Chapter 14
Stimulating Learning via Tutoring and Collaborative Simulator Games

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1 Introduction

The main goal of teaching in higher education is to foster autonomous knowledge construction and skill development. Considering the present knowledge society and the demands of the socioeconomic environment, the learning processes cannot be limited by traditional teaching frameworks. Although teaching in the traditional system, in either a formal or informal way, is necessary and, in some knowledge areas, irreplaceable, the use of other teaching and learning approaches is crucial. This chapter presents two initiatives developed at the University of Aveiro addressed to enhance students learning: (1) a tutoring system, to support undergraduate students' learning in science, technology, engineering, and mathematics (STEM) subjects and tools, and (2) a simulator game to support telecommunication engineering students' learning and entrepreneurship.

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1.1 Background

The profound mutations that took place over the past decades in terms of enabling technologies, emerging business models, and organizational structures challenge continuously the labor market and demand, more than ever, a competent and flexible workforce. The labor market looks for graduates equipped with the competences required by the new professional environment. However, successful recruitment is hard to achieve, as recent graduates are considered not sufficiently prepared with knowledge and skills to face the uncertainties of the market. They frequently lack some fundamental soft skills such as problem-solving, teamwork, communication and the ability to learn continuously and autonomously.

Higher education institutions have responsibilities in preparing their graduates to work competently and deal with unpredictable challenges. Despite this, higher education curricula are still characterized by a strong emphasis on theoretical science and technology disciplines instead of assuming more practical approaches. STEM disciplines are essential requirements to prepare students with the analytical skills that an engineer must have. However, this preparation on propaedeutic and specific subject matters of each engineering field frequently is not accompanied by an effort to prepare students about equally important nontechnical aspects of their profession. These shortcomings are particularly felt in relation to soft skills such as planning, organization, and interpersonal communication. All this is further aggravated when they have to work within a team. In addition, it is also frequent that during their courses, students develop very little awareness about the outside world, namely about the markets where soon they will be looking for a job or struggling to keep it.

For many engineering graduates, when starting a career, the unsuitability of companies' demands and educational programs results in serious behavioral mismatches and very limited knowledge about the activity sectors and businesses where they become involved. These circumstances can represent an important handicap in their careers, and the resulting limitations can significantly impair their capability to play the roles that enterprises expect from them. In addition, these weaknesses also do not favor the emergence of an entrepreneurial spirit (Smith et al. 2006) among young engineers, restricting their ability to contribute to economic and social growth. Ultimately, all this can jeopardize their employability.

This situation creates new responsibilities on the part of higher education institutions. Curricula should match industry needs, not only in terms of contents but also in terms of pedagogical approach. Learning processes should be focused on the learner, captivating his/her interest and promoting active and autonomous competence development. Problem-based learning and tutoring are student-centered methodologies that support these challenges.

2 Promoting Learning by Tutoring Support Tools

There are many different approaches that can be used to complement the traditional "classroom system." Nonetheless, one of the most known and considered approaches in many schools and colleges is the tutoring systems where a teacher, an advanced student, or a peer colleague who knows more about certain subjects, helps or supports tutored students' learning.

The tutoring advice or assistance, in either a more formal or an informal way, is based on the tutorial method that was first developed and implemented by Cambridge University and Oxford University. These tutorial methods consisted in organizing a small and limited group of students, where they were stimulated to debate and argue in the subject they are focusing their studies on, and to analyze it under the orientation of the tutor. The tutor not only is usually a teacher or trainer but also can be an experienced or an advanced student (Moore 1968; Palfreyman et al. 2008).

Although all the methodologies and proceedings behind a tutorial support and assistance program are important to implement and guarantee the success of the tutoring, the use of well-spread and accessible resources is essential. Among these resources, the new technologies such as computers, smartphones, websites, and services are some of the most significant and useful ones to be considered in a modern tutoring process. In fact, these technologies have been replacing the first resources used before the information systems and technologies (IST) were universally available to students, teachers, and any common person (Fedorov 2007).

Even though the Internet has a great potential to improve and create new tutorial services and resources that are helpful to the learning process, the human relationship between students and teachers should not be faltered due to the use of Internet and its easy access regardless of the learning subject, place, and time. If a tutorial assistance program starts to rely mostly on the technology and its resources, even that for some students this can be very attractive, for other students this situation can bring some difficulties and new ways of isolation can start since everyone is not limited to the formality of classroom (Ozad and Kutoglu 2010; Vagos et al. 2010).

With the intention of creating a tutorial program that could be used to promoting the learning process, and also addressing the problems identified before, a project called LUA-iNova was deployed at the University of Aveiro. This project was responsible for analyzing and evaluating the advantages and disadvantages of information and computing system and technologies in a tutorial program that could be based on both defined types of tutors (Duarte et al. 2011b):

- Physical tutor—where a person (teacher, advanced student, etc.) is responsible for conducting and supervising the tutorial session and sequence, though other resources can be used (television, radio, Internet, etc.)
- Media tutor—where a medium (television, radio, Internet, etc.) is used to guide and organize the tutorial session and sequence, though a person (teacher, advanced student, counselor, etc.) can also be available to support or assist occasionally when extra help is needed.

2.1 Tutorial Supporting Tools

As mentioned earlier, the LUA-iNova project has the main goal of helping students with learning problems by giving them a tutorial program that can support their learning processes. In order to reach its goal, this project needs, not only, to consider that a majority of learning gaps of students are usually related with personal and social problems than with the learning process itself, but also know and understand how technology changes education and how it can be used to promote the learning process (Bates and Poole 2003; Kent and McNergney 1999).

To address the former this problem, the experience obtained by the initiative and program still running LUA was possible to denote that advanced students with more ability and experience could deal much better with personal and social problems, and also with academic life, in comparison with the more inexperienced students. In fact, while some students can organize their life in order to study and accomplish their academic tasks and, if necessary, help their colleagues, others simply cannot deal with their problems and also are not capable of asking for help or tutorial orientation and support (Duarte et al. 2011a; Direito et al. 2010).

Although universities were the first to introduce tutorial support to help their students, some institutions realize the great potential and opportunity of helping students from all the stages of education. Among the several examples, there are paid services such as Exeter Tutorial College (www.tutorialcollege.com), Tutorial Services, (www.tutorialservices.org), Great Mind Tutoring (www.greatmindsnw.com), and also free services such as Wikiversity (en.wikiversity.org), W3Schools (www.w3schools.com), BBC Learning (www.bbc.co.uk/learning), which typically offer more diversity and quantity of information, and resources than other universities' tutorials, be it in dedicated matters and subjects or in more generic and embracing subjects.

After some study and research, the architecture of the LUA-iNova system was defined as illustrated in Fig. 14.1.

2.2 Requirements and Specifications of a Tutorial Tool

The IST currently available (computers, websites and services, software, etc.) make the process of producing, cataloging, sharing, and accessing tutorials simple and easy for anyone. In spite of the amount of available resources, the quality of the tutorials will only be guaranteed if special care is taken with the following aspects:

- Developing tools (software, websites, etc.) that are easy to use by both, students and tutors
- Designing a website that allows effective and organized cataloging of the tutorial resources for future use
- Ensuring quick and simple search features in the website
- Providing answers to the students' needs, problems, and difficulties

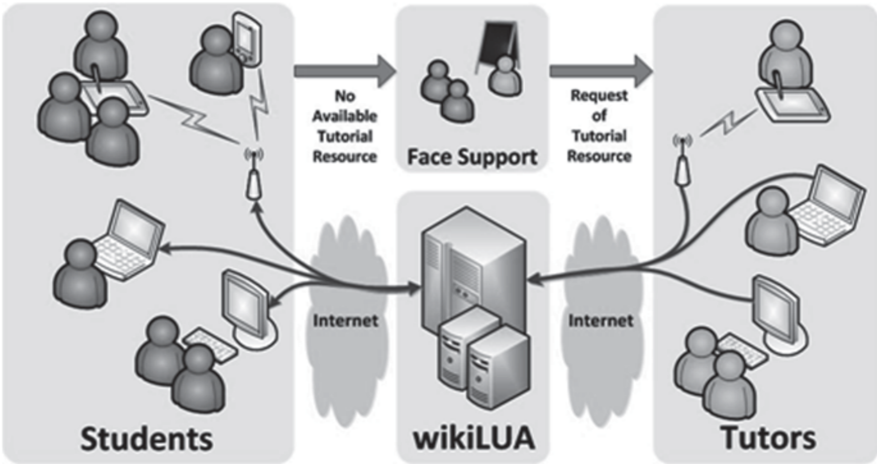

Fig. 14.1 LUA-iNova tutorial support program structure

Although the previous topics are essential, it is also very important to highlight that a good quality and presentation of the tutorial resources should be considered to ensure a comprehensive and efficient approach to the subjects addressed by the tutorials (Wales 2008).

To achieve the above requirements it was decided to use tutorials of the screen recording type, which are easier for the tutors to create, edit, and produce. Video tutorials are also much easier to reuse and update. On the other hand, students are more open and focused when using visual resources (Furse 2009; Stannard 2009).

The tutorials should also follow some specifications not only to guarantee their quality as useful resources but also to accomplish the requirements defined to the website tool, in order to be complemented by each other. The specifications are the following (Furse 2009):

- Each tutorial should be prepared for a specific and particular subject.
- The tutorial's length should not exceed more than 5 min, so that it could be easier for students to learn a particular subject.
- It is important to avoid repetition of subjects in order to clearly present the subject, permitting students to access a particular section of the tutorial when they need it and want it.
- A good preparation and organization of the topics to be included in the tutorial are essential to create a structured and comprehensive tutorial.
- Ensure an easy, simple, and universal access to the tutorial resources.

Regarding the previous specifications, a website called wikiLUA was designed that follows the architecture presented in Fig. 14.2.

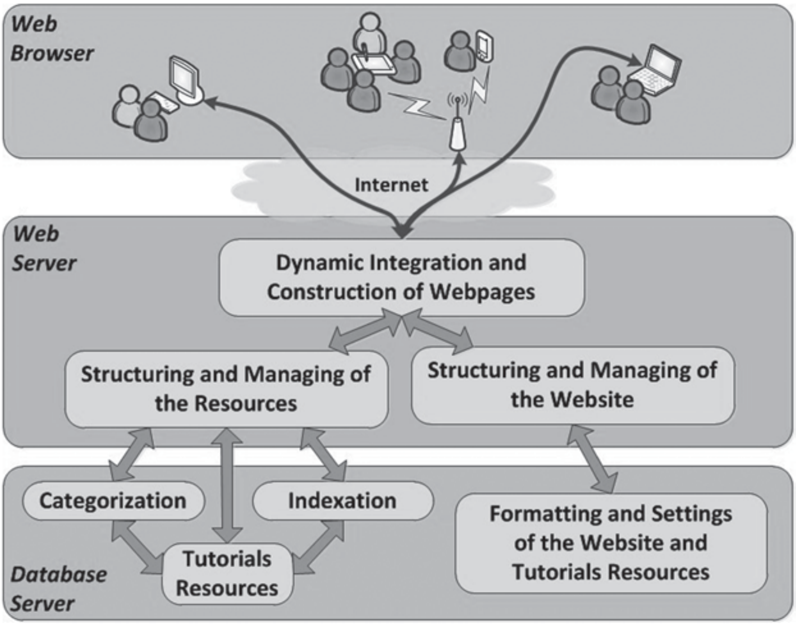

Fig. 14.2 Internal architecture of the wikiLUA website

This architecture is organized in three levels/layers:

- Database server—where all the tutorial resources are stored, as well as all the formatting and setting applied to both the resources and the website
- Web server—where the tutorial resources and the website are structured, organized, and formatted according to the settings and configuration stored in the database, in order to be dynamically constructed/designed webpages to be access by users
- Web browser—browser of the user where the contents are displayed according to the structure and formatting stored in the database

2.3 wikiLUA

The wikiLUA website is a Web system that supports and makes available the tools that can be used to create, edit, produce, and share tutorial resources. This website was implemented following the requirements and specifications defined and detailed in the previous section.

Since the creation and sharing of a large amount of tutorial resources can become a possibility in these systems, their access can become slower if the system architecture behind the website does not have some characteristics. The wikiLUA website is a new starting project that does not, yet, need any special features because its needs, at the present moment, are at the level of a prototype. However, wikiLUA aims to be a site that will gather and manage hundreds, or even thousands, of tutorial resources. For that reason, it was important to follow the architecture presented in Fig. 14.2, and also to consider the specific details.

wikiLUA was structured and organized to consider a database layer in such a way that all the settings and optimizations made at the software level in the upper layers (interface and Web) are stored in the database as formatting settings. Using the same idea, all tutorials were stored according to a category and index, which provide an indexing service that allows fast and correct access to the tutorials resource. These features allow the database to flexibly and autonomously index and categorize tutorials, increasing the size and complexity of database.

The interface layer is running on a Web server where the data stored in the database will be processed in order to format the site and tutorial resources to be used by the students.

The Web layer is the browser used by students where all the formatting and tutorials are rendered to be seen. This layer depends and relies on the commercial browsers.

Since the conceptualization, development, and implementation of such a website would require a lot of time and consume many human and economic resources, it was considered to use the content management system MediaWiki, which is used on the site Wikipedia, one of the biggest sites in the world, that holds features and specifications that fulfill the requirements previously defined.

After all the necessary configurations, optimizations, and customizations to implement the wikiLUA website, the result was a site with a "Wikipedia" style, as it can be seen in Figs. 14.3 and 14.4, but holding features that suit the requirements specified.

2.4 Test and Validation

Before the usage of the wikiLUA website tutoring tool by the students, a minimum set of tutorials were designed and uploaded. Therefore, the first users of wikiLUA were tutors, who had to create, edit, and upload tutorial resources, and only then, it was available to the students.

Consequently, the tests and validations of the tool were divided into the following actors/agents:

- The tutors, who have the main responsibility for the tutorial resources on wikiLUA, were asked to focus their attention and appreciation on the details related to the accessibility, usability, response, easiness, feasibility, quality, accuracy, security, and privacy from the tutor's point of view concerning the creation and production of tutorials and the upload of these resources on the website.
- The students, who intend to access and use the tutorial resources of wikiLUA, were asked to focus their attention and appreciation on the topics of the tutor,

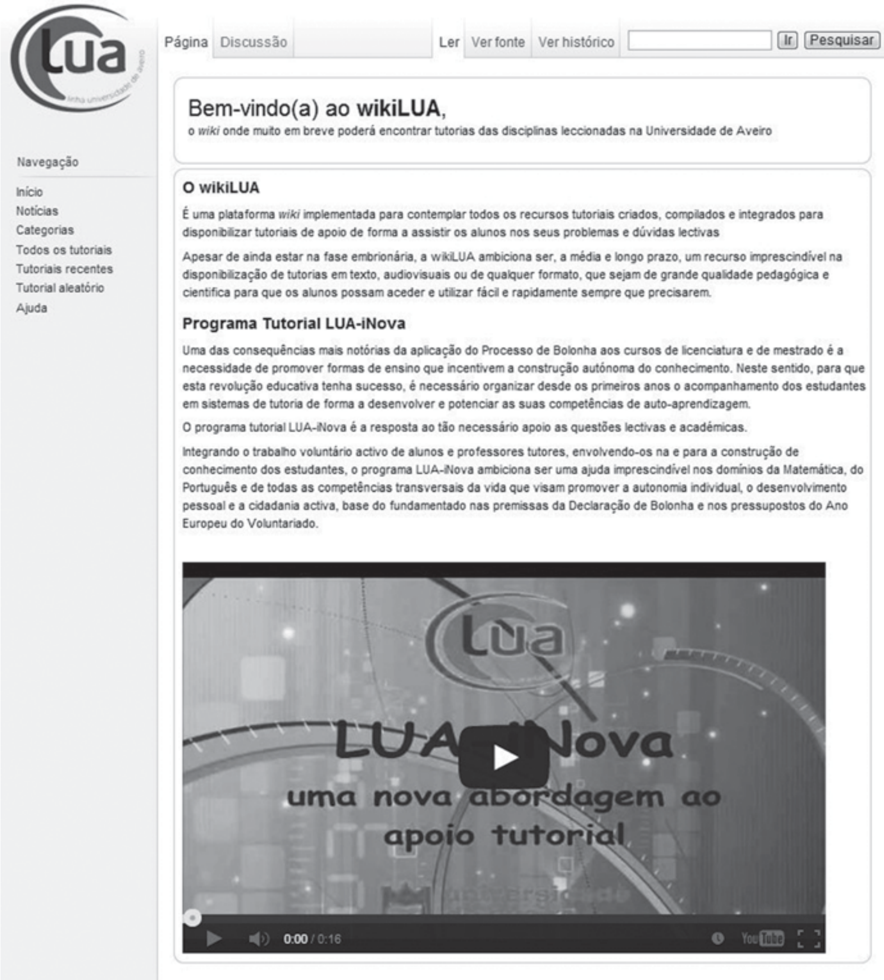

Fig. 14.3 Homepage of the wikiLUA website

but from the point of view of a user who wants to learn and understand specific academic subjects when using the website's tutorial resources.
- The guests, who are users doing a casual Web search for help or examples on particular subjects, were asked to give their first impression of user experience of the wikiLUA website.

Based on the details mentioned before, and to guarantee that the tests were not influenced by the request of specific tutorials, which could influence the attention on the tutorial rather than on the tool, the first tests of the website wikiLUA, as a

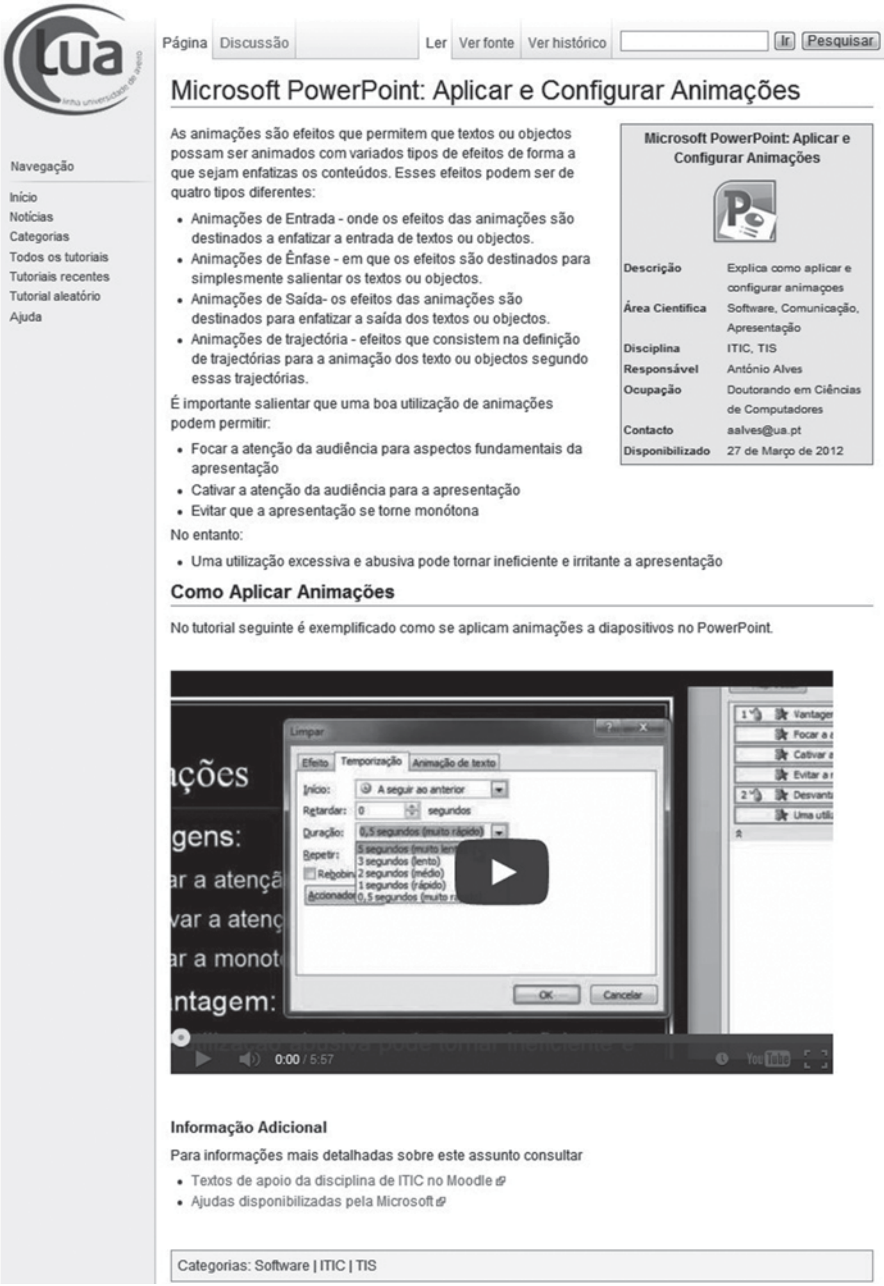

Fig. 14.4 A tutorial resource in the wikiLUA website

tutoring tool, were done by the tutors, then by the students, and finally by the guests. This sequence was defined to avoid influences and effects between types of users.

The first groups of users involved in the tests were teachers and students of three courses of the University of Aveiro where productivity software (Microsoft Office®, LivreOffice®, etc.) was incorporated as a mean of supporting written and oral communication and also basic calculation activities. These courses were selected for being initial areas where students already have some experience but need to strengthen their skills, and tutors do not need to spend too much time for preparation, since they already have done some work and also have adequate experience to start creating, editing, producing, and deploying tutorial resources.

To start the use of the wikiLUA website, tutors were trained in an extensive preparation program where they also received a quick guide and a comprehensive manual. Tutorial resources and online helpdesks where tutors could ask for help were also made available.

The test and validation of wikiLUA, regarding the tutors' perspective, were done through the process of making tutorial resources and preparing the wikiLUA website. There were regular meetings to share and discuss new ideas, different points of view, new approaches, bugs, and possible improvements. In addition, in the end of all these processes, tutors were asked to answer a simple survey from where it was possible to extract information useful to improve the website.

As soon as wikiLUA was ready to be available (something close to a prerelease version), students were invited to access, search, and use the tool. An online helpdesk to help students in any question, difficulty, or problem they find during their experience was offered. After some time of usage, students were invited to answer a survey about their experiences on the wikiLUA website. Something similar was done with the guest users. The main difference was that guest users were randomly selected and asked to access, search, and use the website for a couple of minutes, and after that they only needed to answer some simple questions about the wikiLUA website.

2.5 Assessment of the Experience's Impact on Student's Learning

In the first weeks of the wikiLUA website being available, the first analyses were done, which showed that the first results were not so "encouraging" as expected. The majority of the students liked the idea of wikiLUA, but they were expecting much more from the website.

They were initially expecting a website with thousands of tutorials, where it could be possible to find answers for all of their questions. In fact, they quickly started to compare wikiLUA to YouTube®, and making comparisons of different aspects and characteristics of both services.

The other initial reaction was that they thought that the website was to be a substitution of the traditional tutorial support and not a tool to help and complement

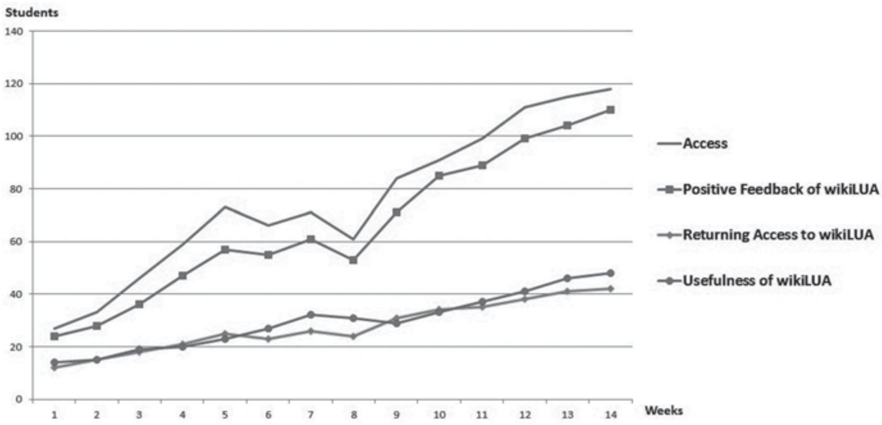

Fig. 14.5 Measures of the use of the wikiLUA website as tutorial support tool

the traditional support. This situation led some students to think that they could have more learning difficulties because any tutorial in those particular subjects was not available, or, worse than that, they do not need to worry about their doubts since nothing about those subjects was available, and therefore it should not be so important.

After the first misinterpretations, the students started to understand more clearly that wikiLUA was part of a project called LUA-iNova that intended to use i IST to help and complement the traditional way of tutorial assistance and support. At that point, things started to run normally with a dynamic and very interactive use of wikiLUA by the students. This situation also was a consequence of the fact that more students were involved in the tutorial program and therefore they were helping and guiding each other.

Soon, the use of wikiLUA inside the LUA-iNova project was clarified, and it was possible to collect some interesting and useful measures. First details are shown in Fig. 14.5.

Regarding students' answers, it is possible to see that the majority of the students who accessed and used wikiLUA gave a positive feedback about wikiLUA and its usefulness. It is also possible to see that some students returned to access wikiLUA. Also, students answered that they understood more quickly and easily the subjects found in wikiLUA, and that it helped them to clarify their doubts and difficulties.

Overall, it can be concluded that, even though the process is slow, the number of students who return to use wikiLUA are increasing. Also, the students who return are being more efficient in solving their difficulties, learning gaps, and doubts about the subjects they search. Although at this point it can be concluded that wikiLUA is a successful tool, if the number of students using the tool continues to increase, this conclusion will supported.

2.6 Assessment of the Experience's Impact on University Teaching Performance

The results of this project under the university performing perspective are difficult to be quantified, since the main focus of the project is the students' problem and difficulties rather than the university performance. Another main reason for the absence of more and detailed data, that possibly could be used to extract more measures, is the fact of the LUA-iNova project still is under development and implementation. However, with the initial information obtained from the surveys conducted with students and tutors, it was possible to gather the presented data and correlate them with some measures and statistics from the university.

It was possible to see that students frequenting the initial years of their courses were, less than usual, requesting and using the orientation and explanation-offered extra classes available in all the courses delivered in the University of Aveiro.

Although these results cannot be completely related to the LUA-iNova project and the wikiLUA tutorial tool, it could be that this tool has positively influenced the performance of the extra classes and, probably, the lectures itself, which is very encouraging and states a good starting point for further developments and expansion of the tutorial program in the university.

3 Promoting Learning with Simulating Games

Over the past years, a study has been conducted encompassing approximately 250 students of engineering courses (higher education) and approximately 500 students of foundation courses (postsecondary education; Duarte and Direito 2009), in order to gain a better understanding about the matching between industry needs and curricula, and also to prepare future actions. This study addressed the following aspects:

- Student's representations with respect to the specific subjects of study of their courses
- Representations of enterprises that received either young graduates or trainees from engineering and foundation courses

Among the findings of this study, it is possible to highlight the following aspects:

- Engineering and technology students receive tools for solving problems that they have never faced before and for which they do not have an adequate appreciation.
- Because of their limited real-world experience, engineering and technology students have difficulty in understanding the practical applications of their studies.

Another frequent feeling among many engineering students is that they find that classes were boring (Anderson et al. 1996). Previous research (Duarte and Direito 2009) found that this is mainly due to the following causes:

1. Because of their limited real-world experience, students have difficulty in understanding the practical applications of their studies.
2. As a direct consequence of the traditional universities' teaching approach, students receive tools for solving problems that they have never faced before and for which they do not have an adequate appreciation.

In summary, many students do not develop meaningful knowledge and competences and this is caused by the adopted pedagogical approaches that do not promote active learning.

With role-playing approaches, students are engaged in authentic real-world problems and active learning, having the opportunity of learning by doing, receiving feedback, continually refining their understanding, and building new knowledge (Bransford et al. 2000). Simulators can enhance this experience by reproducing complex scenarios and by reducing, considerably, training costs and resources. Training simulators are being used in engineering education, supporting hands-on experience and student motivation in the learning process (Cooper and Dougherty 2001; Fournier-Viger et al. 2008; Gomboc et al. 2008)

3.1 Role-Playing: Promoting Active and Meaningful Knowledge

In order to provide answers to the problems identified in the study outlined previously, a pedagogical initiative was launched targeting the promotion of active and meaningful knowledge creation in engineering students. This initiative is currently taking place in the context of several courses in the area of electrical engineering (with majors in telecommunications and information systems) at postsecondary, BSc, and MSc levels (Bologna system). The basic concept behind it is rooted on a capstone-like project where groups of students play the role of telecommunication companies competing against each other, resorting to decisions that they have to make based on sound engineering studies: technology choices, network design and dimensioning, market simulation, and economic–financial analysis.

This initiative is intrinsically dynamic, learner centered, and more experiential than traditional ones. It represents an attempt to improve student's classroom involvement, bridging the gap between the engineering profession and the classroom, attempting to contribute towards better success rates and improved employability. It also helps the development of professional identities. The initiative followed two phases:

1. Definition of project ideas was made with the contributions of practicing engineers from several companies who are invited to present some of their real-work challenges in a series of seminars. Students engaged in weekly discussion sessions with practicing engineers and experts (industrial guest speakers) in order to exchange ideas and discuss career paths. The main objectives of these sessions were: provision of the "big picture" about core characteristics of what telecommunication engineers do, exposition to positive role models, and encourage questions and understanding.

2. Projects were designed around a situation where teams play the role of competing companies in a market place. Competition initiatives among teams playing the roles of competing companies in an open market were delivered, in order to expose students to business dynamics (Carpio et al. 2007).

This leads to an atmosphere of project-based active learning combined with an interactive entrepreneurial atmosphere in the area of telecommunications engineering. The role-playing competitions followed three steps:

1. Faced with a specific challenge (as will be outlined ahead in the chapter), each team tries to identify possible solutions and must make its evaluation, both in technical and economic terms.
2. Chosen solutions must be converted into a business case, with different teams playing the roles of competing companies in a marketplace.
3. A didactic market simulator is used to create conditions similar to those found in real markets and to convey experimental lessons transferable to the real world.

A description of this market simulator is provided subsequently.

3.2 The Didactic Market Simulator

Training simulators are designed for education purposes, providing significant hands-on experiences that motivate and facilitate learning (Kartam and Al-Reshaid 2002). Additionally, they can also offer experiences that resemble those of the real world and, thus, can give students the opportunity to apply theory in an efficient, economic, and interactive fashion.

The work described in this chapter was supported by the usage of a didactic market simulator that can be used to make students familiar with the dynamics of the telecommunication sector. It can easily be transposed to other economic sectors. Its structure, in its present state, is depicted in Fig. 14.6.

3.3 Purpose of the Didactic Market Simulator

The simulator is designed so that students will learn how telecommunication engineering decisions (e.g., network architecture, physical media, bandwidth, latency) associated with marketing, economic, and financial decisions (e.g., offered services, tariffs, competition among operators, etc.) affect the overall network performance and the ways markets react.

In a preliminary phase, Excel was used as the basic platform. This enabled some fine-tuning of the mathematical model and also proved very useful for the determination of several parameters. At a later stage, the implementation was migrated to a Web environment supported by database and appropriate query languages.

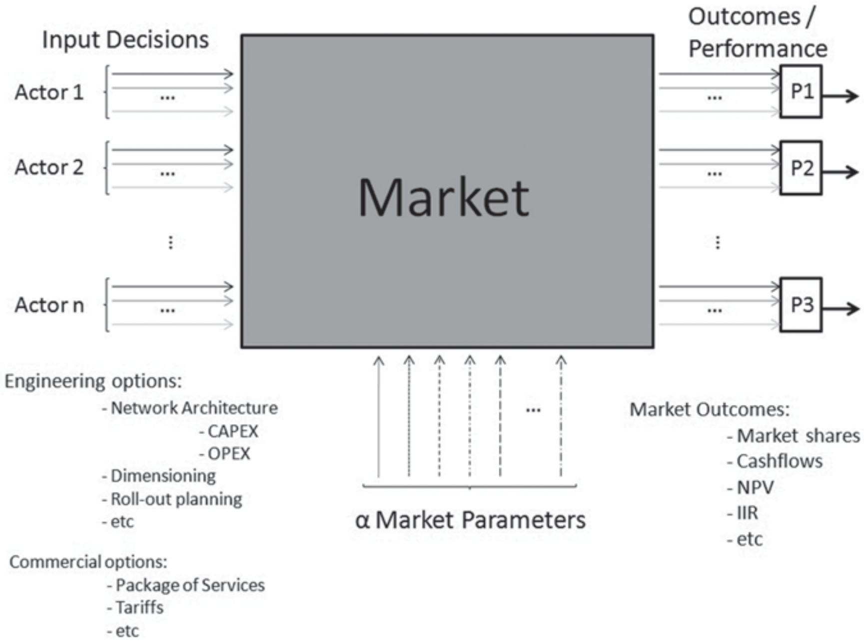

Fig. 14.6 Didactic market simulator structure

Figure 14.7 illustrates some screen shots obtained with the market simulator in a Web environment.

3.4 Test and Validation

In order to test and validate the approach described in this chapter, a series of experiments were conducted over the past 2 years. This was done in the context of a capstone project in the third year of an MSc in electronics and telecommunications engineering (total duration of 5 years: 3 years of the first cycle and 2 years of the second cycle).

The basic objective of this capstone project is to make students face the challenge of projecting an access network using up-to-date technologies (e.g., fiber-to-the-home, LTE, WiMAX, etc.) and evaluating the different architectures (point-to-point, point-to-multipoint, etc.), different engineering solutions (active, passive, etc.), and roll-out strategies (market size estimates, time plan of investments, tariffs, etc.). In this work, students are required to integrate knowledge and skills developed in other disciplines, probably over a period of several years.

To estimate (quantitatively) the impact of the approach described in this project on student learning and understanding, during 3 weeks of a semester (over the

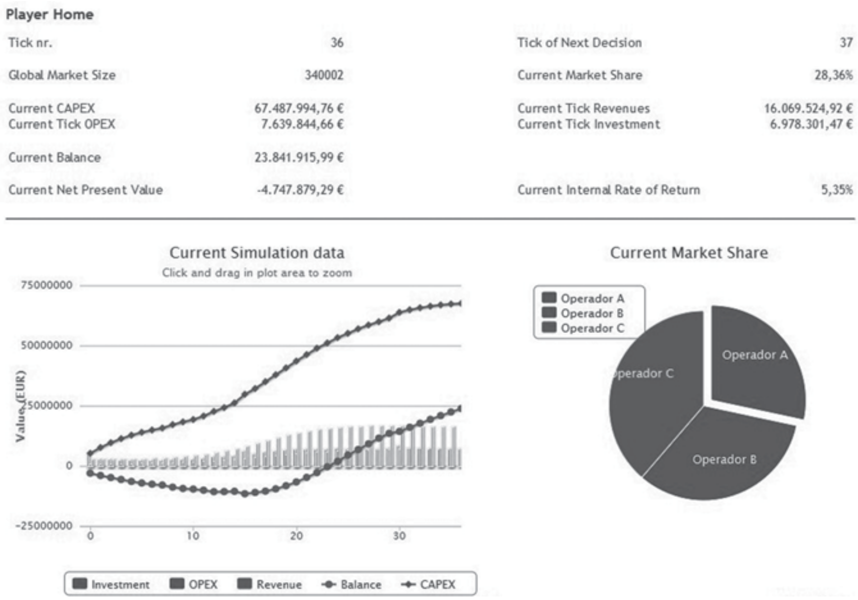

Fig. 14.7 Screen shots obtained with the market simulator (investment analysis in an access network with three operators)

last academic years), the class (45 students, average) was given an assessment test (multiple-choice questions) on access networks (a subject not specifically studied in the preceding 9 weeks, and which requires the integration of knowledge and skills developed in other disciplines, over a period of approximately 2 years before the capstone project and the market simulator was introduced).

After this test, the class had the opportunity to attend a seminar (1 h) by an invited senior telecommunications engineer responsible for the access network planning in a major telecom operator. Here, students had the opportunity to witness some of the challenges faced by a telecommunication engineer in planning, designing, and operating an access network under severe market competition conditions. At this point, the class was split into nine groups of five students for a short period (1 h) doing hands-on familiarization with the market simulator. This was followed by a period of two more working sessions (4 h over 2 weeks) where the class was organized into sets of three groups. In each set, each group played the role of a telecom operator competing with the other.

TabletPCs were made available for these sessions in order to facilitate interaction and discussion of ideas inside groups and among groups.

In the first of these two sessions, every group started with equal market share as the other groups. Following a choice of engineering options related to the specific access network under consideration (architectures, active or passive network elements, market size estimates, expected competition, time plan of investments, tariffs, etc.), the simulator produced the market share situation for every competitor,

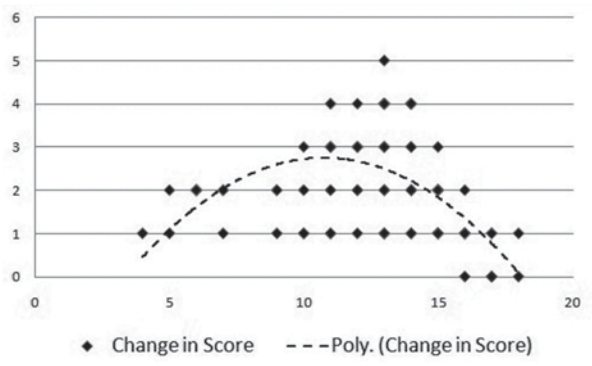

Fig. 14.8 Impact of the capstone project approach on student outcomes

corresponding to half of the study period under consideration. During the period until the following session, in the week after, every group tried to devise possible strategies to either recover from the bad position where the first run had left them or to keep the advantage that eventually they had already obtained. The second run dictated the final results of the market game.

After this experience, an assessment test on access networks as similar as possible to the original one (but not equal) was given again to all 45 students in order to measure eventual changes in student learning and comprehension.

Figure 14.8 shows the aggregate results of these tests over several academic years.

3.5 Assessment of the Experience's Impact on Student's Learning

The results obtained, in spite of referring to just two runs of the experiment over the past years (others will follow in subsequent years), were very encouraging:

- The classes, as a whole showed an average improvement of 2.06 points (out of possible 20), that is, approximately 10.3 %.
- It was interesting to notice that the improvement was particularly significant in students with average marks, where the vast majority of engineering students do stand more frequently.

The above results were complemented by a set of (informal) interviews with a sample of 10 students (out of 45), in both academic years, in order to gain some feedback about how students felt with the experiment. The outcome of these interviews was generally very positive, underlining particularly the following aspects:

- The very positive effect of having a practicing engineer sharing with students some of his/her professional experience in problems very similar to those that they were facing in the capstone project (a typical case of "situated learning"; Anderson et al. 1996)

- Having the possibility to play with the didactic market simulator proved to be extremely useful to integrate and consolidate previous learning, to help gain a better understanding of businesses dynamics, and to improve teamwork

3.6 Assessment of the Experience's Impact on Employers

Given the fact that the experiment was done with students attending their last year of the first cycle of the engineering degree (Bologna type), it was possible to track some of these students in their first employment. This was done with a group of five students who graduated in the previous years. Results are being subsequently updated with groups of students from the succeeding course editions.

As part of this exercise, several interviews were conducted with responsible personnel of the employing companies following the first 3 months of employment of the graduates.

In spite of the limited statistical value that this limited number of enquiries might have, it is very encouraging to notice that, in general, they seem to point out the following: As compared to their company colleagues, test graduates exhibit better teamwork skills, show good ability to integrate and associate knowledge from different fields, and reveal good understanding of the telecommunication business markets.

4 Conclusions

In the present education contexts, it is known that students like to have different kinds of digital technologies in the lectures and courses. On the one hand, they consider that a lecture is not updated if it is delivered without technology, even when more traditional subjects are addressed. On the other hand, if a lecture is totally based on technological artifacts, digital contents, and completely technology dependent, the students may think that the lecture is easy, trivial, and "*nothing to worry about,*" which usually leads to poor investment in studies and, ultimately, bad results and grades.

With tools like wikiLUA and the didactic market simulator, it was possible to understand that students feel more motivated with the use of digital technologies applications and resources, rather than the technologies by themselves. In fact, the results showed that students are interested in the use of information and computer technologies as tools to help them when they have learning difficulties.

Although these projects are still under development, the first results were encouraging. The main conclusions of the wikiLUA experiences are:

- When needing help in particular subjects, students usually like to do a self-search for tutorial resources or receive tutorial assistance in a more informal environment.

- Students feel more comfortable if they can access tutorial resources on the Web, since they can do it autonomously, in any place, taking any time, and whenever they want.
- Students manifested their interest in the availability of the tutorial support tool.
- The number of returning students, that is, the students who accessed the tools several times during the experience, can be considered to be a measure of the perceived usefulness of the tutorial support tool.
- Although there are no sufficient data to be conclusive, it is possible that the decreasing number of students requesting and attending orientation extra classes could be a consequence of the availability of Web tutorial resources.

Regarding the didactic market simulator, the main conclusions are:

- Some improvements were particularly noticeable, not only in classes as a whole but also with the succeeded students.
- It was very rewarding having practicing engineers sharing with students some of their professional experience in problems very similar to those that they were facing in the capstone project (a typical case of "situated learning").
- To play with a didactic market simulator in a typical telecommunication project proved to be extremely useful to integrate and consolidate previous learning, to help gaining a better understanding about businesses dynamics, and to improve teamwork skills.
- As compared to their company colleagues, test graduates exhibit better teamwork skills, show good ability to integrate and associate knowledge from different fields, and reveal good understanding of the telecommunication business markets.

The implementation of role-playing activities proved to be a fruitful pedagogical technique with the potential to transform theoretical concepts into experiential outcomes. In this way, educational role-plays engage students in close to real-world learning, providing opportunities for learning by doing, refining their understanding, and building new knowledge.

In the same way, the tutorial website proved to be a tool that students like to access and use, motivating them to be proactive agents of their learning processes.

Both methods analyzed in this chapter are useful tools for students' learning. However, each method has its own techniques, approaches, and goals.

The collected impressions of students showed that they prefer an informal learning environment and classes where they can practice subjects that were already formally taught in a formal classroom. With informal approaches to learning, students feel more relaxed and more capable to ask for help in the subjects where they feel more insecure. Our results encourage new research into stimulating learning at an individual and a group level and in different types of classes and syllabi.

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