E-LEARNING IN ROMANIAN TECHNICAL UNIVERSITY FOR MECHANICAL ENGINEERING STUDENTS

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Abstract. *Electronic learning, distance learning, collaborative work and internet based study are being used in superior educational system. At the present moment we can access data through search engines (i.e. Google) or we may consult websites, blogs for tutorials and other learning materials.*
E-learning systems can be grouped into online systems without the need for interaction between teacher and student, face-to-face systems which allow electronic access as well as teacher-student interactions or self-teaching systems based on blogs which present tutorials or training programs on a web based platform. The e-learning process is rapidly growing so in many universities are online platforms that help students with their studies. Efforts are well known in changing and improving the present educational system and its orientation towards online. This paper aims to present a systematic analysis of e-learning systems in Romania.

Keyword: *e-learning platforms, engineering education, Moodle.*

1. Introduction

Present performances of CAD, CAM, CAE, PDM and PLM software are driving towards a continuous adaptation process which takes count of the imposed requirements in terms of a performance and quality based engineering processes.

Today efforts are underway to understand the factors affecting the quality of engineering education. Many universities are working to recognize changes in engineering education and to make those changes for excellence in engineering education. Research in engineering education and skills development opportunities aimed at students who will be successful in future careers. Most students say they learn more when they are involved in developing the educational process and is very important for students to work effectively with examples of engineering courses pursued.

Students gain knowledge in engineering design, processing and manufacturing. Thus, in addition to courses CAD, CAM, PLM a certain degree of specialization is required.

2. E-learning system implementation in the Romanian universities

Because of the growing e-learning systems popularity many universities offer online learning alternatives, distance based systems or low-frequented learning systems [20], [21], [Paragina, 2011]. One major issue is represented by the transition to online education simultaneously with the enhancement of the quality of teacher-student relationships. E-learning have revolutionized teaching processes with both advantages and disadvantages. Among disadvantages there are mentions about web systems which encapsulate incomplete or false information

which may lead to wrong methods of learning or incomplete knowledge.

We cannot overlook the advantages of online learning such as easy search, a multitude of data at one click distance, the possibility to save information for later use and gaining success in a short period of learning time as well as good results.

The architecture of e-learning system is formed from user interface which represents what the student sees when accessing the e-learning system, the working environment represented by the media upon which the learning experience is based on and the database which comprises all data and learning system resources, information about users and the core of the studying process structure [Defta, 2011], [Dobre, 2010].

The interface represents the platform's interaction over the e-learning process database. The platform may grant free access (open-source) or it may be commercial based on an expensive programming software. As free systems we mention Moodle, Claronline, Atutor, OLAT, Colloquia and as commercial Blackboard, Angel, WebCT, Desire2Learn, SumTotalSystem or KnowkedgePlanet [Ivanovic, 2019].

Taking into account all the advantages of such a learning system the results may still be unsatisfactory because of the main beneficiaries which are students. It is being appreciated that the interaction of factors that participate in a learning system such as teacher-teacher, students-students and teacher-students may be the way to achieve better results.

The working process as an end user of the Moodle platform comprises lectures content analysis cycle, study material development, exercises and links required as well as a final evaluation by the teacher of results obtained at classroom ends.

It is mandatory to evaluate and grade each student activity. In order to do this, each activity performed by the student must end with an essay in a known format (Ms Word or Adobe's pdf) in a language suitable to learning [Mitan, 2017], [Moraru, 2011].

There are references which state that using an e-learning system is useful for distance learning systems. Training teachers and students in using such a system raises the quality of the educational act and ensures future collaboration in learning activities.

E-learning market in Romania is underdeveloped compared to what happens in this field in other EU states [20], [21].

As a general tendency Romania seems to follow the Russian model where e-learning has grown as a results of direct funding by the government. Plus, it seems that East Europeans are four times less willing to be trained by employers as people from Nordic countries. A study shows that in 2013 at European level there were 3000 e-learning companies. Romania held only 76 compared to Great Britain's 671, 532 in France or 303 in Poland. In France 1% from wages granted by any company must be spent for training and development or is otherwise perceived as a tax for the employer. The same source reveals the fact that e-learning market cumulative value, globally is over 4000 billion dollars from which Europe holds approximatively 25% making it the second large market after Northern America.

The growth potential of e-learning is significant in Romania considering that most companies do not own the required technology or have preferred traditional training techniques or do not invest in employee training. The most covered industries considering training by means of e-learning are financial and pharma ones. Paradoxically general budget related constraints are the main engine that drives towards transition to e-learning platforms of companies.

Reducing movement costs and training costs for each employee represents the key benefit offered by e-learning. It is seen as an attractive solution in ruff economic times by is seen as a viable and profitable solution for companies to enhance knowledge and employee abilities and skills.

In Europe costs for learning and academic education overlap almost 18 times the ones for corporate education. There are major

differences between EU regions. As the study states the European companies interest for e-learning is rapidly growing having Great Britain and Spain leading the trend.

This paper highlights the importance of electronic learning in the modern educational systems and discusses its technical aspects, the market, advantages and disadvantages, comparative analyses of this system versus the one led by trainers and the possibility for future opportunities in electronic based learning. E-learning offers the advantage of 24/7 and 365 day per year availability versus trainers based instruction.

Electronic learning is efficient in terms of costs because the course core content being fully developed is easy to adjust and improve depending on teaching and initiation activities. It represents the future of education because its interactive formula which helps bring novelty, interest and fun into the process thus replacing books with tablets or other mobile devices [Oproiu, 2015].

Even though e-learning systems are being frequently used in the past years there is criticism about the quality of the in-use systems bringing into focus another significant matter, the evaluation systems of e-learning ones.

Approaches regarding quality have different perspectives depending on the applicability domain (domain policies, quality management, and quality assurance); target groups (students, teachers, service providers, developers and e-learning system providers); used methods (process oriented, product oriented or skill oriented).

The paper analyses a series e-learning qualitative evaluation systems and in-use standards. Although the evaluation of quality of the information provided by e-learning has become important a consensus has not been yet reached with regards to evaluation methods and standards.

The criteria and used methods for the evaluation of e-learning materials has to contain specific features which are different from those used in the evaluation of traditional educational ones. Thus specific quality related criteria has been developed to have a proper answer to the need for adequate measurement methods for this type of information.

Yet the user perspective in method development must be taken into account as well as measurement and evaluation indicators of digital resource quality and e-learning services.

The teleworking with Moodle platform permits saving time and money for the trainer, even if that implies higher costs for the tele-course realization. Telework with Moodle is due, even sometimes difficult. To work at home is an advantage and the telework offers both to the trainer and for the trainees a flexible schedule and more time for family and they own person. The information transmission has a higher speed in distance learning. Moodle course platform allows: activities' monitoring, upgrade to the latest technical concepts and specialization without expense or business agreement, discussion groups for the teachers' categories and to adjust homework to the levels of the students. A lot of participants are not able to estimate the costs of implementation and it is necessary update or clarification of the knowledge because the content is too scientific, or the students design a class project for teaching without using the computer. It is possible in telework to have low interaction between students, and student motivation is necessary to prevent the loss of interest and abandonment, or lack of motivation in learning, or also the danger of lack of initiative. Sometimes, for participants with low experience, it is not enough one demo session. Also, in computer sciences laboratory, there are problems with the Internet access, in face to face activities. The Moodle course platform administrator set a small storage space for homework. For good activities, knowledge for the Moodle installation is required and sometimes you need to promote the course on the social networks. Another threat, it is the danger in which the, computer becomes a new organ of the body.

It is the clear evidence that usability evaluation of e-learning environments and systems is crucial for achieving better, easy,

and more user-friendly interfaces and communication in these systems, from both points of view: learners and teachers (Ivanovic, 2019). Next quality step, ahead in designing usability questionnaires for evaluation of e-learning environments should include additional very important aspects of general learning theories. Such new evaluation instruments should for example focus on emotional and affective states of learners. It is also unavoidable to take into account deeper

understanding of the design issues. Furthermore, significant input to e-learning design comes from assessment of learners. New forms of questions and quizzes (similar to different forms presented in ASQ system) are necessary to be included in e-learning systems in order to increase learners' motivation. Currently, the proposed usability evaluation instruments can point towards specific usability problems which can be solved with help of an e-learning system.
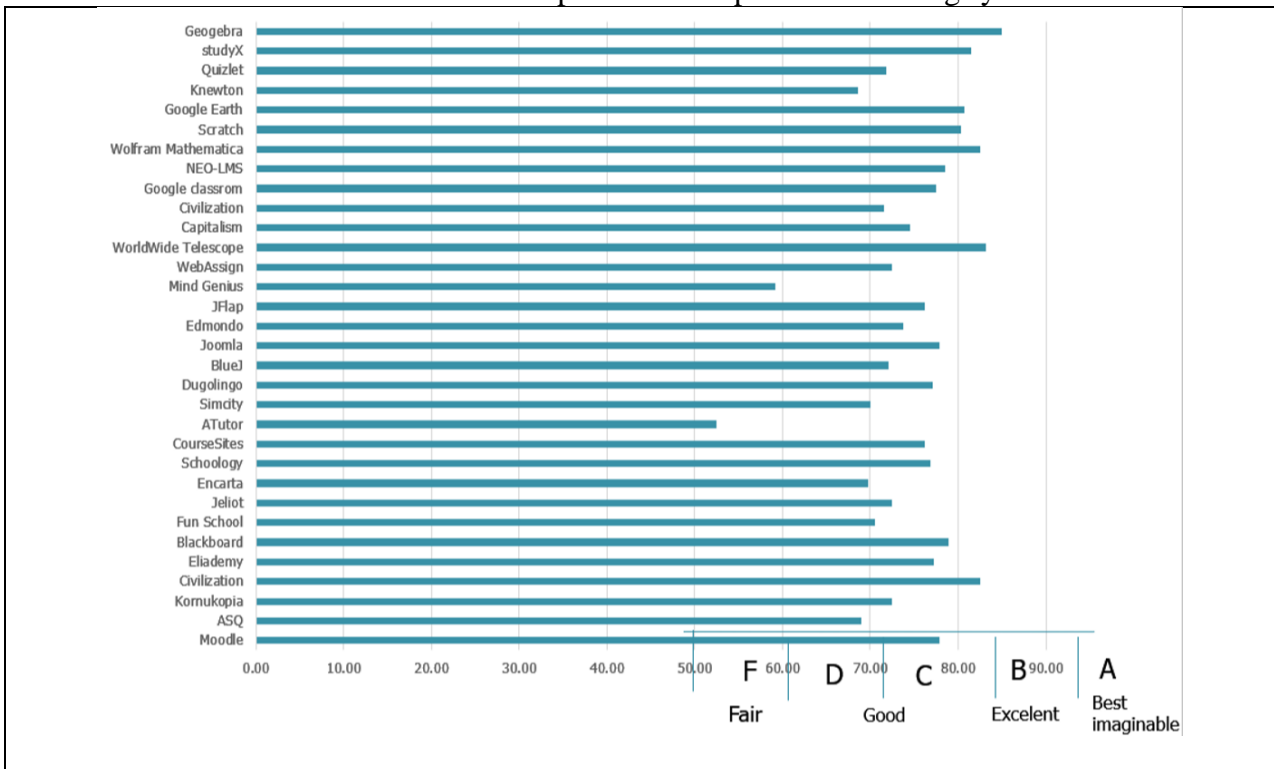

Figure. 1. *E-learning software comparison (Ivanovic, 2019)*

This paper is a part of the Serbia-Romania-Poland collaboration within multilateral agreement on "Agent systems and applications" and Romania-Poland collaboration within bilateral project "Semantic foundation of the Internet of Things".

A critical overview of Romanian e-learning systems is being developed by Dobre I. [Dobre, 2010]. Its study presents general

aspects regarding e-learning systems, the most renowned platforms, main achievements from the county and throughout the world.

Using e-learning platforms is not an attribute of schools and universities. It also applies to companies of such diverse field of work starting from governmental ones to military, insurances, pharmaceutical, manufacturing, transportation, utilities, banks and many others.
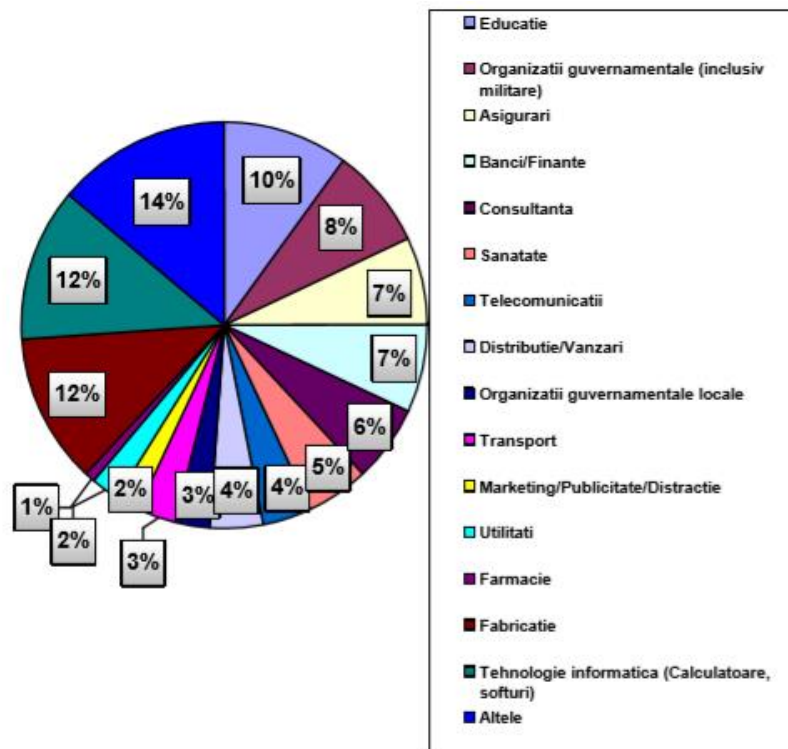
Figure 2. *E-learning applicability domains [Dobre, 2010]*

Also there are references to different database storage solution emphasising cloud systems as the most wanted ones.

In Romania and abroad there are many e-learning systems known approaches. One of them, nationally implemented is the one from the Polytechnic University of Bucharest [19] whom functions among others for skill improvement of engineer professors from pre university technical educational system and as a benchmark of the project's success its participant's results were considered as reference in the management of resources related to mechanical computer assisted design.

Targeting the development of several tools used in sheet metal processing the authors developed a collaborative system which involved teams from different universities.

The system has been presented to a CAD project development specialized company but also to different companies that are performing in the field of implementation of various manufacturing processes.

It was received with interest by some as it appeared to solve some of their current production issues but overall they all expected real time data delivered after its implementation.

The paper [Moraru, 2011] presents the team efforts of the CAD/CAM/PLM laboratory of Machine Manufacturing Technology department for collaborative development in case of several industrial projects.

The project development has been achieved due to collaboration between mechanical student's team, researchers and engineers from manufacturing based enterprises.

Because the level of competences was different for every team involved that problem meant that training sessions were necessary in order to get team members to be familiar with CAD/CAM software and PLM related technical data administration.

The teams have developed and sustained a series of working modules based mainly on the documentation they had at their disposal as well as the one found online.
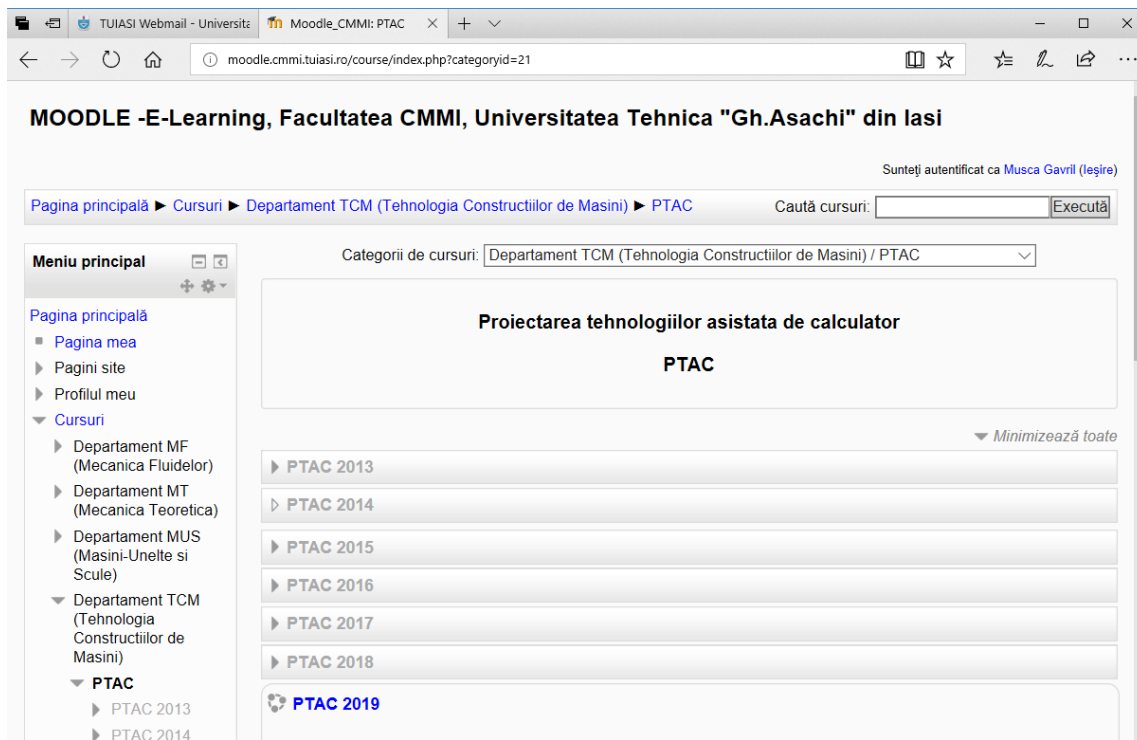
Figure 3. *E-learning system evolution at the Machine Manufacturing Technology department from Technical University of Iasi*

The decision was in favour of multiple working modules because past experiences shown that module based testing systems are more efficient because they provide convergence of training processes allowing main issues to be clearly highlighted within tests that being the very foundation of testing to begin with. The project expanded on several branches and directions and it also included quizzes, clearness and efficient content management for ease of training, problem identification and solving, on place verifications and evaluation for the evolution and the degree of understanding during training sessions, adaptability and dynamicity. Of course the authors appreciate that there is room for improvement constantly trying to fine tune and make all the necessary adjustments in such a way that quizzes may be more objective orientated inside trainings and in such a way that they could be easily adapted to every team's specific needs and degree of knowledge and professional experience. The need for adaption arises when members of even the same team started to respond differently to the same training content thus making it clearly that the questionnaires have to be addressed to certain aspects individually. Experience showed that question formulation had to be different for every team due to their degree of understanding, knowledge, and experience and implication level. The team of researchers was the most involved ones being very capable and responsive. It also had been the team which learned the quickest. The student team was very receptive but it lacked experience and professional knowledge thus making it the one which had less questions and for that matter, debates regarding discussed matters within the project. But the overall experience had proven the authors that such an adaptive training system is a must and may be used with success at university level because in this case it helped at developing competences and skills in a relatively short period of time for trainees with different backgrounds and professional experience. That being said it is very much alike with what Moodle proposes and succeeds by its implementation in technical superior education systems.

E-learning methods apply to most modern and various domains but also represent a great tool for the mechanical educational system where there are a lot of sustained efforts for its

implementation. A very interesting direction is that of the m-learning platforms which are complementary to e-learning ones in terms of future development of engineering teaching methods or measurements dissemination. As an a immediate application Moodle may be used as a comparison form between results that were obtained traditionally in the field of science of materials with the ones obtained by e-learning methods for graduate students starting with their first year of study [Musca, 2018].
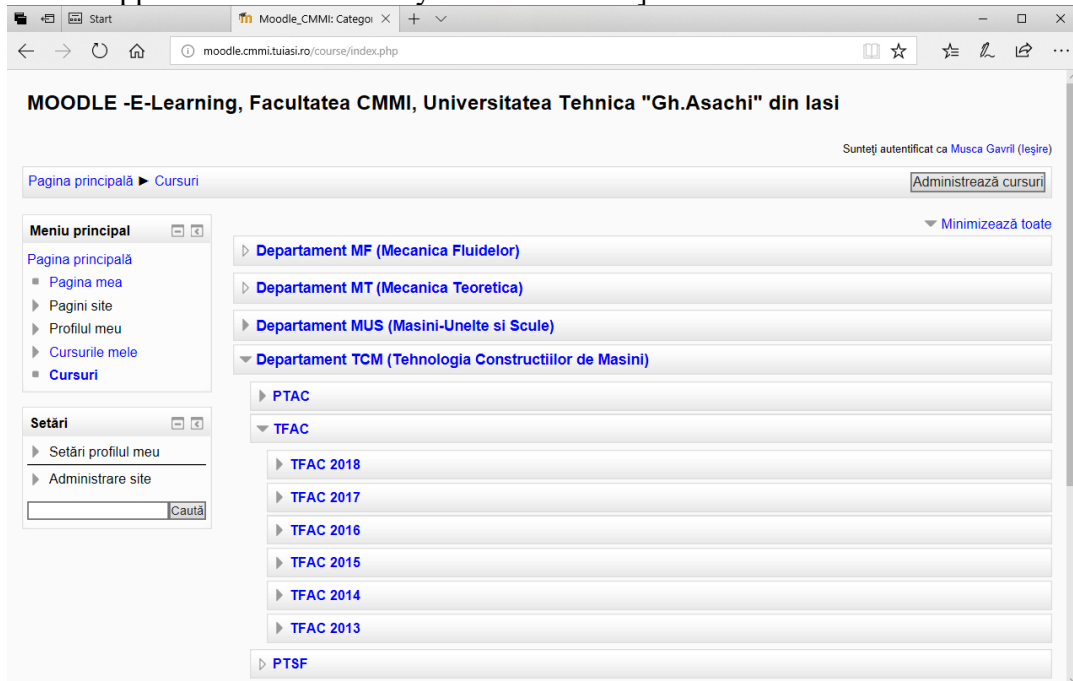

Figure 4. *E-learning course structure developed in Moodle*

One of the main problems in developing an e-learning system is that of quality evaluation and components optimization [Mitan, 2017], [Moraru, 2011]. As result we appreciate that the development of any learning system is a dynamic activity carried out over a period of time and comprises the resource planning part with the one of appreciation of activities undertaken by students.

The collaborative system developed by the authors [Musca, 2011], [Musca, 2016] targets the development of some tools used in sheet metal processing, by several teams belonging to some universities, to a company specialized in CAD projects development and to an enterprise which provides the implementation of the manufacturing process and the effective realization of the product.

Development of such a project has been carried out throughout collaboration between teams of mechanical engineering students, researchers and engineers from private sector specialized in manufacturing.

Because of different degree of abilities among teams a need for a proper training arose for all team members to gain knowledge in the use of CAD-Cam software and technical data administration PLM.

The elaboration of some efficient questionnaires, able to assure the facilitation of the training process, problems identification and correct evaluation of the training process is a dynamical and adaptive activity. We appreciate that there are necessary adjustments and adaptations of the questionnaires to the specific of the team participating in the training. There has been registered the need for adapting the questions to the specific of the activities of the teams' members. The formulation of the questions has been different in the situation when the tested team was composed by specialists having experience in engineering design and in manufacturing, in comparison to the team formed by students.
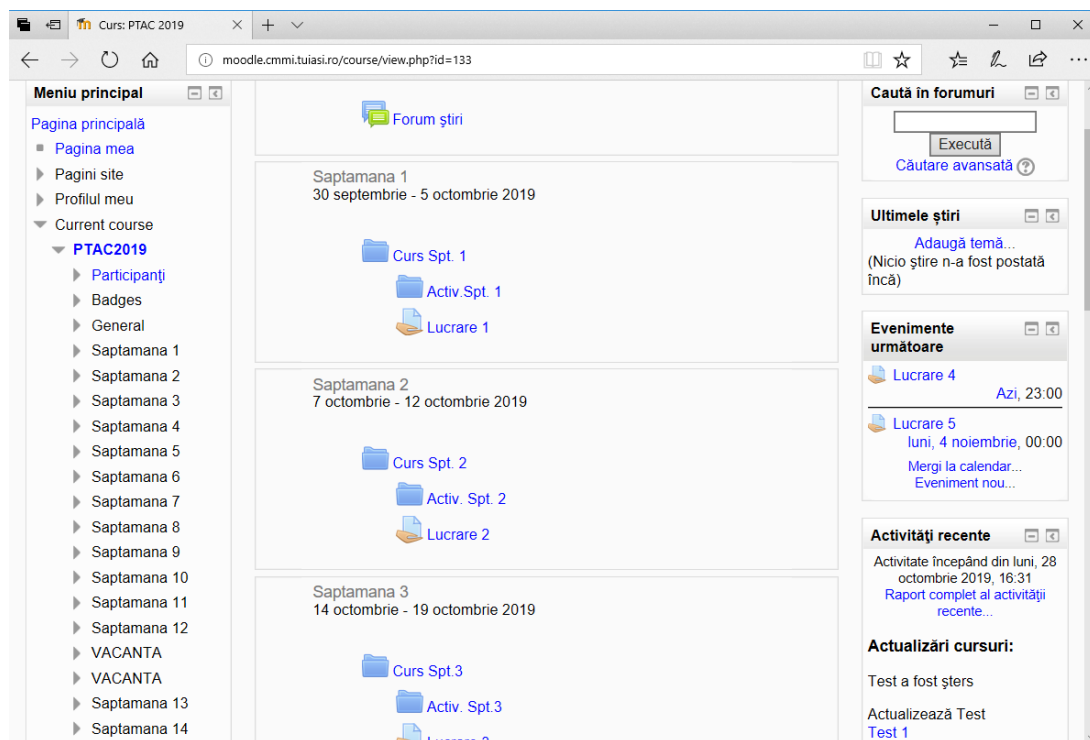
Figure 5. *Course of a 14 weeks program of study*

The implementation of management systems regarding Moodle training knows domains of utilization diverse but also refers to connectivity means such as computer networks, cloud systems, mobile phone and tablets [Goyal, 2012], [6]. Their applicability varies from education to economics where dynamic imposes swift adaptability and training on-the-go for all personal [Benta, 2014], [Florea, 2011], [Ripanu, 2014].

At Al. I. Cuza University of Iasi there are e-learning systems at many departments such as Law, geography, Economical Sciences, Philosophy, Social Political Sciences, Psychology and others. We would like to mention especially the activity sustained by means of e-learning at Computer Assisted Schooling.

UMF Iasi has an e-learning platform which comprises in a *Didactic* module several online courses, grades, a virtual library and tests. The platform also contains informations about users [Cobzeanu, 2017], [Grigorovici, 2017].

Some concerns in this filed are noticeable at Ovidius University of Constanta which hosts a customized e-learning platform. One of the modules allows access at courses and exams and another provides the link between *Distance Education (DE)* and *Low Frequency Education (LFE)* domains.

Timisoara's West University has an e-learning platform which uses *Turnitin* used mostly in the US, Canada, India, Great Britain and some Asian countries as well. The Politehnica University of Timisoara has an active centre of both *(DE)* and *(LFE)* and e-learning which proves long time activities in the field.

UPG University of Ploiesti has active *Distance Education* and *Low Frequency Education* centres with a large number of visits (329.315 from Romania and almost 34.000 from abroad).

The experience in setting and keeping a continuous up-to-date e-learning platform has been regarded as a valuable engineering tool.

Trends in e-learning are also met at the Bacau and Galati Universities.

Babes Bolyai University of Cluj Napoca has an interesting structure deployed for their e-learning platform. Along available courses for most departments the platform contains a section dedicated to tutorials for both students and teachers. The *DE/LFE* centre as well as the

(CeL) e-learning one was implemented in 1998 by UPT Timisoara with the help of colleagues from Cluj Napoca.

CeL organizes the following specializations: Technologies and Telecommunication Systems, Applied Computer Science, Communication and Public Relations in Distance Education regime and Machine Manufacturing technology in the Low Frequency Education regime for Bachelor degree.

Politehnica University of Bucharest in 2018 celebrated 20 years from the first e-learning centre *(CeL)*. Specialist preoccupations have made possible a collaboration with the Gh. Asachi Technical University of Iasi since 2012 for the development of an e-learning system for teachers from high schools, Concorde project [19].

At Stefan cel Mare University of Suceava starting from December 2011 a new project has been developed: Development of an E-education information platform that electronically supports the educational process carried out by Stefan cel Mare University of Suceava co-financed through the European Regional Development Fund, based on the financing contract concluded with the Ministry of Communications and the Informational Society.

The proposed e-learning portal sustains the learning process with computer help as a complementary method to the traditional training. It offers course support, didactic materials in digital forms to students form nine faculties of USV and collaboration instruments between students and teachers in order to access various projects specific to bachelor education as well as master or even PhD studies.

Students gain access to the section specific to their level of authorization and participate to online training programs by enrolment in classes and by accessing electronic associated resources.

3. Course development in machining computer assisted domain on Moodle e-learning systems

At Gh. Asachi Technical University of Iasi the majority of faculties and departments benefit from the implementation of e-learning platforms. At the Electro-technics department there is a well-known activity conducted by professor Adascalitei which "competes" with colleagues from Computer Sciences and Automation who have 71 applications and courses online.

The requirements of learning processes in engineering have pushed forward to the development and implementation of an e-learning system in the CAD/CAM laboratory from of the Machine Manufacturing Technology department inside the Machine Manufacturing Technology and Industrial Management of the Technical University of Iasi [Nagit, 2017].

First version was functional since 2013 and it used a local server. At the present time the system has been expanded and is being hosted on the university's servers thus making it accessible to all departments (see Fig. 3).

The platform encapsulates 12 courses and has been used over 1128 students from both Bachelor and Master degree (see Fig. 4).

Resources available to students contain manuals, tutorials and software documentation related to those used in constructive design and manufacturing technologies (Solid Edge, NX CAM, ESPRIT, CIMCO). They also contain scientific papers and web links to domain related content.

At first students receive access data: user and password. In order to avoid errors caused by insufficient knowledge related to the login process the administrator turned to either individual enrolment or working groups.

For a better interaction between teachers and students it has been imposed that each participant would have to use a photography associated to his user that would show at the majority of events such as messages, results or any other.

Each course has a pre-established structure which lasts 14 weeks (see Fig. 5). For each week we are able to allocate working resources (course, links, additional information or scientific sources) and set the student's

activities (presence, applications correlated with materials presented at lectures, tests and forum based discussions).

Tests are grouped on lectures chapters. Students undergo all kind of tests with multiple answers or of an essay type (see Fig. 6).

For final assessment two homework are proposed concerning design of manufacturing technologies for CNC lathes and milling machines. The assessment finishes by taking a final test comprising all the elements of the course.
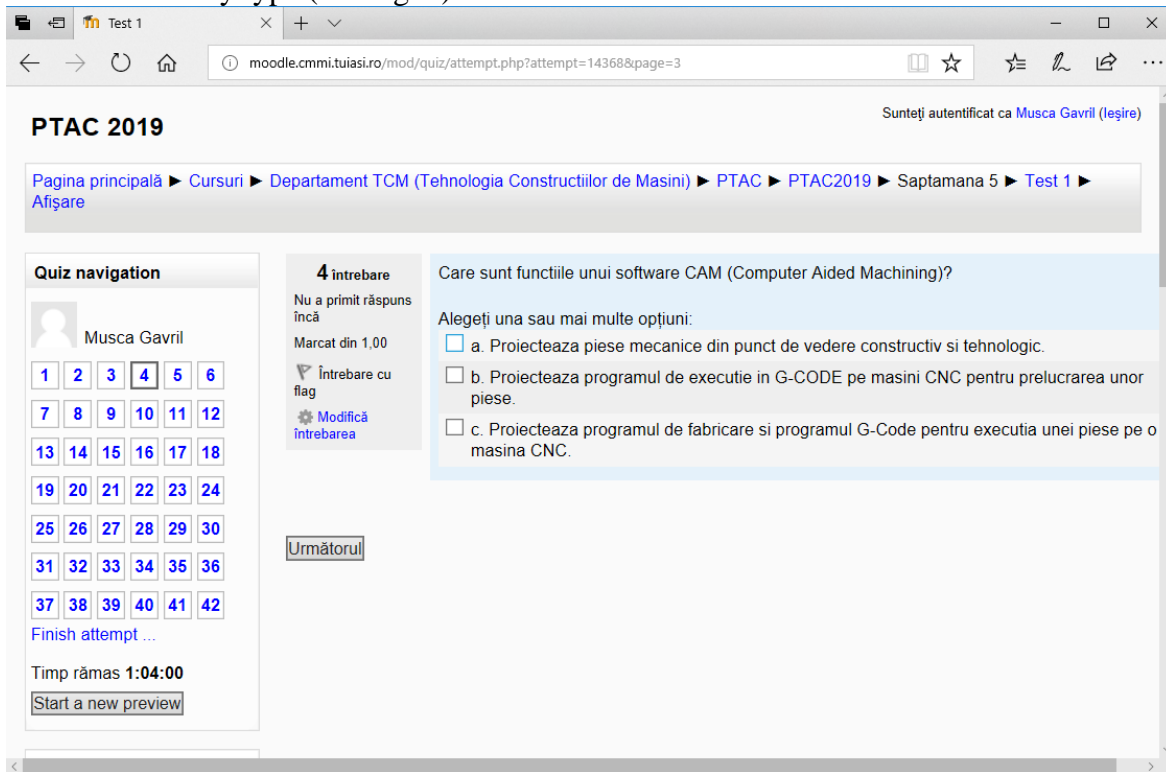

Figure 6. *Interface of a knowledge verification test*

4. Contributions to the development of e-learning courses in constructive and technological design

Even though subjects are related each course study is original because the authors have adapted them to trainee's specific activities and knowledge. The available resources for students contain manuals elaborated by the authors, tutorials and product documentation for each software solution used in the laboratory (Solid Edge, NX CAM, ESPRIT, and CIMCO), scientific articles and links to relevant content website.

One of the most important activities is the participation to the course related forum where different ads are always renewed regarding activities or documentation or even resolved exercises proposed by the guiding teacher to students.

Involvement of students in the collaborative activity of forum access must be known and well graded by the guiding teacher.

As a report of all activities conducted by participants we may encapsulate and export them as text or an Excel sheet. Depending on the data management type this elements are centralised or sent by email to all participants.

For assessing the correctness of testing activities the following Moodle features have been used:

- Verification of normality status of the test by analysing grade distribution by class study;
- Analysis of obtained results and test related question migration if answers turn out to be mostly unsatisfactory. In order to achieve better results a re-run of tests has been allowed with the option of keeping the bigger grade.

5. Conclusions

Use of cloud systems, smartphones or tablets represents present times and has a great

potential of growth for future e-learning based systems.

With performances brought by new intercommunications technologies e-learning will become more and more attractive as they will be able to encapsulate more up-to-date information which are of interest for students. Presentation forms will make the difference as they need to be intuitive and attractive.

The quality of information from e-learning courses is decisive for a successful implementation of an e-learning platform. Keeping information up-to-date helps in structuring student activities from deepening course materials to proposals for newly developed applications for a better understanding. This also helps in putting to practice theoretical knowledge.

The appearance of new information in the field has led to the idea of continuous improvement of the presented materials which somehow explains new courses for each year of study.

The authors believe that the success of a Moodle course of study is based on the interaction between students and teachers. In case of computer aided design and manufacturing there is a constant need for applications which would ensure a proper understanding of CNC machines, tools and holders, materials mechanical and physical characteristics and those related to manufacturing regimes. This is needed alongside with solid knowledge about NC programming languages and CAM software used for simulations of manufacturing processes and the generation of codes for the CNC's.

Success in case of an e-learning system depends on the quality of presentation, results and most important, student satisfaction.

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