Oliveira, L., Vaz de Carvalho, C. (2009). ***Towards e-learning sustainability: Designing and reusing student-centered learning scenarios.*** Social Networking - Proceedings of Sixth Annual International Conference Silesian Moodle Moot 2009 - Access to Education by Learning Personalization.

Conference
SILESIAN MOODLE MOOT

Faculty of Economics
VŠB-Technical University
of Ostrava

Čeladná, Beskydy
12. - 13. 11. 2009

Towards e-learning sustainability: designing and reusing student-centered learning scenarios

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Abstract: *Learning Management Systems have gained an increasing role in the context of Higher Education Institutions as essential tools to support learning. Amongst the wide variety of platforms, the open source Moodle is one of most widely spread and is becoming more and more present in teachers' everyday, granting new teaching and learning opportunities and enriching educational processes. However, before the exponential growth of the use of these platforms, it becomes necessary to reflect on the real benefits that teachers and students are taking from educational technologies. When we look closely it's possible to identify three main purposes of these technologies: content storage and distribution, vertical communication and classwork management. The integration of these technologies in the teaching-learning process has been offering students higher levels of access to course materials and new forms of communication. The current technology also provides teachers with a set of auxiliary management tools allowing for the automation of some processes, such as the management of coursework submitted online by students, automatically graded quizzes with feedback, etc. This means a great step towards e/b-learning accessibility and management, but teachers and students are not taking full advantage of the capabilities offered by these technologies. There is still a notorious tendency for the development of content-centered learning environments, in which teachers are using new tools to implement the same old procedures: content and information distribution. There is a widely recognised need to transform these environments into to true learning spaces, expanding pedagogical methodologies in order to give students active and collaborative learning opportunities that allow them to develop their skills. However this has been a tremendous challenge for teachers, once designing and implementing situated or articulated online learning activities is a complex and time-consuming process. In this presentation we point out what we believe to be a possible solution for these constraints, showing how a range of cyclical processes of inter-subject reuse of pedagogical strategies has allowed us to register a substantial reduction of the time and the skills that teachers are required in the construction of active learning situations.*

Keywords: *reuse, pedagogical strategies, ROI, LAMS, MOODLE*

1 Introduction

The rapid growth of the use of the Internet and educational technologies has allowed deep transformations in the teaching-learning processes and paradigms. Where education is concerned, the Internet has been gaining an increasing role as a mediator-facilitator platform, thus allowing the creation of new contexts where learning opportunities can be expanded, dynamic, and potentially collaborative and where the resources are widely available.

Some authors [1, 2] highlight that the purpose of technology-mediated education relies in its potential to produce customized, generative, adjustable environments and systems that add value to traditional classroom work. In fact, these traditional environments are being expanded towards the virtual world in a growing relation of complementarity that can be either purely electronic (e-learning) or combined (b-learning).

Nevertheless, the source of educational potential does not rely on technology itself but on its creative and reflexive application [3], since technology does not replace the teacher nor guaranties learning [4].

In this new paradigm, the role of the online tutor shouldn't be a replica of the teaching models based on the traditional lecture. It is necessary to adopt student/activity-centered models/strategies, according to which the tutor is an organizer, a facilitator and a mediator for the construction of knowledge and interactions, allowing the student to succeed as a learner and as an individual [3]. This new stance implies recognizing that changing the means through which education occurs means changing education itself [5].

These modifications should, therefore, impact the organizational culture of schools, its pedagogical practices and the redefinition of the roles of its intervenients. In fact, when considering the growing technological evolution, allowing the stagnation of pedagogical practices may also allow technology to become a recreational agent, misleading the real purposes of educational institutions.

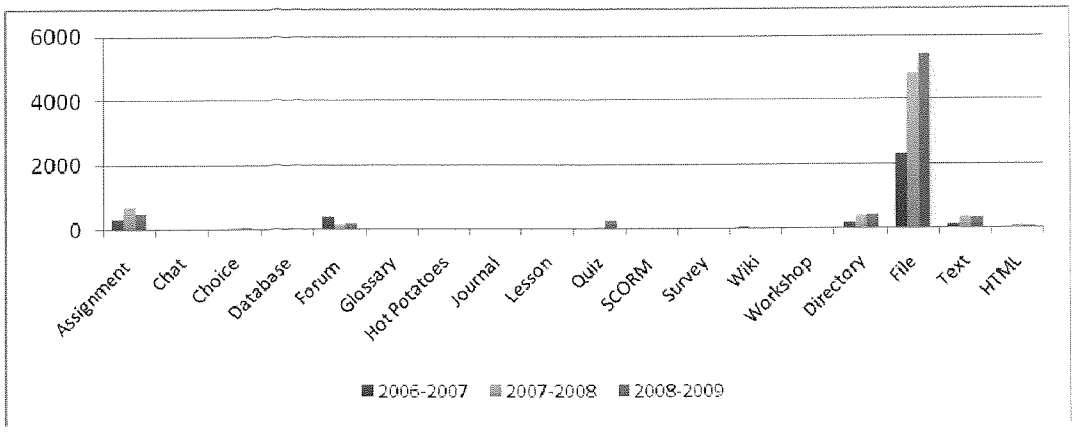
2 Current use of educational technologies

There has been an enthusiastic effort demonstrated by teachers to include VLEs in their daily practices. In fact, annual reports [6] from the Online Support Project (PAOL) concerning the use of MOODLE at School of Accounting and Administration of Oporto (ISCAP) reveal a notable increase of users (teachers and students) in the last three years.

This means a great step has been given particularly in terms of the increasing the number of student access to course contents, the reuse of MOODLE course pages from one year to another and the adoption of tools that facilitate teacher-student communication.

Nevertheless, in the majority of the situations, VLEs have been used as libraries for content storage and distribution [7], where there is neither accommodating for learning activities [8] nor for students' opportunity to perceive the different phases of their learning process [9]. It is possible to verify that the integration of technology in the teaching-learning process has not accompanied by a shift in the pedagogical methodologies that would to truly transport the teaching-learning process into VLEs and in fact boost the teaching and learning opportunities. This is in fact the biggest challenge of today's education [10] and one of the major difficulties that teachers face.

As it is possible to verify trough PAOL's reports summed up in Graphic 1, the number of online activities in MOODLE courses is extremely reduced or nonexistent. Although in a very low number, the most commonly used activity is the MOODLE assignment to receive and grade students' classwork. We are not considering the forum activity, once it mainly corresponds to the news forum that is standard to all courses and is rarely used by teachers.



Graphic 1 The use of MOODLE activities and resources in the last three years

The most preeminent results concern to the number of online files, directories and texts that are made available to students. In fact, between 2006 and 2009 the number of online contents has doubled to approximately 5500 files, clearly indicating the usage that teachers have been giving MOODLE: an educational model supported by technology that is based on content storage and distribution.

We believe that this tendency for development of content-centred environments results not only from the absent and/or slow adjustment of new pedagogical strategies to technology, but also from the VLE's architecture itself. This is also a reflection of the international efforts that have been occurring in the past 9 years and that lead to the creation and development of the Sharable Content Object Reference Model (SCORM), envisaging content interoperability and reuse. Overall, the technology mediated education of the last years is consistent with a global attempt of adjustment of educational processes, institutions and people to new tools and paradigms. There is also an attempt to reproduce the traditional classroom methods, in order to grant teachers and students some level of comfort when using technology. Despite everything, we believe that this was a very important and absolutely necessary stage.

However, it is necessary to expand educational methodologies by designing learning activities that promote student involvement and allow them to develop/apply their knowledge/skills [11]. In fact, it is possible to identify two downfalls of content-centered environments throughout the literature that refers to the use of Learning Objects (LO): on the one hand they are pedagogically neutral or poor contents in order to maintain their potential for reuse [12, 13], on the other hand they don't accommodate collaborative learning/work opportunities. Actually they keep the individualized legacy of the 70'sinstruction endorsed by many authors [14, 15].

This is the "sad truth about e-learning" [10 - 7] in the majority of educational institutions, since the ambition to optimize technology-based education trough digital reusable contents has lead to the content distribution habits and to rhetorical pedagogies.

3 SD4L - Supporting Design for Learning Project's methodology

In the context described above we believe that it is necessary to instigate a new teaching and learning culture [16], where technology: acts as a facilitator of fundamental changes

germinating and diversifying new processes and contexts [17]; promotes collaborative and personalized learning opportunities; generates higher levels of student performance and motivation [18]. It is important to incorporate Instructional Design practices as a means for pedagogical planning, taking into account students' previous knowledge, the teaching and learning objectives and the most appropriate set of activities to pursue those objectives. This planning process is generally defined by the Joint Information Systems Committee (JISC) [19] as the "process of designing, planning and orchestrating learning activities" where the student is the central element and the contents are mere information resources integrated into that planning. As a result the teacher will be increasing student active and potentially collaborative engagement. As Salmon [20] states, the success of online learning relies on the balanced arrangement of the old but still relevant teaching-learning concepts and the implementation of innovations that take full advantage of technology's potential.

We also believe that this new learning culture must incorporate collaborative efforts in order to facilitate the necessary shift and to motivate new practices and postures, habits. Therefore, one of our major guidelines is focused on encouraging share and reuse habits amongst teachers. Supporting the idea of reusability as fundamental concept to e-learning sustainability [2], it is essential to document pedagogical planning and strategies in order to perfect them by its repeated usage [11]. We believe that the existence of documented strategies facilitates their comprehension, their reuse and instigates the development of active learning scenarios by giving teachers concrete examples. This will also allow the economy of time and effort inherent to its construction, because generally the teacher intellectually builds and adjusts teaching processes and implements them without having documented them and as a result there are very few collections of documented strategies that teachers can use to satisfy their educational needs [21]. We also believe that learning scenarios can be reused amongst different courses (inter-subject reuse) by being adopted or adapted, refilled with new contents and services and thereby generating variations from pre-existent strategies.

In order to test our methodology we have assembled what we considered to be the essential technological infrastructure, using three components: a new learning environment – the Learning Activity Management System (LAMS) – that was integrated with the pre-existent MOODLE platform and a small repository. We also designed an exercise composed of two fundamental cycles (Fig. 1) and we invited a pilot group of three teachers that were willing to design, implement, share and reuse pedagogical strategies.

According to this exercise, in a first phase (inner cycle), after receiving initial training, the three teachers had to build their own learning scenarios using LAMS and run them in MOODLE with their students. After that, the teacher had to fill in a description grid about the implemented strategy and store it together with the LAMS exported pack in the repository.

In a second phase (outer cycle), each of the teachers had to choose a scenario built by one of their peers from the repository to be adopted or adapted to their own context and run it in MOODLE again. Once that is accomplished, the teacher had to fill in a description grid about the adapted/adopted strategy and store it together with the LAMS exported pack in the repository.

During and after these phases, interviews, documents, inquiries and system logs were used to assess and measure the proportion of changes between the first and the second

scenario, the capacity of a scenario to be used in different areas (inter-subject reuse) and students' and teachers' response to the methodology. The purpose was mainly to analyze student engagement and satisfaction, the efficiency of the learning environment to fulfil the learning objectives and amount of return in terms of time and effort that the rapid change of activity sequences is able to grant teachers [22].

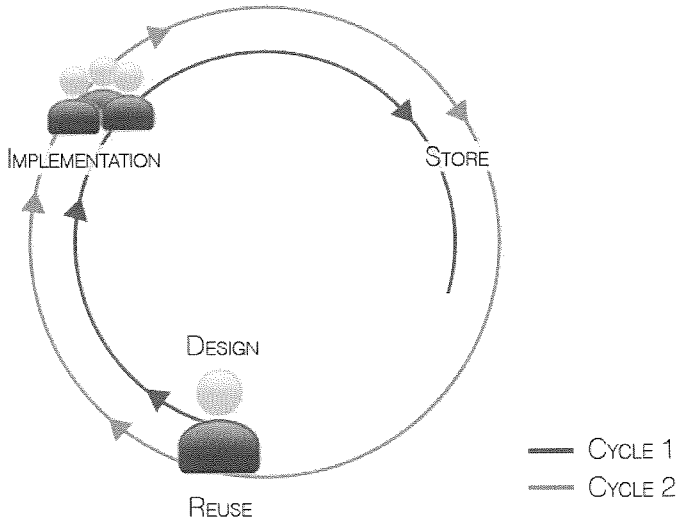


Fig. 1 Activity cycle accomplished

We investigated with more detail the processes and events related to teachers, since they had more potential to report on reuse benefits. Therefore, here we mainly used a qualitative approach, because it allowed us to understand particularities that could not be stated trough enquiries and that required careful analysis and observation [23]. Where students were concerned, we applied the quantitative approach through inquiries, in order to allow us to refer to the impacts of active engagement in learning situations.

4 Technological Infrastructure

The technological infrastructure we used had three components. We integrated LAMS and MOODLE into a new built-in learning environment that allowed us to take advantage of the well established MOODLE platform, with which teachers and students were well familiarized. Simultaneously, we built the Supporting Design for Learning portal (SD4L) where we published a set of support resources and LAMS tutorials for the participating teachers. This portal was also designed to embed the small learning scenarios repository.

The use of MOODLE and LAMS as a built-in learning environment allowed teachers to access LAMS authoring environment trough MOODLE and to add to their course pages the sequences of activities created in LAMS. In the same way, students only had to access the corresponding MOODLE course page in order to complete the sequence of tasks that the teacher had made available. However, adding an authoring and learning environment to MOODLE was not the only accomplishment of bringing these two

systems together. Teachers also had the opportunity to monitor students' progress in real time, being able to open or close learning paths and to move students along the different tasks. Thus, LAMS integration with MOODLE allows teachers the benefit from the orchestrating of activities in different types of learning flows, which is not provided by MOODLE alone.

4.1 What is LAMS?

LAMS in an open source authoring tool and learning environment inspired by the IMS LD specification, which can be integrated into most of the wide spread LMS. This system was developed by the Macquarie E-Learning Centre Of Excellence (MELCOE) at Macquarie University, and has become the world's leading design software [24].

According to Britain [8], the evaluation of Learning Design software may be considered in two perspectives: the level of conformance with the IMS LD specification (conformance level) or its capability to design the learning contexts/scenarios that have been motivating the construction of that same specification (educational potential).

When we consider LAMS advantage we cannot refer to high levels of conformance, but there are significant benefits for developing learning structures. The tool has a great pedagogical planning potential and offers an accessible interface that allows for a quick global comprehension and edition of learning sequences, as it possible to see in Fig. 2 [25, 26].

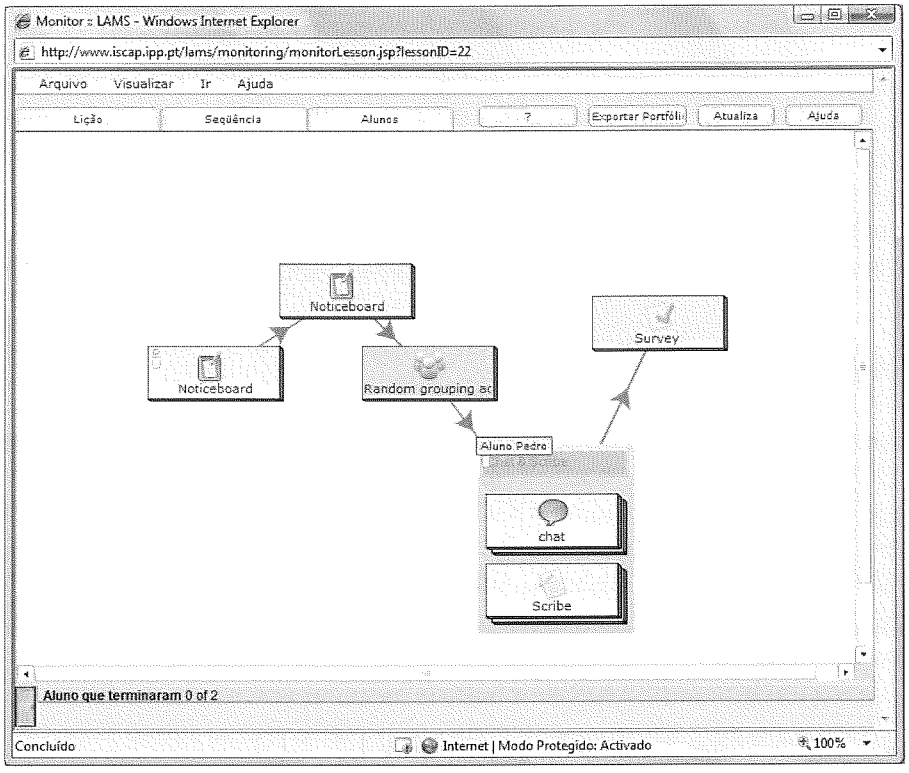


Fig. 2 LAMS monitoring environment

LAMS construction philosophy also meets one of the biggest digital learning trends announced by IMS GLC in late 2008: "The future of digital learning revolves more around context than content. (...)Multi-media and online activities are the learning tools of tomorrow because you can tell so much more of a story with it than you can with the simple written word. Reading about science can be tedious and boring, but to actually watch and experience it can be amazing." [27]. Indeed, active learning grants higher levels of student motivation and assessment [28].

LAMS allows the creation and orchestration of activities in linear, conditional and branched learning flows, offering teachers a growing set of instruments: sequence management tools, activities and combined split-screen activities [29].

LAMS is composed of three main environments: the authoring environment – where activity sequences are constructed – the run-time environment – from which students have access to activities – and the monitoring environment – from which teacher can control the learning flow.

5 Pedagogical strategies reuse processes

During the reuse processes no restrictions were imposed to teachers concerning the number and nature of the modifications that could be made to the original learning strategies. Teachers were given total freedom to change them partially or entirely, to change the order of tasks and to replace, delete or add new ones. The main purpose was to bring this process as close to daily reality as possible, by offering opportunities to accommodate someone else's strategy in a new learning context.

From the three initial strategies two of them were reused by the three teachers during the second cycle explained above in the project's methodology. This happened because some strategies showed more potential for reuse than others. Fig. 3 shows the dynamics generated during this phase.

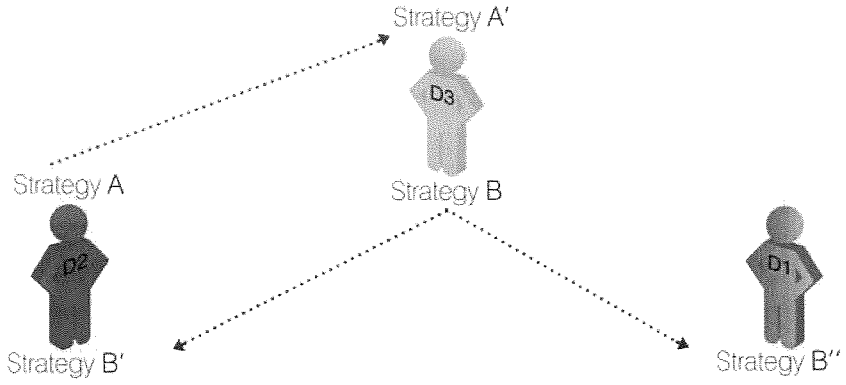


Fig. 3 Reuse processes carried out by the participating teachers

As it is possible to verify, the strategy developed be teacher D3 was the one with more potential for reuse, once it was chosen by the other two teachers. In his turn, teacher D3 chose teacher's D2 initial strategy. The accommodation of pear strategies allowed us to

identify three types of reuse, in what the structure of the strategy is concerned and which are: integral reuse, shifting the nature of tasks and partial reuse.

In the first case, the teacher reuses the entire structure of activities that the scenario contains. The main changes are, therefore, only adjusting, substituting or adding new contents or instructions. This means that, for instance, if one or several activities contain questions it is possible to reuse their syntax to ask about a different subject, so that it is not necessary to rewrite a whole new set of questions from scratch. In terms of learning instructions, they can also be almost entirely reused. It might be necessary to do one or another adjustment or to translate them into another language, but again they don't need to be thought from scratch. In terms of course contents, if the reuse processes happens between teachers lecturing the same subject then the contents can be fully reused to.

The process of shifting the nature of tasks is somehow similar to the integral reuse. In fact, the sequence of each task's objective remains the same and, therefore, there are no structural modifications. However, for some reason, the teacher feels more comfortable or believes that it is more appropriate to use a different type of activity to accomplish the same objective in a certain learning path. For instance, the teacher replaces a forum with a chat tool because he is interested in a more synchronized or immediate learning context.

Partial reuse happens when the teacher excludes one or more tasks from the original set of tasks that the learning scenario contains. In this case, the teacher can reuse only an initial or a final set of tasks or even delete some tasks in between the sequence.

These were the three types of reuse that we were able to identity so far and that have proven to be efficient. However, we are able to put forward some other types of reuse, such as: replacing previous tasks with new ones that have new learning objectives; adding new tasks to a previous set; etc. In fact, there is a wide range of possibilities when reusability is concerned and it may be possible to combine different types of reuse processes. For instance, it is possible to reuse the first three tasks of a set of six tasks and change the nature of the second task.

In our investigation, the reuse processes focused more on maintaining, shifting or subtracting, leading us to believe that these are the processes that allow teachers to take more advantage of reusing pear's strategies. Naturally, the processes of adding something to previous pedagogical structures will require more time and effort from teachers, so it might be less frequent.

Our research also allowed us to recognize that, in general, in the selection of a certain pedagogical strategy teachers generally consider the amount of proximity between the previous learning objectives and their own. This leads us to believe that teachers search for a means to accomplish a certain end or, in other words, to accomplish a set o learning objectives. This objective-oriented planning/reuse has proven to be an efficient criterion for the selection of pedagogical strategies and, therefore, for the reuse process as well, once it grants teachers a certain amount of comfort and confidence on the planning process. Sometimes teachers want to accomplish a certain goal, but they find it hard to determine what could be the possible mean or means to achieve it. Thus, the objective-oriented reuse helps teachers relating a great diversity of educational means to educational purposes.

5.1 Return On Investment

The SD4L project main goal was to accomplish a reduction on the time and effort that teachers dedicate to the design of pedagogical strategies, once these are the two factors that determine their availability and motivation to develop active learning situations.

In order to determine the time and effort variation between the design phase and the reuse phase, we interviewed teachers after both these moments.

In the design phase teachers indicated that they required a great amount of time and effort to develop their learning scenarios, although in some cases more than in others. The variation of time and effort amongst teachers is determined by their individual capability to manage educational technologies and their pedagogical planning habits. Therefore, the teachers with less technological and pedagogical experience had more difficulties during the design phase. This happened, for instance, with teacher D1 who had never used online activities with his students.

In general, teachers indicate that they spend one day up to three days thinking, gathering material and constructing the learning scenario. In all the studied cases the most complicated task was to mentally develop an efficient strategy that would allow the teacher and the students to achieve a set of desired learning goals. Indeed, teachers need a lot of creativity to develop enriching and challenging teaching and learning contexts and this takes time. It is necessary to carefully think about the student needs, the learning goals, to prepare reinforcement mechanisms, to predict behaviours and/or student questions or difficulties, etc. The teacher must be able to foresee the whole teaching and learning process in order to develop an efficient plan that covers all the needs and all the goals.

From here forward, the time and effort that teachers dedicate to pedagogical planning can be aggravated by the lack of the technological skills that are necessary to build that learning experience.

During the design phase teachers felt the same constraints that they have been feeling about planning and building active learning strategies: lack of time, lack of motivation, lack of technical skills and lack of pedagogical skills, ideas or concrete examples to build upon. However, we managed to put some of these constraints aside when we introduced the reuse process.

In what time and effort are concerned, we accomplished a reduction that varies from 40% up to 80% and this variation is partially related to the amount of changes that teachers have to perform to previous pedagogical strategies. In our study this variation was also influenced by the teachers' previous experience during the design phase. In fact, the amount of return of time and effort that reusability can guarantee is determined by the teacher planning and sharing habits. If the teacher has never spent time or taken effort to plan any kind of learning experience other than transferring content to students, then we can only refer to a total gain instead of certain amount of return. For those who usually invest their time and effort on these activities and also on sharing their work, it is possible to refer to different variations on the amount of return on the investment (ROI) that was made.

Our investigation allowed us to identify several factors that contribute to the reduction of time and effort, when building upon peer's pedagogical strategies. Where the reduction of time is concerned the major factor relies on the opportunity to reuse concrete examples developed by colleagues. The reuse process offers the chance to

perceive all the phases of a certain teaching-learning process that concerns to a certain educational goal or set of goals. This dismisses the need of spending a great amount of time thinking about what to do in order to accomplish a something. As we have stated before, one of teachers' biggest difficulties is to come up with a good teaching-learning strategy, because it requires a great deal of creativity and time. Therefore, by being able to use concrete examples, teachers are given suggestions about educational possibilities without having to spend time developing them. As a result, teachers also have the opportunity to diversify their pedagogical strategies and to give back their colleagues even more creative suggestions that they have conceived.

Particularly in the cases that we studied are concerned, the use of LAMS has also contributed to a reduction of time once it allows a very modular construction and reuse of pedagogical strategies. In fact, one thing is being able to share ideas or conceptions with colleagues, another thing is being able to share ready to implement technical-pedagogical structures. In the studied cases, the introduction of a learning design-oriented technology has allowed teachers to rapidly disintegrate and modify the previous learning paths and the contents of every task in order to run them again with their own students. LAMS has allowed teachers to materialize their pedagogical strategies into to learning scenarios where students could be active participants.

Thus, summarising, the two major factors supporting time reduction are the availability of concrete examples of pedagogical strategies and the existence of a learning design-oriented and very modular technology that supports reusability.

Although we believe that this time reduction is inherent to an effort reduction, there are other factors impacting this second variable. The availability of concrete examples of pedagogical strategies also allows for a more fluid planning process, encouraging teachers' motivation and willingness to construct active learning situations. In this context motivation has a decisive role on teachers' posture towards educational processes and goals once a motivated teacher is more willing to produce creative strategies and to commit to innovative solutions. Therefore, motivation will allow to decreasing the sense of hard work and effort implicit to pedagogical planning.

The amount of time and effort reduction that we were able to measure was pointed out by teachers as important enablers of positive changes in teachers' posture towards a more efficient use of educational technologies. These were also recognized by teachers as determinant variables that impact the sustainability of educational practices.

6 Conclusions

The design of learning experiences in the context of higher education is a complex task, where, for example, a great diversity of student backgrounds and competencies need to be taken into account. In fact, Instructional Design is a field in which the majority of teachers don't have formal competencies. From our daily contact with teachers, we could also perceive that the lack of the technological competencies necessary to manage VLEs has, in some cases, led to a discredit in the pedagogical added value of technology-enhanced learning. Therefore, there is an emergent need to develop new mechanisms with potential to enrich online learning environments and thereby education itself, by supporting teachers and providing them with adequate training, tools and resources. This is why the SD4L project relies on the development of collaborative

efforts amongst teachers, in a way that their time and effort investment may have the highest possible return, as they are members of a community that works together in the development and reuse of pedagogical strategies and methodologies.

Our research so far has also allowed us to bring forward a series as findings concerning a range of broader reuse impacts, concerning, amongst other, the enlargement of the levels of collaboration amongst teachers from different subject areas, the augment of the diversity of the implemented pedagogical strategies, the development of teachers' pedagogical skills, the enhancement of active learning opportunities and the refinement of pedagogical strategies through several cycles of reuse, etc.

However there is still a lot of work to be done. The proven benefits from the inter-subject reuse of pedagogical strategies must be widely disseminated in order to stimulate the teachers' still scarce sharing habits and their sense of return on investment.

The evolution of the SD4L project must also enclose, for instance, the development of more robust technical structures, particularly where the repository of pedagogical strategies is concerned, in order to offer optimized store and search mechanisms. However, despite the technical infrastructure of this initial phase of the SD4L project, we believe that we have achieved our initial goals by offering teachers' the opportunity to search for educational solutions in other areas of knowledge and to simplify the optimization of pedagogical habits.

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