

Variation and Reusability in E-learning: not Compatible?

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Abstract: One way to improve e-learning systems for higher education is to look at the weaknesses of today's system and do something about these weaknesses. Obvious weaknesses of today's systems are lack of opportunities for variation and reusability. This paper focuses on describing the concept of "variation" and discusses the problems and opportunities appearing when variation and reusability are combined. The work done so far to improve reuse, has not been considering all the factors that are important to achieve high quality in e-learning. Learning objects and learning activities are not the only important aspects if the goal is quality *and* reuse.

Introduction

E-learning communities have been experiencing tough times after a promising introduction, but some positive experiences trigger researchers to still work on improving e-learning. The hot topics in e-learning during the last few years have been standardization and reusability.

Variation has been regarded as an important principle within teaching and learning for many years. This principle seems lost on the road to the online university. Many online teachers use a few delivery methods over and over again: This is convenient for inexperienced online teachers. Britain and Liber concluded in 1999 that the majority of VLEs (Virtual Learning Environments) were designed to support an education model based on information transmission (Britain & Liber 2004). However, a model based on information transfer alone does not take into consideration the pedagogical challenges facing teachers and students in online communities.

Teachers with classroom experience know that instruction needs to be varied to retain students' motivation for learning. Sometimes problem-based learning is the best delivery method, at other times collaborative learning, lectures (one-to-many) or drill exercises are effective. The best delivery method depends on many parameters, including the age or cultural background of the students, their background and motivation, the subject, the theme, the teacher and the learning environment.

Is it possible to combine the needs for reusability with a focus on variation in e-learning systems? Are the two concepts compatible? In this paper I will first define "variation" and "reusability" in an "educational technology" setting, giving examples and references to the literature. Then I will look at the combination of the two concepts, discussing the challenges and opportunities the combination gives. Finally I will draw some conclusions and sketch future work.

Variation

"Variation" is a concept that can have many different meanings, depending on the reader and on the context. In this paper I will use the concept of variation in a wide interpretation, as it should in educational settings.

Varied Pedagogical Methods

First of all variation can mean *varied pedagogical methods*. Koschmann wrote a position paper in 1996 that has been a common introduction to e-learning. He based the different paradigms in e-learning on different learning theories and theories of pedagogy (Tab. 1).

Paradigms	Event marking emergence of	Theory of learning	Model of instruction	Research issue
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	paradigm			
CAI	Coursewriter I	Behaviorism	Programmed instruction	Instructional efficacy
ITS	Carbonell's dissertation	Information Processing Theory	One-to-one tutorial, interactive	Instructional competence
Logo-as-latin	Publication of "Mindstorms"	Cognitive constructivism	Discovery-based learning	Instructional transfer
CSCL	NATO workshop	Socially oriented theoris of learning	Collaborative learning	Instruction as enacted practice

Table 1: Paradigms in e-learning (Koschmann 1996)

These paradigms produced different types of e-learning systems, and have lead to the fact that variation of pedagogical methods in the e-learning systems has not been prioritized. There has not been focus on inclusiveness, but more often a focus on exclusiveness when new e-learning systems have been developed. Both teachers and developers have been convinced that a specific theory of learning has been the right one, and consequently the e-learning systems have mainly been supporting one theory of learning. Some systems therefore have the main pedagogical focus on problem-based learning or simulation, others on drill/practice or collaboration.

Varied Learning Styles

Variation can also indicate *varied learning styles*. "Every human being has a learning style and every human being has strengths. No learning style is better or worse than any other style" (Dunn & Dunn 2004). The D&D model on learning styles has 21 elements grouped as five "stimuli", including environmental, emotional, sociological, physiological and psychological preferences. Some people learn best while reading (visual learning style), while others learn best while hearing (aural learning style). Some people have to move around to concentrate (kinesthetic learning style), others have to finger, note or do something with their hands (tactile learning style) (Dunn & Dunn 2004).

Howard Gardner and his theory about "multiple intelligences" provided another contribution to the discussion about who the learner is. In this theory he is defining eight different intelligences:

1. Visual / spatial intelligence:

The ability to visualize and make mental maps. Persons using mind maps are using this intelligence.

2. Verbal / linguistic intelligence:

The ability of reading, writing and communicating with words. This intelligence is well developed among writers, journalists, speakers etc.

3. Logical / mathematical intelligence:

The ability of logical thinking and performing calculations, and for abstract thinking. Mathematicians, engineers and lawyers have often developed this intelligence well.

4. Bodily / kinesthetic intelligence:

The ability of body coordination and conscious use of own body and hands, an ability typically well developed among athletes, dancers, actors and craftsman.

5. Musical / rhythmic intelligence:

The ability of singing, playing, composing and having a good musical ear, usually found among composers, conductors and musicians etc.

6. Interpersonal intelligence:

The ability of understanding people and communicating, usually well developed among competent diplomats, charismatic leaders and among "persons that people like".

7. Intrapersonal intelligence:

The ability of understanding our "self".

8. Naturalistic intelligence:

The ability to recognize and classify elements / patterns of the natural world (Gardner 1985).

The thought is that all persons have eight intelligences, but that some intelligences are better developed than others. It is therefore possible to use the knowledge about a student's intelligences to let him/her feel mastering, but also to give adequate challenges to improve weak abilities. It will in the future be important for e-learning systems to offer a varied learning environment supporting the different learning styles and intelligences to provide individualized learning.

Varied Levels of Intellectual Behavior

In some cases "variation" also could indicate *varied levels of intellectual behavior*. Blooms taxonomy (Bloom 1956) has been an important contribution to educational literature.

Knowledge	Observation and recall of information
Comprehension	Understanding information
Application	Use information, methods, concepts, theories in new situations
Analysis	Seeing patterns, organization of parts, recognition of hidden meanings
Synthesis	Use old ideas to create new ones, generalize from given facts, relate knowledge from several areas
Evaluation	Compare and discriminate between ideas, assess value of theories.

Table 2: Blooms taxonomy

In addition, Dreyfus has another approach to the view of the heterogeneous student group. He makes a division between different stages for learners, and claims that students on different stages have different needs. The stages he uses are:

1. Novice
2. Advanced beginner
3. Competence
4. Proficiency
5. Expertise

(Dreyfus 1998).

Despite different professional competences, there are some characteristics identifying a specific progress (Vavik 2005). The "novice" needs models, rules, prescriptions, while an "advanced beginner" starts to recognize based on experience. With "competence" the user chooses a plan of progress to reach the goal based on instruction and experience, while with "proficiency" the theory connected with the skill will gradually be replaced by situational discriminations accompanied by associated responses. With "expertise" the learner not only sees what needs to be done, but also sees how to achieve his goal (Dreyfus 1998).

Varied Teaching Styles

Like students and their learning styles teachers are also a heterogeneous group with *varied teaching styles*. Grasha identified five teaching styles that represented typical orientations and strategies college faculty use.

- Expert: Possesses knowledge and expertise that students need. Concerned with transmitting information and insuring that students are well prepared.
- Formal Authority: Possesses status among students because of knowledge and role as faculty member. Concerned with the correct, acceptable and standard ways to do things and with providing students with the structure they need to learn.
- Personal Model: Believes in "teaching by personal example" and encourage students to observe and then to emulate the instructor's approach.
- Facilitator: Emphasizes the personal nature of teacher-student interactions, with the goal to develop in students the capacity for independent action, initiative, and responsibility.
- Delegator: Concerned with developing students' capacity to function in an autonomous fashion, where students work independently on projects and teacher is available as one of many resources (Grasha 1996).

Varied Content

An additional meaning of variation in an e-learning setting could be *varied content*. In the e-learning field a lot of effort has been put into this area. Defining learning objects has created discussions in the field. IEEE defined a learning object as “any entity, digital or non-digital, that may be used for learning, education or training”. Wiley found the definition too broad, and defined a learning object as “any digital resource that can be reused to support learning.”(Wiley 2005). The components of a learning object are the content (image, animation, text, quiz etc) and searchable metadata.

Varied Media

Varied media (multimedia) has for a long time been one of the major advantages of e-learning and it has been used as a justification for still working in the area of e-learning. Books, lectures etc. have not been able to match the added value of multimedia with its opportunities for pictures, video and audio etc. “Interactive multimedia is notoriously expensive and time-consuming to produce, yet there is evidence that if made and deployed effectively it can enhance the learning experience” (Leeder & Morales 2004).

Varied Goals

Traditional education as well as e-learning has to consider the fact that learning can have *varied goals*. Bloom has identified three domains of educational activities: cognitive (mental skills), affective (growth in feelings of emotional areas) and psychomotor (manual or physical skills) (Bloom 1956). This paper distinguishes learning goals into three types: Skills, Knowledge and Attitudes, based on Blooms identification. There has not been much focus on different types of learning goals in e-learning, but learning a skill requires other environments, tasks and activities compared to learning attitudes or knowledge.

Varied Assessment

E-learning systems have for some years provided net-based assessment, like multiple-choice tests, digital portfolios etc. The ideas of multiple intelligences and different learning styles also demand varied ways of assessing a student. Therefore *varied assessment* should also be considered when discussing variation in e-learning.

The Concept of Variation

Focusing on variation in e-learning I have now defined the following aspects that need to be considered, some closely connected:

- Varied pedagogical methods - Varied teaching styles
- Varied learning styles - Varied levels of intellectual behavior
- Varied content - Varied media
- Varied goals - Varied assessment.

Reusability

IEEE has defined “reusability” as “The ability of a component to function and integrate outside the environment for which it was primarily designed.” So far there have been many barriers to reuse; examples are copyrights, technology, economy, missing standards, language and culture of sharing.

Discussion

Reusability and Varied Content / Media

When it comes to the combination of variation and reusability a lot of work has been done on especially one of the variation aspects mentioned above; varied content. The reusability of a learning object depends on the granularity of the learning object. Some consider an entire curriculum as a learning object (Wiley 2005), while others consider a picture (e.g. .jpg-file) as a learning object. This is of course a problem regarding reusability.

Standards exist to ensure the reusability of learning objects, and the term RLO (Reusable learning objects) is used extensively. Examples of standards for content are SCORM, IMS, IEEE LOM and DublinCore. The main problem of the standards mentioned is the amount of metadata connected to each learning object. “From an “efficiency” point of view, the decision regarding learning object granularity can be viewed as a trade-off between the possible benefits of reuse and the expense of cataloging” (Wiley 2005). There is software (authorware) based on

these standards, made to produce learning objects possible to integrate into different learning management systems. Just the fact that there are many standards concerning learning content, that authorware has to adapt to, shows how difficult reusability in e-learning is.

Varied media needs to be closely connected to content. One goal within e-learning will be to give access to learning content in a variety of media. This is necessary to satisfy different learning styles or intelligences of the students. The e-learning systems must therefore categorize learning objects not only according to learning outcome and theme, but also to media used. The fact that interactive media is expensive and time-consuming to produce (Leeder & Morales 2004) is a good reason to work for reusability.

Reusability and Varied Pedagogical Methods / Teaching Styles

Combining reusability and varied pedagogical methods is a topic many researchers are working on right now. Teachers education consists of several parts, one important part is to learn the subject that you are going to teach, but as important is to learn how to teach the subject. Pedagogical methods are traditionally possible to reuse in different subjects, e.g. the pedagogical method “problem-based learning” is used within health care education (higher education) as well as in geography in primary schools. It should therefore be possible to reuse pedagogical methods also in an online learning environment. When Koschmann wrote his article (Koschmann 1996) about the paradigms in e-learning, he claimed that three paradigms (CAI, ITS and Logo-as-latin) were passed by and that CSCL was the *emerging* paradigm. After the article was written all paradigms have developed further and there has been acceptable to blend tools etc. from the different paradigms based on knowledge about the opportunities and limitations of the tools.

IMS Learning Design (IMS-LD 2003) is IMS’ contribution to standardization of pedagogical methods and is now being tested all over the world. Downes is criticizing IMS Learning Design, claiming “In order to use a learning design with a set of objects, the learning design must specify the objects to be used and if the objects to be used are specified, then the learning design is not reusable”(Downes 2003). As Robson stated it shortly; “Context is the friend of learning and the enemy of reuse” (Robson 2004).

One of the problems of IMS Learning Design is, like with content and learning objects, the granularity of the “learning activities”. The “LAMS” system can give an example of the low level granularity. According to Leeder and Morales the e-learning system “LAMS” has innovative design features that put it at the forefront of current tools for activity management (Leeder & Morales 2004). “LAMS” provides a simple interface where the user can choose from a list of pre-defined learning activities (e.g. brainstorming a concept, taking a poll etc). Learning activities like these are reusable in several pedagogical methods. Standing alone like they do in “LAMS” the danger is however that “best practice” connected to pedagogical methods disappear. The learning activities in “LAMS” do not provide any help to the teacher nor are they connected to specific pedagogical methods. As they now are presented in “LAMS” they are nothing but tools rewritten into learning activities; e.g. brainstorming tool → Brainstorming a concept, polling tool → taking a poll. Is the flexibility in LAMS and IMS Learning Design too large, and will it depreciate the quality, because of the demand for reusability?

Online teachers have typically adopted the delivery methods of pioneer online teachers. They have also been dependent on and limited by the learning system used. “Many first-time users of VLEs (Virtual Learning Environments) seek to adapt the way that they work to the way that the software needs things to be done” (Britain & Liber 2004).

E-learning courses for higher education usually are based on a VLE / Learning Management System (e.g. Blackboard, WebCT, Fronter). The weakness of these systems is that they give too much attention to online administration and too little attention to pedagogical concerns (Britain & Liber 2004). The LMS forces the teacher into using only a few delivery methods. Teachers are used to finding the best methods of teaching their subject, and online teachers also should have the same opportunity. Most online teachers do however still need systems that help them discover the different pedagogical methods to use in a computer-based learning environment. In an earlier paper we suggested the use of wizards, based on pedagogical methods, where tools like brainstorming tools, discussion forums etc. were integrated into the interface through the wizard, providing “interactive pedagogical methods” (Kolås & Staupe 2004). This example shows the granularity level of “learning activities” on a higher level than for instance “LAMS”. The drawbacks can however be less flexibility.

Maybe e-learning should be used as an opportunity to change the traditional coupling “one teacher – one subject” to “several teachers – several subjects”. If systems are built with opportunities to make teachers aware of their strengths and weaknesses in teaching, the teacher could specialize on one teaching style, and additional teachers provide additional teaching styles in one subject. Awareness about teaching styles might lead to more reuse.

Reusability and Varied Learning Styles / Levels of Intellectual Behavior

The work done on learning styles (e.g. Dunn & Dunn, 2004) can make it easier to reuse “individualized” material, because they divide the student group into several subgroups with the same needs. The “individualized” material needs to be connected to the learning objects, but adding even more metadata to the learning objects is however not the perfect solution. The dilemma using learning styles is whether to capitalize or compensate, that is should a student with a visual learning style get all learning material visualized, or is it better to try to improve his/her weaker sides, and instead focus on other learning styles? This is a dilemma experts disagree upon in the ATI-field (Aptitude Treatment Interaction).

To be able to individualize learning, one needs to consider both varied learning styles and varied levels of intellectual behavior. Combining H. Gardner’s “Multiple intelligences” and Dreyfus’ five stages will give a two-dimensional illustration (Tab. 3) of how many different users one need to take into account developing an e-learning system allowing differentiation and individualization. There could also be added a third dimension to this problem, e.g. age, culture etc.

Dreyfus’ stages:	Novice	Advanced beginner	Competence	Proficiency	Expert
Gardner’s intelligences:					
Visual / spatial					
Verbal / linguistic					
Logical / mathematical					
Bodily / kinesthetic					
Musical / rhythmic					
Interpersonal					
Intrapersonal					
Naturalistic					

Table 3: Combining Gardner (1985) and Dreyfus (1998).

This illustration allows a critical view of tools like personas, usability tests etc. commonly used in system development. Personas are difficult to use because it is hard to find the general types of users. Usability tests are difficult to use because a system that works for a student on a novice level with a strong visual intelligence might not work for a student on the competence level with a strong logical intelligence. The problem of the heterogeneous student group needs to be considered well if we are going to succeed with both reuse and individualization. IMS-LD and the toolkit of Conole (2004) focus on “roles” of the participants (both students and teacher), e.g. individual learner, group participant, presenter. These roles are very general, and they are more connected to the pedagogical method in use, than to the individual needs of a heterogeneous student group. By focusing on the heterogeneity of the student (and teacher) group more aspects are brought into the discussion (varied learning styles, varied levels of intellectual behavior etc). To succeed with individualization and differentiation in e-learning we need to know the different types of users.

Reusability and Varied Goals / Assessments

Conole connects “learning outcome” to a learning activity. Learning outcome is what learners should know, or be able to do, after completing the learning activities e.g. understand, demonstrate, and design (Conole 2004). These learning outcomes are on a lower level compared to the learning goals previously defined in this paper, but fit into the three categories (skills, knowledge and attitudes), and are therefore reusable in the different categories.

The assessment ought to fit all types of students, and work needs to be done to develop digital assessment tools that give students with different individual needs the same opportunity for good results. The work on digital portfolios is maybe the best contribution so far, where students get individual feedback throughout the course. The portfolios are also reusable, with reference to the demand of variation described in this paper.

Conclusions

One problem succeeding with the combination of reuse and variation, is that the demand of reuse is based on need for saving money, while the need for variation is based on the need for quality. Reuse may also give better quality, and is therefore an important goal within e-learning, but it needs to be seen in connection with other aspects, e.g. variation.

Wiley stated that “Learning objects must participate in a principled partnership with instructional design theory if they are to succeed in facilitating learning” (Wiley 2005), but this paper has suggested aspects additional to content and pedagogies. The work done so far to improve reuse, has not been considering all the factors that are important to achieve high quality in e-learning. Learning objects and learning activities are not the only important aspects if the goal is quality *and* reuse.

This paper is a contribution to the work of producing a framework for evaluating e-learning systems, with the focus on the concept of variation and reusability. It represents also background work in the EU-project QUIS (2005), where it will be used in the work of developing a requirement specification for a future e-learning system.

References

Bloom, Benjamin (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Britain, S. and Liber, O. (2004). *A Framework for the Pedagogical Evaluation of eLearning Environments*. http://www.cetis.ac.uk/members/pedagogy/files/4thMeet_framework/VLEfullReport

Conole, Grainne (2004). *Report on the effectiveness of tools for e-learning*. University of Southampton, http://www.jisc.ac.uk/uploaded_documents/Report%20on%20the%20effectiveness%20of%20tools%20v5_Martin_Oliver.doc.

Downes, Stephen (2003). *Design, standards and Reusability*. <http://www.downes.ca/cgi-bin/website/view.cgi?dbs=Article&key=1059622263&format=full>.

Dreyfus, Hubert L. (1998) *Intelligence Without Representation*. <http://www.hfac.uh.edu/cogsci/dreyfus.html>

Dunn, Rita and Dunn, Ken (2004-05). *Learning Styles Network*. <http://www.learningstyles.net/>

Gardner, Howard (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Grasha, Anthony (1996) *Teaching with Style*. Pittsburgh, PA: Alliance Publishers. <http://web.indstate.edu/ctl/styles/5styles.html>

IMS Learning Design (2003). *Learning Design Specification*. <http://www.imsglobal.org/learningdesign/>

Kolås, Line and Staube, Arvid (2004) *Implementing delivery methods by using pedagogical design patterns*. Ed-Media 2004 Proceedings, pages 5304-5309.

Koschmann, Timothy (1996). *CSCL: Theory and Practice of an emerging Paradigm*. Southern Illinois University, ISBN 0805812463.

Kraan, Wilbert (2003). *Learning Design and reusability*. CETIS – Centre for educational technology interoperability standards, <http://www.cetis.ac.uk/content/20030902133812>.

LAMS – Learning Activity Management System. <Http://www.lamsinternational.com>

Leeder, Dawn and Morales, Raquel (2004). *Study, Report and Suggested Framework to support the JISC Distributed e-learning program*. <http://www.ucl.ac.uk/framework/JISC-Distributed-e-learning.doc>.

Robson, Robby (2004). *Reusability Guidelines for Authors, Designers and Repositories*. Eduworks Corporation, <http://www.reusablelearning.org/docs/presentations/elearningguild-0404/robson-reusabilityguidelines.ppt>.

Vavik, Lars (2004). *Perspektiver på samarbeid og veiledning i nettbaserte læringsomgivelser* in: Sigmundson, Hermundur & Finn Bostad (Red.), *Læring. Grunnbok i læring, teknologi og samfunn*. Universitetsforlaget. Kap 6, ISBN 8215006302.

Wiley, David A. (2005). *Connecting learning objects to instructional design theory: A definition, a metaphor and a taxonomy*, Utah State University, <http://www.reusability.org/read/chapters/wiley.doc>.

QUIS – Quality, Interoperability and Standards in e-learning, EU-project (2005). <http://www2.tisip.no/quis/>