instructional design is often to design learning objects and VLE that are pedagogically neutral which would mean that they can be used in connection with different courses. This focus on pedagogical neutrality has meant that instructional design has prevented from explicitly designing technology in support of certain activities of a learning environment. Instead, the focus has to a large extent been on the organisation of content. Hoel (2002) argues that the standardisation of e-learning lacks pedagogical consideration, and he criticises the SCORM standard for a focus strictly on content without considering the consequences for and restrictions on activities of a learning environment.

In contrast to a focus on content and pedagogical neutrality, I argue that it is necessary to direct the design process at certain activities - which implies a certain organisation of content. The argument is that organisation of content is closely connected to the activities of the learning environment which means that organisation of content is never pedagogically neutral. Consequently, organisation of content and thus the designed technology will (implicitly) determine the potential activities in which technology can be used. It means that technology can - unintentionally - put restrictions on activities.

Below, I will argue that technology should be designed explicitly to support certain activities instead of attempting to achieve pedagogical neutrality. The purpose is not to discuss the specific use of e-learning technology. Instead, I will provide some brief illustrative examples of design of e-learning technology with a focus on activities. The starting point of the discussion is the advantages of e-learning mentioned in the introduction (cf. independence of time and space and individuality). On the basis of the evaluation criteria (table 4) of the three different learning theoretical approaches, I will discuss possibilities of the creation of new activities that support a flexible education. The framework puts the concept of flexibility into perspective and leads to a discussion of the use and design of VLE and learning objects.

Flexibility as independence of time and space requires activities that are based on individual work where the students are not interdependent. With individual work activities it is possible to organise the course flexibly. In contrast, collaboration between students is extremely difficult to combine with this kind of flexible organisation of the course. In collaborative activities the students are interdependent which means that their work must be coordinated with each other. Flexibility as independence of time and space, to some extent, supports cognitivism and radical constructivism, because according to both approaches (however, in different ways) the students should work individually. Activity theory, on the other hand, is difficult to combine with independence of time and space, since the approach focuses on collaboration.

Flexibility in the sense that students individually choose their course materials requires that the content is organised on the basis of the students. If students work independently and control the course, they can decide which course materials to use. A curriculum ordered in a predetermined sequence, on the other hand, is not flexible. This means that this kind of flexibility seems, to some extent, to support activity theory. The content of the course needs to be flexibly organised, because the students have control of the work process and choose the content on the basis of their independent work. To a lesser extent, the same applies to radical constructivism. Flexible organisation of content, however, does not support a cognitivist approach. Students cannot organise their own work process, because it is structured and sequenced on the basis of an inner structure of the subject matter.

Design of activities involved in these two different meanings of the concept of flexibility shows that different learning theories support different aspects of flexibility. It is perhaps possible to create flexible education on the basis of all three learning theories, but the nature of education will vary considerably. This means that e-learning technology should be designed differently according to the different theoretical approaches. In other words, the discussion of flexibility shows the importance of designing technology that explicitly supports a certain pedagogical approach.

Below, I discuss how e-learning technology can be designed explicitly to support activities of the three different approaches. In the discussion, I position myself within the field of activity theory as I wish to focus on the demands that this approach places on e-learning technology. I believe that existing technology supports this approach very poorly, and that activity theory places challenging demands on design of e-learning technology. Design of e-learning technology is discussed through some illustrative examples of the use of VLE and learning objects in support of different activities.

A radical constructivist approach is supported by an activity where the students work individually on identical assignments. This activity can be supported by a certain use of a discussion forum. The students can use a discussion forum to help each other solve the assignment, and the teacher can participate in the discussions. This activity is supported by a single discussion forum dedicated to the specific assignment. To some extent, this activity also supports a cognitivist approach. However, the focus of cognitivism on individual training means that discussions are not important in relation to a cognitivist approach. Activity theory is supported by an activity where the students collaborate on a shared project. This activity can be supported by a different use of discussion forums. Since the students need to discuss different aspects of their project and share their thoughts and findings, the activity is supported by a system of discussion forums (created by the students) in which the students can share discussions as well as documents. Although

some VLE support collaborative activities, there is a need to further develop VLE in this direction. To support an activity theoretical approach, VLE should be designed as environments or settings in which the project is placed and can be discussed as well as developed by the students.

Whereas the definitions of learning objects are numerous (see Wiley, 2002), it is easier to find an agreement on the ideas behind the use of learning objects. The main purpose is to break down learning materials into smaller units - learning objects - which can be reused in different contexts. The advantages are, as mentioned, that the teachers can reuse and rearrange learning objects in different courses, and that the students can organise their courses individually.

According to a cognitivist approach it is possible to structure the activities and divide the content into a number of smaller units. In other words, it is possible to create learning objects that are mutually independent and can therefore be used in different activities. In line with cognitivism it is possible to structure the learning objects in a linear sequence. It is the job of the teacher to structure the learning objects for the students' activities. The learning objects can be designed to cover a specific and isolated learning goal which means that when the student has finished working with the learning object, he/she has acquired a very specific part of the subject matter. Each learning object can organise the path of the students' work in a predetermined sequence of steps. Since the content can be divided into small units, the learning objects can cover a narrow learning goal which means that they can be very small and therefore highly reusable.

In support of radical constructivism one possibility is to create learning objects that represent a problematic situation for the students. The learning objects should support the students' independent activities. Similar to the cognitivist approach, it is possible to create learning objects on the basis of specific learning goals, because the problematic situations cover isolated topics. However, since the independent activities demand problematic situations that cover a larger area than the small units of a cognitivist curriculum, the goals will be much broader defined. Consequently, the learning objects will be larger and less reusable in comparison with the cognitivist learning objects described above. Such learning objects will not consist of isolated units with a specific build-in path or sequence for the students' work. Instead, the learning objects will present a problem field for the student to explore in their own way.

In line with activity theory one possibility is to create learning objects that represent problems and attached resources for the students' independent projects. Consequently, a learning object would be a large compilation of resources and would have limited reusability. Reusability can, however, be obtained if learning objects are created as resources for the students. Such learning objects must be neutral in the sense that they do not contain a learning goal. The reason is that students should be able to use them differently in connection with different projects. This means that the learning object in itself as a resource does not teach the student a specific part of a subject matter. Instead it can be used in connection with different goals of the students. According to an activity theoretical line of thought it is not possible to predetermine a sequence or a set of learning objects for the students to use. Instead, the students should have access to a wide variety of learning objects or resources to use in their own way in connection with their independent activities. The activity theoretical approach to learning objects as resources presents a type of learning object which has not been developed. The problems concerning

reusability, learning goals and sequencing inherent in this type of learning object presents serious challenges for design of learning objects. Therefore, there is a need to further explore the possibilities of designing learning objects explicitly on the basis of an activity theoretical approach.

These differences in design of VLE and learning objects show that e-learning technology designed to support one approach does not necessarily support a different approach. Similarly, e-learning technology can be designed in different ways to support the activities of different approaches. This stresses the importance of designing e-learning technology in support of certain activities in relation to a specific learning theoretical approach.

Conclusion

The purpose of the article has been to provide a pedagogical approach to design and use of e-learning technology. In order to develop and improve education pedagogically, it is necessary to reflect and evaluate technology in relation to a learning theoretical foundation. Further, technology should be designed explicitly to support activities in a learning environment, in contrast to a focus strictly on organisation of content.

It is problematic when technology is designed in the belief that content can be organised independently of activities, and that technology, consequently, can be used in different activities. The examples of design of e-learning technology in support of different activities illustrated that VLE and learning objects are not pedagogically neutral, but always support certain activities. The apparent advantages of e-learning such as flexible education are put into perspective when viewing them from a pedagogical point of view. Different aspects of flexible education do not necessarily match a given pedagogical approach. Instead of attempting to achieve pedagogical neutrality, it is necessary to focus on design of technology that explicitly supports a certain learning theoretical approach.

This calls for more attention on the pedagogical consequences of the use of e-learning and for an explicit use of learning theoretical approaches in the design of new technology. The consequence is a shift in the role of instructional designers; a shift from a focus on content to a focus on activities. Designers should design technology to support the organisation of activities of the learning environment. By an explicit use of an evaluation framework, such as the one presented in this article, it is possible for the designer or user to determine the pedagogical possibilities and advantages of e-learning technology and to develop new technologies to support and improve learning.

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