Reflective Blended Methods for Teaching and Learning Operating Systems

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Abstract

Traditional university world with both faculty and students enjoying the intellectual challenge of knowledge mastering is not a reality anymore. Nowadays students juggle their university studies together with parallel studies of other subject, paid employment or other activities. In order to keep them close to the knowledge world, educators have to devise new attractive ways for reflective learning. Blended learning seems to be a natural evolution for our instruction agenda. It represents an opportunity to integrate the best traditional instruction with e-learning. We present here our current solution, constructivist and collaborative, for a reflective blended teaching and learning environment around Operating Systems subject, that is a combination of an open engagement for lectures with working action project-based groups for laboratories, and an integrated e-learning hypermedia application.

1. Introduction

Traditional university world with both faculty and students enjoying the intellectual challenge of knowledge mastering is not a reality anymore. The pressure of the quickly changing reality has strongly affected this model. Nowadays students juggle their university studies together with parallel studies of other subject, paid employment or other activities [4, 11]. In order to keep them close to the knowledge world, the only known way to a sound personal evolution, educators have to devise new attractive ways for reflective teaching and learning (TL). Reflection can be seen both as a process by which an experience (thought, feeling, action) is brought into consideration (in- and following-action) and as a way to create meaning and conceptualization from that experience and to look back at it from another perspective (critical reflection), independently or in a social context.

Blended learning seems to be a natural evolution for our instructional agenda. It represents an opportunity to integrate the innovative pedagogical and technological advances with vibrant interaction and collaboration offered by the best traditional instruction. Blended learning needs enthusiasm, energy and commitment to make a difference towards reflection in an instructional environment.

E-learning has had an interesting impact on the learning environment. Although it has a huge potential for revolutionizing teaching and learning, it has rapidly attached to the concept of blended learning, which mix online learning with traditional methods for instruction [7, 13].

At the core of the e-learning context is a collaborative constructive transaction. E-learning is exciting from this perspective, because it enhances and enriches both the content and the context. The challenge is to design and create a context around it, with appropriate level of social presence, which provide for congruency with the instructional goals and for enhancement of learning outcomes [4].

Teaching Operating Systems, with the complex world of data structures and algorithms inside it, is not a straightforward process, as students do not usually have a natural perception of a computer essentially extended with the operating system, as an ontological accessible reality. Few years before when we started to lecture this subject for the students from two specializations in our university (Automatics, Mathematics-Informatics) we have realized that the traditional way of teaching and learning will just do not work. As hybrid (blended) models, including both online and face-to-face teaching and learning were becoming a de facto solution [4, 6, 7, 12, 13] we have thought to start developing such a teaching and learning experience.

We present here our current solution, constructivist and collaborative, for a reflective blended TL environment around Operating Systems subject, that is a combination of an open engagement for lectures with working action and project-based groups for laboratories (small 2-3 student groups), and an integrated e-learning hypermedia application.

The paper is organized as follows: Section 2 is a brief motivation for the need for reflection in TL process, Section 3 presents the open engagement model for lecture that we have been using, Section 4 introduces the reflective laboratory work that we

have developed, Section 5 describes the modality in which we have been doing assessment of learning and of the TL process, and, finally, the last section presents some results, conclusions and future work.

2. Need for reflection

The dominant issue in education today is not access to more information. In fact, making sense of the amount of material they are exposed to is a serious challenge for students. It is impossible to meaningfully assimilate all the relevant information in even narrowest of subject areas.

Because of this informational explosion and the amazing advances in ICT, new approaches are required and become possible. In order to have our students managing this overwhelming mass of information the only long-term solution seems to be the construction of an educational environment in which students will not only learn, but they will learn to learn and to reflect in their learning process into a social context [3, 4, 7, 11].

Upon reflection, it should be no surprise that most research into using technology for educational purposes has shown no significant differences in learning outcomes between traditional and technically advanced media [4, 7, 11]. This is true because we do essentially the same thing as always with respect to teaching and learning, except that the medium of communication has changed.

An educational experience has a dual purpose. The first one is to construct meaning (reconstruction of experience) from a personal perspective. The second is to refine and confirm this understanding collaboratively within a community of learners. These aims are interleaving each other within teaching and learning situations resulting in an educational process which is a unified transaction.

Educators must create cognitive and social conditions that will allow and encourage students to approach learning in a meaningful way. Of course this demands content expertise, but it is what the teacher does pedagogically that determines the degree to which students assume responsibility for their learning. Having the learner accepting this responsibility is a crucial step in realizing successful educational outcomes – both in term of specific functional knowledge structures and in terms of developing the higher-order cognitive abilities that are necessary for continuous learning [3, 4, 7, 11].

Reflection of a learner's practice may take place within actions and following actions. The reflection-in-action can be a conversation with oneself during action and/or with others engaged in it through, but not necessarily via dialogue. It is possible to communicate also by non-verbal means. The opportunity and ability to reflect after an action is critical to the potentiality of future actions and events. The reflection-on-action which take place after the action is important with other(s) in dialogue because the actor may not be able to see herself/himself but limitedly.

Under reflection perspective, the desired outcome of education becomes the construction of coherent functional knowledge structures adaptable to further lifelong learning.

3. Open-engagement model for lectures

The key requirements for reflective practice are dialogue, intention, process, modeling, and personal stance. Underlying the capacity for educators to engage in reflection with learners is the explicit recognition of the interaction as a relationship with learners. As a consequence, knowledge will come through mutual communication. Prior conditions for reflection require the educator to be aware of process, intentionality about it and the fact that s/he is modeling the process, as well as the appropriate form of dialogue. Personal stance is an important part of the process by which we all learn. How we place ourselves, within any instructional context, whether formal or informal, is fundamental [3, 10].

For acquiring reflective instruction educators and learners must engage and work together so that they jointly construct meaning and knowledge from the course material. The educator becomes a facilitator of learning and the focus is on students' learning and how they may come to understand, appropriate, modify and transcend meanings with the content.

Traditional transmissional lectures are a good way to deliver content to a large number of learners cheaply, but they do not provide for reflective learning [2, 7, 11]. If lecturing is to be justified educationally, it must be done in terms of the one major advantage it has over all other methods of teaching: the unique experience of live, face-to-face contact with a large number of learners.

Being "live" provides a great opportunity for engagement and dialogue. Being "large" gives to the dialogue the potential for a tremendous sharing. These should not be underestimated or devalued. They create the premises for a broad mutual intellectual experience of "being where the action is". A possible way to benefit from this view implies that traditional lectures need to be re-envisaged as a large-scale dialogue in which both lecturer and learners are being truly engaged [7].

The two models of lecturing can be summarized as in Table 1 [7]. The first model focuses on the content of the lecture almost exclusively, the lecturer being viewed as an instrument for transmitting information, while the second one focuses on the lecturer as a person committed to engaging with learners in a dialogue concerning particular material.

We have started by introducing an engaging lecture that has had its focus on the process by which the lecturer engaged learners in a reflective dialogue for communicating the knowledge. The main characteristics of this kind of lecture have been openness and friendliness to learners.

	Transmission	Engagement
Structure	information monologue linear transmit	understanding dialogue non-linear appropriate
Method	lecturer agenda transferring info surface lecturing lecture as truth get content "out"	learner agenda engaging minds deep lecturing lecture as narration get content "in"
Lecturer	head and body sober persona cognitive focus objective/subjective	head, body, self engaged persona interpersonal focus inter-subjective

Table 1. Two models of lecture

The content has been constructed together with the learners in a snowball fashion. We have been trying to help students make connections, challenge preconceptions, relate the content with concrete problems/real cases, and to critically analyze hypotheses and interpretations. Instead of being worried about passing to the learners huge amounts of information within the given syllabus, we have been concerned with helping the students to appropriate the content and to co-relate it with their previous similar practices and to their general real-world experience. Periodical few minutes periods out of the lecture flow have been used for reflection by means of:

- providing time for students to "digest" the content and to construct their own personal knowledge from it. This have been achieved usually by focusing around a specific question at a time (like 'what real-world situation is synonym with this from the operating systems');
- sharing ideas and difficult issues with their neighbors, which have resulted in inquiries for the lecturer and opportunities to re-iterate from another point of view those issues;
- working on some specific task (e.g. quick design sketch of an algorithm for best-fit partitioning, after they have been presented with the first-fit partitioning one).

Student interaction with the content takes usually place in an iterative process that includes the following steps: statement of objectives, exploration, experimentation, simulation and knowledge testing [6, 7]. We have been trying to shift the manner of approaching this, from the objectivist paradigm of teaching and learning (introduction, concept, example, practice, reflection) to the constructivist one (problem, background, concept, analysis, solution, reflection) by facilitating, rather then teaching the content.

What the facilitator does that is different from lecturing, supervising or leading seminar discussions? In fact the activities that s/he performs are mainly the same. What is different is her/his attitude towards them and to the learners. We can all remember at least one bored or haughty educator who have replied in an un-facilitating manner to one of our questions (if we have dared to ask it, of course), while we have been students ourselves. A facilitator is supposed to be the total opposite of that. The personal presence and conduct, the working and interaction (e-)framework s/he provide, her/his non-verbal and verbal communications, the way s/he listens and responds empathically as well as accurately to the students are some of the means to be used to improve educator's facilitative abilities, while performing usual TL transactions.

4. Reflective laboratory work

Research on teaching and learning generally shows that in order to have students understanding and applying what they learn, the learning experience should be collaborative, facilitate applying the new knowledge to various real-life scenarios, and deal with content applicable to students' life and work situation. This can be accomplished with well-designed and constructed online material and collaboration tools for integrated learning experiences [6, 7, 11].

At the beginning, laboratory sessions were supported by a written material, which has been supposed to follow the student natural approach for learning a new operating system, Unix in this case. The material was designed to be easy to understand (with many examples intuitively explained), self-contained, supportive, and fun. Instructor role was only to assist the learners, to stimulate them to work together on common small-size projects, but also to compete with other teams, and to animate a reflective dialogue around the working issues and about their work as individuals and as teams.

S/he also have had to provide for openness and empathy between team members, for awareness and acceptance of diversity, for equal expression opportunities tailored to personal needs, both observed and explicitly expressed, and finally for constructive criticism.

During semester, the small teams have been kept in many cases the same, giving the possibility for the groups to act as action learning sets. According to our personal experience too, working together with your fellow students at common or similar projects can provide a not replaceable support [3, 4, 7, 11]. If the learner feels comfortably enough with her/his peers to share and reflect upon their existing knowledge, their relationship to particular situations that may be familiar or novel, and to context in which they are happening, the conditions for reflective dialogue and critically reflective learning are created. Thus a cycle of action, learning and reflection is built into the process, for every group member.

We have not neglected the fact that there are some students who prefer to work alone without being involved in group activities. Our strategy has

been to offer the best learning experience for every student. However, generally, our students have preferred to work in groups rather than alone, in spite of the fact that there were enough computers to have each student working by oneself. We think that has been happening because the action group learning is both supporting and challenging and we have been witnessing this ourselves and during the last years, as educators.

We can say that provided there are many well-articulated opportunities for interaction both between learners and with the instructor, it becomes possible to create vibrant interaction among the participants, at least from time to time.

Lately, with the amazing advancement of ICT, the next natural step was the use of computer-based learning in order to increase the opportunities for reflective learning. We have developed an integrated e-learning package that uses Macromedia and Java technologies. It incorporates operating systems' knowledge with our ideas about reflective learning means and with the well-known advantages offered by well-done e-learning applications to students (anytime/anywhere/anyone access, pace/path/depth of learning suitable to learner needs, abilities and schedule, possibility of repeated e-experimentation and self-testing etc.). We present a sample screen of this application in Figure 1. It offers to students various possibilities from accessing the content of course and laboratory sessions, to various tests, interactive exercises, simulations, useful links, exam requirements or contact information.

A great advantage of using e-mediated content has been that it provides for having students' practicing the concepts and techniques repeatedly, with instant visual or text-based computer generated feedback. The value of well-designed e-learning is also in its capacity to support reflective interaction, independent of the time pressure and of the distance constraints, and to facilitate communication and thinking and thereby to construct meaning and knowledge [4, 11]. Online content can go beyond what can be presented in a textbook or in the classroom: interactive exercises with computer-generated responses, graphical representations of various scenarios that immediately respond to student manipulation, threaded discussions where the conversations can be continued beyond class time etc. [6, 11, 13]

5. Evaluation

Assessing students is probably one of the most emotionally sensitive part of our instruction, being in the same time intellectually demanding. It can be also emotionally and socially disturbing and divisive for learners. Students need to feel that they have been given the best opportunity to express their ability in the discipline, but also to convey something of themselves on what the subject means to them [3, 7]. Without this, evaluation is associated with a system of control and this can be disturbing for students and for the learning process.

In academic settings, assessment is often associated with grades, which offer very limited possibility for what students have learned. This form of assessment if often referred to as "norm-referenced" evaluation. The result here is not so much about what students achieve, but more about their position in relation to other students [4, 7]. Assessment that evaluate against sets of predetermined criteria (criterion-referenced) helps students to understand how their performance has progressed and educators to check the achievements of the instructional process.

The two main types of evaluation are formative and summative. Formative evaluation is an ongoing process that takes place throughout the whole course delivery, in order to fill gaps and to clarify and adjust the content and the delivery mechanisms. This kind of evaluation is crucial for exclusive e-learning transactions, since the non-verbal feedback easily picked up in a face-to-face setting is not available.

Summative evaluation, in form of a grade, takes place after the course. In order to assure the best possible assessment, multiple sources of information should be used [6, 7]: self-evaluations, quizzes, quality of projects, interaction and collaboration within lectures and practical work sessions, and, finally exam results.

Whether criterion or norm-based methods are used, the assessment of reflection, either formative or summative, will include a judgment about the outcome, namely the quality of learning which emerges. For instance, for our course, evidence of critically reflective learning will require students to have not only understood and appropriated the key aspects of Operating Systems, but also will reveal that they have begun to question the paradigmatic basis of the discipline itself, as well as some record of their reflective journey to that point. Thus, the grade indicates both the acquiring of knowledge and the reflection involved in the process. What cannot be recorded in such an assignment is the relationship which evolves between course material, learners, and educators.

If critically reflective learning has occurred then the first person to know about it is the learner. When one's learning is communicated to others in writing or verbally, this is known as "self-report". When others, possibly fellow students or tutor, report on their observations or experience of the learner, this is known as "other-report". If one "other" is the tutor, then the well-known reliability of triangulation is achieved: self, other-student and other-tutor [3, 4].

To provide evidence of the learning relationship and the learning journey, "other-reports" are essential, therefore evidence from fellow-students is needed. This is not peer-assessment, because students do not evaluate each other, but they are a

source of information about the learning process revealed in reflective dialogue [3, 4].

To assess both the evidence of critically reflective learning, in terms of outcome within the subject discipline, as well as the process of the student's reflection can be used the following strategy [3]:

- a way to identify critically reflective learning in terms of outcome within the subject discipline;
- a way to ascertain that reflective dialogue has taken place (at least personally, but ideally with others);
- a way to establish that there is evidence of the learner participation in that dialogue;
- a way to identify evidence of a developmental process over time;
- a way to make certain that there is evidence that a process review has taken place, enabling the student to take away some understanding of the learning process.

For the first step of the strategy we have been using a combination of small size projects during laboratory work, timed quizzes, and special tasks to be solved during exam (involving critical thinking – as developing of algorithms for particular problems, other than the ones presented in the course, analyzing various strategies and choosing the best one for a specific situation etc.). In order to make students feel confident about their approach to the assessment we have been giving them the possibility to consult every material at their choice. We have eliminated this way the need for memorization as a goal in itself and have been trying to lead them to deeper forms of understanding and learning.

In approaching the other four steps, until now, we have been trying not to burden more our students with recording in writing their learning logs (which contain the description of their learning experience) or portfolios (that are compilations of learning intentions, accounts of learning activities, learning outcomes, and records of reflective dialogue). For the time being, all these are still at an informal level. Even so, we have got valuable feedback from our students and colleagues, and we have been improving our general strategy on-the-fly. Taking some time off from the course flow, regularly, to reflect together on the instruction process in which we have been equally engaged and responsible have proved to be very useful and valuable.

7. Results, conclusions and future work

The myth that higher education nowadays comprises a community of learners dedicated to achieving high-level learning outcomes is no more a reality. The assertion that communities of inquiry in higher education encourage students to approach learning in a reflective, critical manner and process knowledge in a deep and meaningful way is rhetorical. Therefore educators have to devise appealing and efficient ways to instruct and educate their students. Integration of meaningful educational approaches with innovative technological enablers can be suitable for solving this problem. Blended learning solutions tailored to the specific communities of students can provide for this goal.

Students will not learn if educators fail to convince them that learning is important and related with their day-to-day life, to guide them according with their need and learning styles through the knowledge content, to relate the topic to be taught to their experiences and to motivate them by constructing the learning experiences around their natural motivations.

A blended learning experience demands the insight and agility of a reflective and knowledgeable teacher who can translate principles and guidelines to the contingencies and exigencies of their unique contexts [4, 7, 13]. The new e-learning paradigm move some of the power over content and delivery from the educator (who becomes a facilitator) to the learner and makes it possible to develop a sustainable and close-knit community of peer learners without ongoing face-to-face interaction [6]. Well-designed e-learning within blended learning solutions represents a unique opportunity to change the way we teach and learn [6, 11]. It makes possible to collaborate across time and space, giving educators a good chance to explore sound pedagogical principles (e.g. constructivism).

Results that we have obtained by now are encouraging and we are trying to enhance our courseware with other reflective opportunities as prior-notice exams, larger size/time projects to be tackled by 6-8 student groups during the whole semester and involvement of learners in marking process against a set of well-defined criteria.

We recognize that the move from teaching subject content or demonstrating an experiment to facilitating reflective dialogue with students is not straightforward. But we cannot simply recommend critically reflective and transformational learning to our students without aiming to be such learners ourselves, despite the fact that teaching is seen as a Cinderella in higher education nowadays, when research is taking all the credit.

The transition from transmitting content to attending to the learners' needs is unfamiliar and can be difficult for both educators and learners. We have started with us engaging with each other in reflective dialogue by recourse to the course content and to our practice: teaching, scholarship, course leadership, instructional design and implementation, and research. This experience acted as a precursor to working as facilitators of reflective dialogue to student learners.

In the facilitator's role is embodied knowledge, self and world, the three domains of expression, whereas, in traditional teaching, the practice emphasizes primarily one domain, that of knowledge. The three domains of knowledge, self (emotion) and world (inter-action) have been identified as necessary for the survival of higher level learning and the emancipatory endeavor of a university education [2, 3].

By focusing on the idea of reflective dialogue between educator, as facilitator and learners, we have been aiming to a basic form of an emerging relationship that can evolve to a framework for transformational learning. Critically transformative learning involves not only deconstructing meanings and the taken-for-granted attitudes, ways of seeing things, and myths, but also reconstructing by re-conceptualizing and rebuilding. This continuous process becomes the subject of further transformative learning. It is a restless, ever-changing process of evolution for the learner where the basis is laid in the experience of higher education for life [3].

As future work, we intend to develop a more structured and flexible e-communication framework including both synchronous (chat) and asynchronous possibilities (threaded discussions, collaborative e-exercises). A common misconception is that interaction in e-instruction is of lower quality that the one from regular classroom. Research shows that, due to various flexible (time/place independent) modes of interaction, this can be more rewarding, provided that it is properly handled [1, 4, 11, 13]. These enhancements depend on availability of resources being well known the fact that developing complex immersive e-learning applications is very costly both as time and of other resources.

We are also working to a more formal implementation of the assessment strategy for the reflective instruction cycle. Finally, we would like to analyze properly the outcomes of this blended learning solution and to prepare a methodology for reflective learning in science, having aid from specialists in education field. Of course, we do not forget that "nothing has brought pedagogical theory into greater disrepute than the belief that it is identified with handing out to teachers recipes and models to be followed in teaching" [5]. Effective teaching requires more than a repertoire of techniques. To make real a coherent interplay between the collaborative (social) and constructivist (cognitive) nature of proper teaching and learning it takes more than a methodology. It takes personal engagement from all the actors involved in instructional transaction.

Increasingly, higher education is returning to its roots by focusing on the values and practices associated with collaborative approaches to learning, and we include here the educator also. Along with this is the realization that constructing personal meaning is enabled by opportunities to test one's understanding in a social context and to apply new ideas and solutions in relevant contexts.

Blended learning represents an important opportunity for building a community of lifelong learners that keep them motivated and close to the knowledge world. Education is but an illusion if it simply disseminates information without actively supporting a critical assessment and the opportunity to provide meaningful knowledge functional structures that will serve for future learning challenges. As Dewey has said: "the result of the educative process is capacity for further education".

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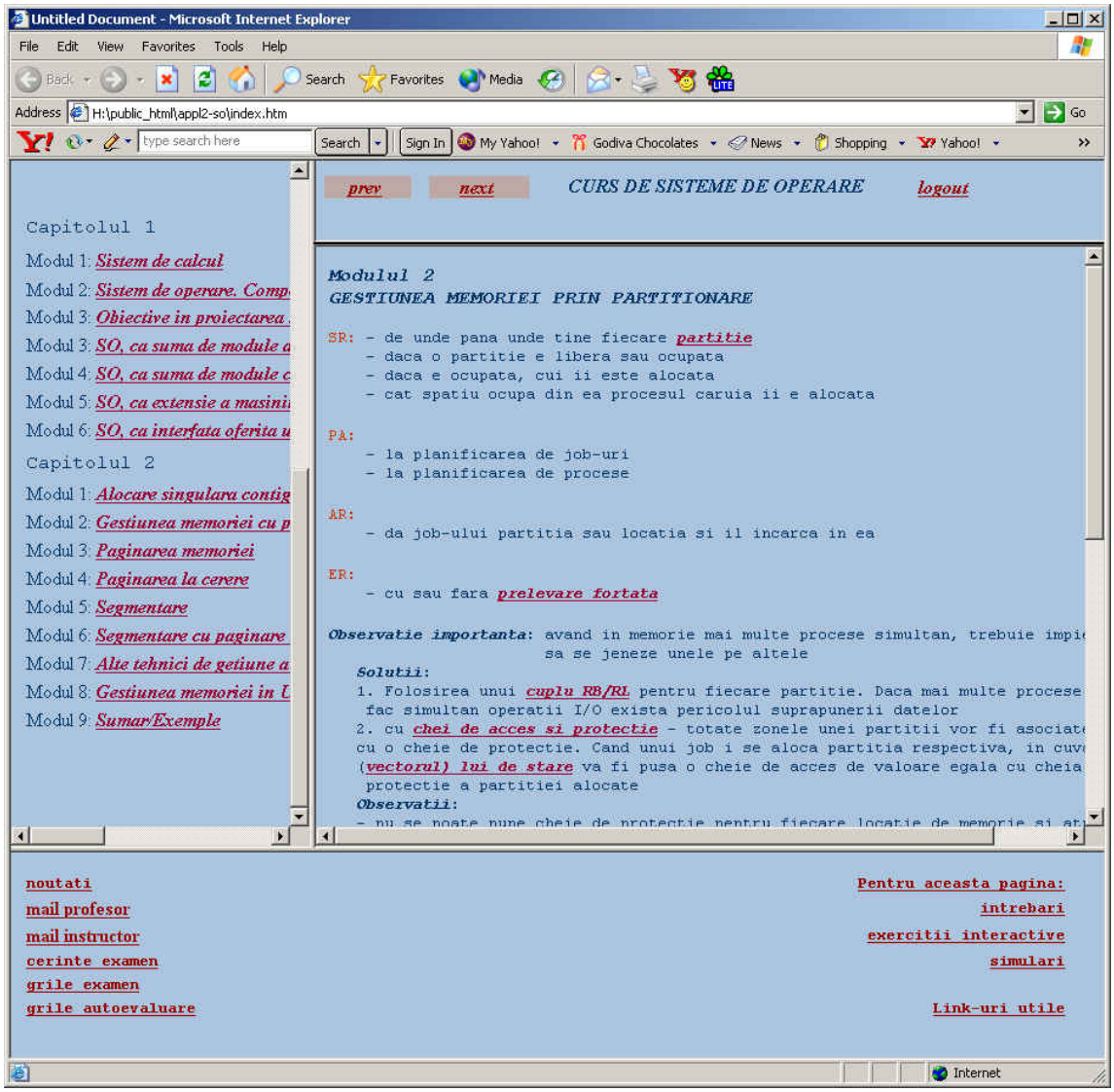

Figure 1. Sample screen from the Operating Systems e-learning application