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EDUCATIONAL SOFTWARE AND PEDAGOGICAL DEVELOPMENT- SUCCESS FACTORS IN TEACHERS TRAINING

Ramón Garrote Jurado[1], Tomas Petterson[2], Angel Regueiro Gomez[3]

[1]University of Borås, Sweden, [2]Librarian and Teacher, Borås, Sweden, [3]Instituto Superior Politécnico José Antonio Echevarría, Cuba,
[1]e-mail: Ramon.Garrote@hb.se

ABSTRACT

This article presents a staff development project, intended to increase the use of educational software in higher education. The data was collected in four Latin American countries where university teachers attended a course about Learning Management Systems (LMS) built on the LUME method. LUME is an acronym for LiveUSB Mediated Education, a method based on a complete course package executable from a portable memory device. The process of planning appropriate changes in a course is outlined by reflecting on previous results. Some critical aspects of teachers' education are identified and the authors argue that pedagogical motivation and collaboration rather than technical skill decide the long-term results.
The authors assert that educational software have the biggest impact on the students when it is used to facilitate social constructivist methods. In order to reap the pedagogical benefits of educational software teachers must understand how sharing the information and the collaborative learning can improve learning and teaching in high education..

KEYWORDS: Information Technology, Learning Management systems, Engineering education, Higher Education, Action Research.

SOFTWARE EDUCATIVO Y DESARROLLO PEDAGÓGICO - FACTORES DE ÉXITO EN LA FORMACIÓN DE PROFESORES

RESUMEN

El presente trabajo presenta un proyecto para el desarrollo profesional de los profesores de educación superior. El objetivo principal es aumentar el uso del software educativo en la enseñanza superior. Los dados que se presentan fueron recopilados en cuatro países de América Latina, donde los profesores universitarios asistieron a un curso sobre Sistemas de Gestión para el Aprendizaje (SGA), basado en el método LUME, un acrónimo de LiveUSB Mediated Education (dispositivo de memoria ejecutable para facilitar la educación). El método está basado en un paquete completo que se ejecuta desde un dispositivo de memoria portátil.
El proceso de planificación de cambios apropiados a un curso, a través del análisis de los resultados de cursos anteriores, es explicado en términos generales. Se identifican aspectos críticos de la formación del profesorado. Los autores sostienen que la motivación pedagógica y la colaboración en lugar de la habilidad técnica, son los que deciden los resultados a largo plazo.
Los autores afirman que el software educativo tiene el mayor impacto, cuando se utiliza para facilitar métodos constructivistas-sociales centrados en el alumno. Con el fin de aprovechar los beneficios pedagógicos del software educativo, los profesores deben comprender como el intercambio de información y del aprendizaje colaborativo pueden mejorar el aprendizaje y la enseñanza en la educación superior.

PALABRAS CLAVES: Tecnologías de la información y la comunicación, Sistemas de Gestión para el Aprendizaje, Educación en Ingeniería, Educación Superior, Investigación por acción.

1. AIM AND PURPOSE OF THIS ARTICLE

This article is intended for teachers in higher education and people engaged in the training of teachers. It outlines the process of planning appropriate changes in a course by reflecting on experiences and gives an example of applied action research from the field of computer facilitated education. The article highlights key factors in the introduction of educational software and presents a list of recommendations based on the authors' experiences and research.

2. BACKGROUND

In the computer age it is an obvious aim for educational research and development to bring educational software and modern pedagogical methods together. Since a key aspect of ICT is the easy copying and sharing of information, we must use Open Educational Resources (OER) to reap the full benefits of ICT in education.
In 2010 a group of Cuban engineering lecturers were introduced to the use of Learning Management Systems (LMS) and multimedia course material in the context of Problem Based Learning (PBL) by the first author of this article. The course Adaptation of Engineering Education to the use of net independent software were intended to give the participants the skills to handle a LMS and act as pioneers and support persons in their workplace. At the beginning of the course the participants were gathered for two weeks of lectures, workshops and hands-on training, followed by three months of work on their assignments, i.e. to adapt a course to the use of a LMS. To meet the shortage of computers and internet access in Cuba, all course material was stored on USB drives together with portable software. All programs were executable directly from the memory stick which allowed the participants to work on any available computer in their own time and save their work between sessions. Only open educational resources (OER) (D'Antoni, 2009) were used, so all material could be copied freely.

Educational software

When we look at Information and communication Technology (ICT) in education we usually make a distinction between hardware and software. If the hardware is ordinary computers and peripheral equipment, then the term computer enhanced, or computer facilitated education is appropriate. Computer programs, used for teaching and learning, are sometimes called "educational technology", but we prefer the term "educational software" to avoid the possible confusion with other technical devices.

As soon as educational software is utilized it is convenient to bring it together in a Learning Management System (LMS). An LMS is a 'toolbox' of software intended to facilitate learning, teaching and course administration (Kats, 2013). There are many different brands of LMS, both commercial and freeware, with similar features.

ICT can facilitate a wide range of pedagogical methods. That in itself does not mean it is used in a pedagogically sound way, the way ICT is applied must take foreseeable learning outcomes and effects on the learner's experience into consideration. This process is called constructive alignment (Biggs, 1999).

LUME: LiveUSB Mediated Education

LUME is an acronym for LiveUSB Mediated Education. It stands for a pedagogical approach that utilizes a complete course package with course material and software stored on, and executable from, a portable memory device (Garrote Jurado and Pettersson, 2011a).

We do not need a true live USB to employ the LUME method but it is always possible to provide a free OS, and if internet is available at low cost and students have laptops, we can distribute the material as a folder via the internet rather than portable memory devices.

Student centered pedagogical methods

The last hundred years of pedagogical development demonstrates a shift from teacher-centered to student-centered pedagogical methods (Bruner, 1986). This change is associated with changed views of knowledge and learning. The traditional view that knowledge exists and can be transferred unaltered from books or teachers to students has largely been replaced by the view that knowledge is created in a process with the learner as an active participant, this view is called constructivism. The process when learners form their knowledge by processing new information and combining it with previous knowledge is usually enhanced by interaction with the outside world, in particular other people. Sometimes this aspect is highlighted by using the term social constructivism (Vygotsky, 1978).

Based on this view of knowledge and learning we can summarize "student centered pedagogical methods" thus: Teaching should facilitate learning by design and implementation of procedures that takes the student's previous knowledge and experience into consideration. Learning, or the creation of knowledge, should be facilitated by a combination of theory, experience and practice. The learning experience should be enhanced by interaction and collaborative efforts.

Open Educational Resources (OER)

Information and software that are free to download and utilize in education are called Open Educational Resources (OER) (D'Antoni, 2008). A commonly accepted definition of OER is as follows: "open educational resources are digitized materials offered freely and openly for educators, students and self-learners to use and reuse for teaching, learning and research" (OECD, 2007, p. 30).

Community of practice

The term community of practice was first suggested by Lave and Wenger (Lave and Wenger, 1991). Wenger defines community of practice as 'a kind of community created over time by the sustained pursuit of a shared enterprise' (Wenger, 1998a, p. 45). He adds that 'A community is formed by people who engage in a process of collective learning by interaction and collaboration within a shared domain of human endeavour' (Wenger, 1998b). If the community does not 'interact and learn together, they do not form a community of practice' (Wenger, 2011). If the common interest in a community of practice is aimed at learning, the term "community of learners" is often used (Wilson, 2007).

3. METHODOLOGY

Gathering of data

The first step in our research was taken when the course Adaptation of Engineering Education to the use of net independent software was created and first given in Cuba in the spring of 2010 (Garrote Jurado and Pettersson, 2011a). The course was then given in Guatemala and Peru, without any changes in the course material. The same plan for lectures and workshops was followed closely with the course in two parts. First the participants were gathered for two weeks of lectures, workshops and hands-on training. By the end of the initial two weeks, questionnaires and group discussions were used to get the participants' opinions about the course and their attitudes towards the use of LMS and OER in education (table 1-3, below). The opinions about the course were given anonymously in a students' assessment questionnaire.

After the two weeks introduction followed three months of work on the given assignments, during that period the participants were strongly encouraged to engage in discussions, work together and share their experiences within the group. The intention was to promote the transition of the group into a community of learners and elicit long-term collaborative efforts.

Since the course was intended to promote the use of ICT in education, the students' assessment was only one step in the course evaluation. To get a picture of the long-term effects the participants' experiences and attitudes were investigated with a questionnaire about one year after the course was finished. It was hard to get in touch

with many of the participants, but about two thirds of the participants answered the questionnaire (table 4, below).

Evaluation of the first three occasions

By the end of the second week most participants were positive about the pedagogical and methodological approach. They expected a LMS to be very useful in their future practice and they agreed that OER can contribute to teaching and learning. So, the course was very well received by the participants. The approach elicited a lot of activity in the first two weeks which facilitated the transformation of the groups into communities of learners. The method raised the participants' awareness about OER on the Internet and the potential benefits of ICT in education.

In Cuba 13 out of 15 participants passed the course. The university strongly supported the course and the participants were highly motivated; the two participants who did not pass took up new work positions and were unable to complete the course assignments. After completing the course the participants have continued to work together to develop the use of computer supported education in Cuba. In Guatemala the institutional support was not as strong as in Cuba and it was more of a personal choice to complete the course. As a result only 14 out of 21 participants passed the course, but most of them still developed sufficient skills to use a LMS in their work.

Only six participants out of eleven completed the course in Peru. Most lecturers in Peru have a very heavy workload, most of them have more than one job, a common practice in Peru (Vandergaag et al., 1989). It was difficult to gather the group during the first two weeks on campus and most of the participants were unable to spend as much time on the course as intended. For that reason it was not much collaboration and interaction going on in this group.

Summary of the experiences before spring 2012

In table 1-3 (below) there is small differences between the groups in Cuba, Guatemala and Peru in their attitudes after two weeks of on-campus activity. However, looking at the different outcomes a year after the course finished (see table 4), the result in Cuba is far better than the results from Guatemala and Peru, in spite of big problems with access to computers and internet in Cuba. The apparent explanation for this difference is the way the work continued after the initial two weeks, in Cuba the group continued to work closely together during the course, and after the course was finished they have continued their cooperation.

Brazil 2012

When the course was to be given in the spring 2012 in Brazil obviously the major question was how to elicit collaborative efforts and turn the group into a community of learners. A few videos were added (in Portuguese language) but more important, changes were made in the plan for lectures and workshops in order to benefit from the earlier experiences. At the beginning of the course, before looking at the LMS or thinking about how to use it, a number of theoretical considerations and key concepts were presented and discussed, using the figure below as a graphical representation of the aim of the course.

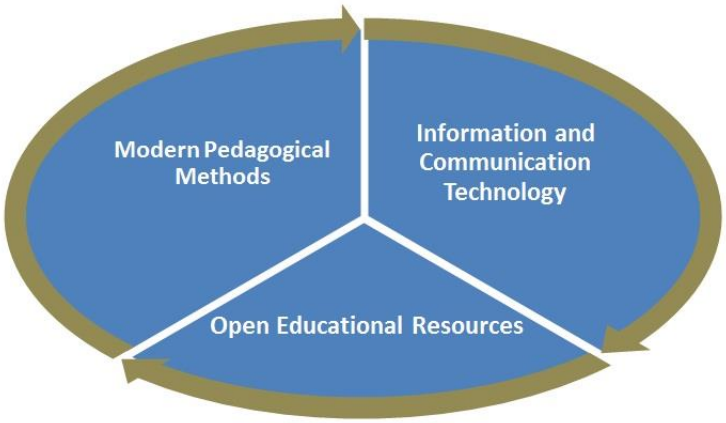

Figure 1: The aim of the LUME method
(Garrote Jurado & Pettersson, 2011b)

Much attention was given to raising the participants' awareness about the underlying pedagogical theories when they were planning the use of different features in the LMS. It is a major consideration that the relation between educational practices and educational software is not the same for different tools. In particular, tools for disseminating information usually facilitate a traditional teacher-to-student practice, while the usefulness of tools for interaction depends on learner centered procedures and a social constructivist perspective on learning (Garrote Jurado and Pettersson, 2011b). Therefore the participants had to discuss the relation between educational software and pedagogical ideas in depth. The participants were also encouraged to discuss possibilities of future collaboration and exchange of information.

4. RESULTS

Table 1 shows anonymous responses to statements in the students' assessment questionnaire, filled out after two weeks of on-campus activity.

Table 1: Table 1: Responses to statements in the students' assessment, after two weeks.
1 = I fully agree, 2 = I agree, 3 = Neutral, 4 = I disagree, 5 = I strongly disagree

No.	Country	Statement	1	2	3	4	5	Avg.
1	Cuba (N=15)	The course fulfilled my expectations	15					1
	Guatemala (N=21)		12	9				1,42
	Peru (N=11)		11					1
	Brazil (N=20)		15	5				1,25
2	Cuba (N=15)	Videos and other materials were well suited to the course objectives	15					1
	Guatemala (N=21)		16	4	1			1,28
	Peru (N=11)		11					1
	Brazil (N=20)		15	5				1,25
3	Cuba (N=15)	There was a high level of cooperation and interaction amongst the participants	14	1				1,06
	Guatemala (N=21)		6	14	1			1,76
	Peru (N=11)		9	2				1,18
	Brazil (N=20)		15	5				1,25

Comment: All four groups were satisfied with the course after two weeks.

Table 2 shows the responses to statements about OER, given after two weeks of on-campus activity.

Table 2: Responses to statements about OER, given after two weeks
1 = I fully agree, 2 = I agree, 3 = Neutral, 4 = I disagree, 5 = I strongly disagree

No.	Country	Statement	1	2	3	4	5	Avg.
4	Cuba (n=15)	I believe the use of the free course material on the Internet (freeware) offers great opportunities for increasing the quality of higher education.	12	3				1,2
	Guatemala (n=21)		14	6	1			1,38
	Peru (n=11)		10		1			1,18
	Brazil (N=20)		18	2				1,1
5	Cuba (n=15)	I am willing to make a lot of my course material available as freeware on the Internet.	13	2				1,13
	Guatemala (n=21)		11	9	1			1,52
	Peru (n=11)		10	1				1,09
	Brazil (N=20)		15	2	3			1,4

Comment: Most of the participants were very interested in the possibilities to utilize OER in their work.

Table 3 shows the responses to statements about LMS, given after two weeks of on-campus activity.

Table 3: Responses to statements about LMS, given after two weeks
1 = I fully agree, 2 = I agree, 3 = Neutral, 4 = I disagree, 5 = I strongly disagree

No.	Country	Statement	1	2	3	4	5	Avg.
6	Cuba (N=15)	A LMS can facilitate the work of the lecturers to a large extent.	12	3				1,2
	Guatemala (N=21)		10	11				1,5
	Peru (N=11)		8	3				1,3
	Brazil (N=20)		14	6				1,3
7	Cuba (N=15)	A LMS can increase the performance of the students at my institution.	9	6				1,4
	Guatemala (N=21)		16	5				1,2
	Peru (N=11)		9	2				1,2
	Brazil (N=20)		16	4				1,2

Comment: Most of the participants agreed that a LMS can facilitate their work to a large extent and can increase the performance of the students. Looking at table 1-3 there are no significant differences in attitudes between the groups.

About one year after the course was finished attempts to contact the former participants were made, but it was not possible to reach everyone. Approximately 70% of the participants filled out the questionnaire.
Table 4 shows the use of ICT, by former course participants. The respondents filled out the form 10–18 months after the course was finished. Answers were given on a three grade scale.

Table 4: Table 4: Responses to statements about the use of ICT, one year after the course
1 ="On many occasions", 2 = "Test or one-time basis" and 3 = "Not at all"

No.	Country	Statement	1	2	3	Avg.
8	Cuba (N=10)	During the last year, the computer network was used in my courses to enable the students to discuss issues and tasks in the course	9	1		1,1
	Guatemala (N=13)		9	4		1,3
	Peru (N=6)		3	3		1,5
	Brazil (N=13)		10	3		1,2
9	Cuba (N=10)	During the last year, the computer network was used in my courses to enable the students to cooperate with assignments in the course	9	1		1,1
	Guatemala (N=13)		9	3	1	1,4
	Peru (N=6)		3	3		1,5
	Brazil (N=13)		11	2		1,2
10	Cuba (N=10)	During the last year, the computer network was used in my courses to Facilitate more general discussions	10			1
	Guatemala (N=13)		5	7	1	1,5
	Peru (N=6)		3	2	1	1,7
	Brazil (N=13)		12	1		1,1
11	Cuba (N=10)	I have used LUME in courses after the course was finished	8	2		1,2
	Guatemala (N=13)		7	4	2	1,6
	Peru (N=6)		3	3		1,5
	Brazil (N=13)		9	3	1	1,4
12	Cuba (N=10)	I am planning to use LUME in the next few years	9	1		1,1
	Guatemala (N=13)		11	2		1,2
	Peru (N=6)		5	1		1,7
	Brazil (N=13)		12	1		1,1

Comment: Cuba and Brazil show more activity than the other two, in spite of limited access to computers and internet in Cuba. After one year most participants from Brazil and Cuba have utilized ICT to enable student collaboration and interaction and most of them are planning to use the LUME method in the future.

5. OBSERVATIONS

A few observations are worth mentioning as viable explanations for the difference in long-term outcome. In both Cuba and Brazil the participants were given sufficient time to follow the course, resulting in almost 100% attendance during the first two weeks. Also, the course was given a lot of attention by the institutions, including senior staff members participating in the course. In Brazil the participants spontaneously formed small groups to work on specific issues and compare notes.

From personal communication we have concluded that a major difference is the way the work continued after the initial two weeks. In Cuba and Brazil the groups continued to work closely together and after the course was finished they have continued their cooperation.

The interest demonstrated by senior staff and the collaboration amongst the participants both increased the level of peer recognition and group identity.

6. DISCUSSION

Teaching-centered pedagogical methods assume that knowledge is transferred from teachers and textbooks to students. Results are commonly measured by exams, testing the students' knowledge of the material covered in the courses. In this mode of teaching, students' interactions are no concern for the teachers.

In constructivist modes of teaching students' interactions are important (Duffy and Jonassen, 1992). Constructivist methods are based on the idea that individuals develop their own knowledge from information, experience and interaction with other people or the outside world. From this perspective, memorizing facts is only a small step in the creation of knowledge; it is by using and processing it a person transform memorized information into functional knowledge.

ICT is a powerful tool that can facilitate a wide range of pedagogical methods, but to reap the full benefits of it in higher education, lecturers must bring together the technology with appropriate ideas of teaching and learning. The way it is used should take into consideration course aims, students' prior experience etc. and this will only happen if the lecturers are motivated and prepared to develop their competence and adapt their teaching practice to the available ICT.

Considering how user-friendly modern LMSes are, the demand on the lecturers' computer-literacy is no higher than we would expect of an average student in the western world. So, if lecturers find ICT difficult to handle, or not useful in their courses, the problem is likely to be a lack of understanding of the pedagogical possibilities it offers. Apparently, teachers must understand the underlying ideas in order to apply computer-supported, constructivist methods. Without that motivation it is unlikely that they will even acquire the necessary skills, just by taking a course. In a similar way it makes no sense to offer technical support on demand to lecturers without developing the pedagogical motivation to utilize it.

The attitudes and reactions from colleagues, or peer recognition, are very important to most people. Our experiences confirm that peer recognition and the satisfaction of personal development are the most important motivators for most educators as soon as sufficient time and other facilities are at hand. A long-term, pedagogically sound utilization of ICT is most likely to occur if lecturers form a community of practice with free exchange of information and collaborative efforts.

The outcomes of the course Adaptation of Engineering Education to the use of net independent software demonstrated the importance of motivation and the strength of collaborative learning. To successfully utilize ICT in education three things are needed; the technology itself, handling skills and motivation to apply ICT in a pedagogically sound way, see figure 2.

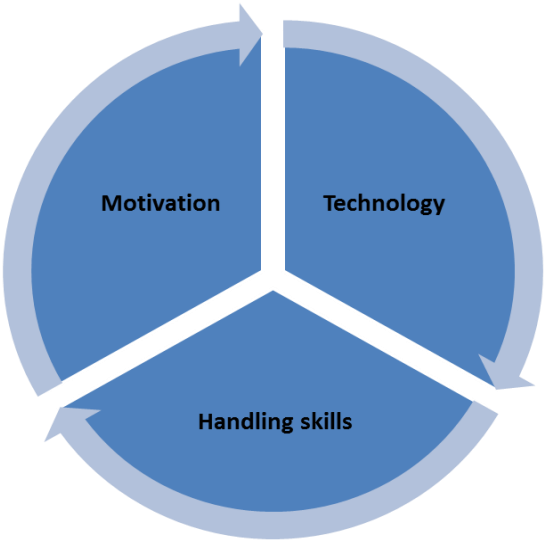

Figure 2: Necessary conditions for utilization of ICT.

Many researchers have argued that access to technology, support and training is not sufficient to guaranty its optimal utilization in education (Blin and Munro, 2008). The literature and the findings reported in this article confirm that a wider utilization of computer-enhanced education demands an initial effort by teachers and institutions (Butakov et al., 2013). We conclude that the motivation to utilize educational software is critical, not only to actually use it in practice, but also in order to learn the basic technical skills.

Unfortunately, the teachers at many educational institutions do not interact and learn together; hence they do not form a community of practice (Wenger, 2006). Instead they work independently within a set frame of traditions, defining both course content and pedagogical methods. This can only satisfy the needs of students as long as the education is dominated by persistent, predefined knowledge.
To meet the demands of changing societies, new knowledge and modern pedagogical methods teachers need to interact and engage in collaborative efforts i.e. develop into a community of practice. Once people form a community of practice, peer recognition and the satisfaction of personal, or group, development provide the motivation needed to engage in learning.

The method we used to learn from experience and improve the course follows the principles of action research outlined by Dewey and Lewin (Argyris et al., 1985). If lecturers give a certain course to new students each year, as times goes by, most lecturers will improve their teaching by trial and error, even if the explicit aims and course plan remain the same. What Dewey and Lewin pointed out was that to learn from experience and improve our practice we must analyze those experiences systematically, not just rely on people getting better with more experience. In this project, we could see significant differences that were not obvious during the course, by gathering additional information after the course was finished. This data combined with personal information from several participants gave a more elaborate picture of the long-term outcomes of the course.

7. CONCLUSIONS

The biggest impact of ICT in education can be expected when it is used to facilitate learner-centered, social constructivist methods. Teachers need to understand the underlying pedagogical ideas in order to utilize ICT in a pedagogical sound way. More specific to reap the full benefits of ICT in education, teachers need to experience and embrace collaborative learning.

8. LIST OF RECOMMENDATIONS

The following list of recommendations is derived from our experiences above, but should apply to a wide range of similar projects intended to improve quality of education.

Set aside time to explain and discuss the course aims and how they relate to underlying theories of learning. Only if the participants understand and share the view can you expect them to put in a solid effort.

Key ideas in modern pedagogy, such as community of practice and social constructivism should be discussed in the group. Teachers need to experience collaborative learning, but also need to understand the underlying ideas of what they are doing, in order to bring it on to their students.

Make sure the participants understand that the forming of a community of practice, resulting in free sharing of information and a supportive atmosphere is crucial for the long-term results.

No economic incentives are needed if the participants are given sufficient work-time to follow the course. Peer recognition and group identity are important, and can be enhanced by attention from senior staff and common activities outside of lecture time.

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