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ICT COMPETENCIES FOR ACADEMIC E-LEARNING. PREPARING STUDENTS FOR DISTANCE EDUCATION - AUTHORS' PROPOSAL

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ABSTRACT

Deployment of distance education (especially e-learning) at universities requires university teachers and students to have adequate ICT (Information and Communication Technologies) competencies. Schools usually provide training for their staff in operating e-learning portals and creating courses, which is the necessary minimum for conducting distance education. On the other hand, schools do not offer any courses for students to improve their competencies necessary for e-learning, as they assume that the students' ICT competencies acquired during the three levels of schooling (elementary, lower secondary and upper secondary) are sufficient. The authors' observations demonstrate that this assumption is not necessarily true, particularly for students at faculties related to humanities and other specializations not of technical nature, such as medicine.

The article presents an overview of ICT competencies necessary for e-learning study, comparing them with competencies of a secondary school graduate. On the basis of a research project conducted at three medical universities in Poland, the authors present the level of knowledge and practical skills in the field of ICT among students who participated in e-learning or blended learning. As a result of the project, a proposal has been presented for modifying ICT education contents for students, as well as a draft course carried on the university's LCMS (Learning Content Management System) portal to bridge the ICT competence gaps for effective distance education.

KEYWORDS

ICT competences, ICT training, e-learning, academic education, distance education, school education system, e-learning technologies

1 INTRODUCTION

Distance learning in its various forms, such as e-learning, b-learning, m-learning, is slowly becoming a regular component of the education system, including higher education. Universities perceive e-learning as an opportunity to reduce the costs of education, to improve the teaching standards, or to engage in continuous education (Mokwa-Tarnowska, 2014; Półjanowicz et al., 2013; Roszak, Kołodziejczak, Kowalewski, & Ren-Kurc, 2016a). On the other hand, the attractive shape of learning materials, often based on multimedia, delivered on e-learning portals, makes it popular among young people (Kołodziejczak, Roszak, Kowalewski, & Ren-Kurc, 2014; Leszczyński et al., 2016). Also, the ability to study any time, anywhere is highly appreciated by students and teachers alike.

Thus, it seems that introduction of distance learning has only positive aspects. Yet it should be borne in mind that this is a multi-staged process, involving significant expenses at its initial stages (Roszak et al., 2016a; Roszak & Kołodziejczak, 2017). Preparation of IT (Information Technology) infrastructure (servers, LAN with adequate bandwidth, computer rooms, software), and employing a group of IT specialists - these costs must be accounted for by every organization that implements this education option. To create digital materials on a satisfactory level, to build ICT competence among the teaching staff - these are the tasks for the subsequent stage, which also requires financial expenditure (Kołodziejczak, Roszak, Kowalewski, Ren-Kurc, & Bręborowicz, 2015; Malach, Kostolányová, & Chmura, 2015; Noskova, Pavlova, Yakovleva, & Sharova, 2014; Roszak & Kołodziejczak, 2017).

One should not forget about the recipients of distance education and their ICT competencies that are necessary for them to be fully involved in the educational process (Rosman, 2013:253-254). The common assumption is that the competencies they acquired at the previous levels of education, i.e. elementary, lower secondary and upper secondary, are sufficient. However, based on the authors' observations, this assumption need not be consistent with facts, particularly with regard to students of humanities and other non-technical specializations, such as medicine (Roszak et al., 2016b). The level of required ICT competencies of distance education participants depends on the advancement of technologies constituting the entire distance learning process management. The next section presents an overview of the technologies implemented in e-learning.

2 ICT COMPETENCIES OF DISTANCE LEARNING PARTICIPANTS VS. TECHNOLOGIES

Contrary to certain opinions regarding the dawn of LCMS distance learning portal applications in the organization of distance learning, they still remain the primary tools, indispensable both for students and for teachers. An LCMS portal application, regardless of the technology applied, will always support the WWW server software responsible for online publication over the Internet. At the moment, an educational organization is not required to have its own independent IT infrastructure - machines, personnel or space. The entire application can be maintained in a computing cloud. This is a paid option for renting hardware working time and IT service. The choice between the cloud or own infrastructure must be reviewed by economists. However, regardless of the economy, the following must always be installed on a physical or virtual (cloud) server machine:

- Web server software;
- Database server software;
- Online application operating technology (e.g. PHP+Moodle, Java+OLAT);
- LCMS installation files.

This does not necessarily involve financial investments - all the above specified applications and technologies are available as freeware or open-source products under GNU General Public License. When planning for implementation of freeware solutions, the architectural limitations must be checked in the application documentation. A issue that goes beyond the framework of this paper is the performance analysis of such an installation, the number of user accounts that can be supported, and the number of courses that can be offered (Roszak et al., 2016a).

The most important feature of LCMS portal application for distance learning is the unique data processing mode: the application is launched from a Web browser, and therefore there are no restrictions regarding the PC workstations to be used for working with the portal. The only prerequisites are: connection to the Internet, and any WWW resources browser. It should be noted here that browsers on smartphones are simpler applications than their PC counterparts. LCMS portals often generate special operator interfaces designed for smartphones. To elaborate on the subject, a separate paper would be necessary, devoted to m-learning.

The URL (Uniform Resource Locator) linking to the Web server resources supported by the LCMS application needs to be entered manually in the browser for the first time; then, it will be prompted automatically to the user. The character string entered by the user is analyzed by the machine, without context. Any error, misspelling etc. would cause the browser to generate an error message. Passive understanding of the subsequent stages of automatic communication between the browser and other network applications is extremely useful in an attempt to understand such message. It would be hard to imagine a user contacting IT personnel about any message displayed on their screens, particularly when there are hundreds of portal users (learning participants) requiring instruction. The LCMS portal administrator is not usually capable of providing extended training to users in real time; therefore, they should have the appropriate competencies already when starting their distance learning experience. The following ranges of competence are mainly required:

- Managing add-ons in browsers;
- National character set coding;
- Enabling script programming language interpreters;
- Receiving streamed media,
- Managing security options.

A good example that illustrates inadequate competencies in the above mentioned range is when a user reports a "white blank field" in the browser window where a video file should be played. E-mail exchange between the user and the administrator to determine the cause and to eliminate the problem can sometimes take a few days.

The phrase "Internet technologies" is used to describe a broad and continuously expanded set of technologies identified by officially registered descriptions for streamlining software developers' work and machine communication. This is an essential aspect of ICT education for distance learning participants: you must absolutely follow all standards and limitations imposed by these standards. These include:

- Selected programming languages for online application development. This competence is considered adequate if the user can differentiate between script languages and other languages, and knows their role in the application creation process.
- HTTP and encrypted HTTPS communication protocols. The competence of understanding the process of encryption and decryption of information.
- HTML tagging system, particularly managing forms.
- Audio and video file streaming.

The assumption is that online technologies operate without any user intervention, fully automatically, but they often require a decision to be taken regarding the (appropriate) operating mode. Identical messages are most commonly generated for the user, whether a student or a teacher, and decision-making capacity is required. A good example of this is a message pointing to a wrong or non-trusted certificate used in HTTPS message encryption. The right decision to take can be specified, and this is usually done by LCMS portal administrators, yet with other related messages the user is helpless again. These situations discourage users, cause time waste and, consequently, lack of a positive attitude towards distance learning.

Thus, a question emerges whether a secondary school graduate (future university student) or a university graduate (future university teacher or administrative employee) is well prepared to function as a distance learning participant (particularly with regard to academic e-learning). It should be mentioned that more

advanced ICT background of technical university students is related rather to their private hobbies or interests than to their school background.

Further into the article, the authors review the competences of a secondary school graduate (potential university students) and compare them with the ICT competences required of a distance learning participant.

3 COMPETENCIES OF A SECONDARY SCHOOL GRADUATE VS. DISTANCE LEARNING

Students can acquire the necessary ICT competencies during the *computer classes*, followed by the subject *computer science*, taught at the particular subsequent stages of education. The syllabus for ICT education for schools in Poland is defined in Regulation of the Minister of National Education of 23 December 2008 concerning "the syllabus for kindergarten education and general education in the particular types of schools". The construction of the syllabus for *computer science* involves spiral education which guarantees continuous development of the student's competencies. Thus, as early as at the lower secondary education stage (stage III of the education system), the student will acquire knowledge and skills in the following fields (Official Gazette of the Republic of Poland, 2009):

- Safely using a computer and software, using a computer network,
- Communicating with a computer and information and communication technologies, including setting up and configuring an e-mail account in an online portal, and participation in discussions on forums,
- Searching, gathering, selecting and processing information from various sources, and participation in creating online resources,
- Problem solving and decision making with the use of a computer,
- Using a computer and educational software and games for expanding knowledge and skills in various fields and pursue the student's interests,
- Evaluate the advantages and hazards arising from the development of information technologies and common access to information, as well as ethical and legal aspects of protection of intellectual property and data protection, as well as signs of cybercrime.

The subject *computer science* at this level of education is taught at 2 hours a week and is expected to provide solid grounds for further development of the student's IT competencies. According to the school syllabus, development of IT education is based on the assumption of expanding computer literacy with the skills which facilitate adaptation to the changing technologies, proficiency in using information and communication technologies, and computational thinking.

Stage IV of education (upper secondary school) is divided into two levels for *computer science*, namely basic and advanced. The basis level of education covers all secondary school students, while the advanced level applies to selected grades, e.g. specializing in IT or technical. The scope of research presented in the article covered university students of medicine, who had usually attended classes specializing in natural sciences (biology/chemistry) in their secondary schools, and participated in the basic course in computer science. Therefore, further in the analysis, we will only review the goals and contents of computer science training on this level. The subject is taught at 1 hour a week, for one year. The learning goals of the fourth stage are equivalent to those pursued at the previous stage of education, i.e. in the lower secondary school. On the other hand, contents are expanded with such areas as: creating and editing graphics, multimedia (sound, video, presentations), relational database handling or using resources published on distance learning portals (Kołodziejczak & Roszak, 2017). A secondary school graduate should theoretically have the knowledge and skills enabling him or her to take an active part in the e-education process (see Table 1).

Table 1 Comparison of ICT competencies of a secondary school graduate with the needs of a distance learning participant

ICT competencies necessary for a distance learning participant	**Competencies of a secondary school graduate that are useful for a distance learning participant**
Distinguishing script languages and understanding their role in the development of web applications Basic knowledge of HTTP and HTTPS communication protocols, understanding the process of encryption and decryption of information	Using basic services in a local and wide area network, related to access to information, sharing information, and communication
Installing and configuring software, e.g. installing a web browser and managing plugins	Using basic operating system and utilities services for managing resources (files) and installing software
Organizing and archiving data and programs, applying antivirus protection	Searching for and launching programs, organizing and archiving data and programs, applying antivirus protection
Creating network resources, Understanding the process of communication with an application server for downloading and copying files, Knowledge of the role and methods of encoding of national characters for different languages, ability to change the code page of a text file	Creating network resources related to one's education and interests
Ability to communicate with other users via e-mail, forum, chat, and in certain specific cases - ability to use Skype or teleconferencing systems	Using communication and information technologies for communicating and collaborating with teachers, learners and other persons (e-mail, forum, chat)
Knowledge of the principles of handling multimedia files, i.e. downloading and playing from online sources, Understanding the concept of audio and video streaming and role of audio/video codecs	Using multimedia devices, e.g. for recording/playing audio and video
Using the educational resources published on distance learning portals	Using the educational resources published on distance learning portals
Knowing the legal regulations concerning use of information and communication technologies, particularly concerning the security and protection of data and information on a computer and in computer networks Ability to manage a browser's security settings	Knowing the legal regulations concerning use of information and communication technologies, particularly concerning software distribution, cybercrime, confidentiality, the security and protection of data and information on a computer and in computer networks

Teachers' professional background and adaptation of syllabuses to rapid technology advancement is a great challenge for education authorities. Advanced courses organized by the local Teacher Training Divisions are not sufficient to ensure adequate quality of teaching information technology. The teacher needs to be passionate and committed to improve his or her competences independently and to be able to follow the rapid changes in the field of information technologies. Also, the currently prevailing trend in primary and secondary school system towards combining competences in teaching more than one subject, e.g. mathematics and informatics, has an adverse effect on the overall level of teaching. In addition, spiral education, which is reasonable in terms of assumptions, often leads in practice to the same contents being repeated at the subsequent levels of education. All depends on the teacher's abilities and creativity.

In 2017, the Polish school system underwent another reform in terms of organization and syllabus. The new syllabus for the school subject called *informatics* puts a special emphasis on teaching students how to think in algorithms and on learning programming, starting with education stage II (grades 4 through 8 of primary school). This is the level of education to which the authorities have moved the objective of development of problem-solving and decision-making skills using a computer, following the algorithmic approach, previously implemented at stages III and IV of the education system. The remaining goals and contents of competence-oriented learning in the field of information and communication technologies, which are differently phrased and often presented in more detail, are generally consistent with the previous syllabus (What's new in teaching computer science in a new elementary school?, 2017). The issue of improving ICT competences to the extent necessary to engage in distance learning still remains unresolved to a certain extent.

Based on the authors' experience, university students in their first years of study, particularly of humanities and other non-technical faculties, have difficulties using an educational portal, are wary of working with new applications, have problems with playing media files. The findings of a study aimed at diagnosing the ICT-related problems among the students of three medical universities in Poland are presented in the following section.

4 ICT PROBLEMS DISCOVERED AMONG STUDENTS AT MEDICAL UNIVERSITIES

What kinds of gaps exist among medical students regarding their ICT competencies necessary for pursuing the education process through e-learning? The authors of the paper are trying to answer this question in this part of the paper on the basis of their practical experience with e-learning at three Polish medical schools: Poznan University of Medical Sciences, Medical University of Bialystok and College of Health Sciences of Collegium Masoviense in Zyrardow.

Materials and methods

The study was conducted after e-learning and blended-learning classes using OLAT (Online Learning And Training) and MOODLE, in the years 2008-2016. The classes under review were taught at the following faculties: medicine, medical emergency services, physical therapy, nursing, obstetrics. Among the students of medicine, there were Polish language speakers as well as foreigners in MD (Doctor of Medicine) Program in English at the Poznan University of Medical Sciences. These were the first remote classes attended by all of the participating students. They had never passed any preparatory courses at their Universities that would prepare them for participation in e-learning.

Over 1600 students participated in the study (1060 students from Poznan University of Medical Sciences, 492 students from Medical University of Bialystok and 100 students from College of Health Sciences of Collegium Masoviense). The study was conducted on the basis of interviews with the 18 teachers (9, 8 and 1, respectively) and 7 administrators (4, 2 and 1, respectively) who participated in implementation of the education process. The authors asked the respondents to describe all the problem cases encountered by their students during the learning process. Some of the problems reported by students were registered in the surveys to evaluate the classes, or communicate orally or via e-mail.

Results

Below is a list of key ICT-related problems and extraordinary circumstances which the participants of e-courses were unable to handle. These problems prove the lack of adequate ICT competencies for working in an e-learning environment (Kołodziejczak & Roszak, 2017). The analysis was carried out on the basis of the classification of ICT competencies necessary for the receiving end of distance education, which was proposed by the authors in 2012 (Ren-Kurc, Kowalewski, Roszak, & Kołodziejczak, 2012).

Problems

Category A – Launching processes and applications.

The students would mostly encounter problems related to:

- Handling learning materials offered as SCORM packs – problems with the opening procedures,
- Multimedia presentations opening only on half of the screen – problem with having to install additional plug-ins,
- Problems with playing the multimedia files on the students' private devices,
- No direct access to the online course on the portal – students' inability to organize their own work on the portal,
- Missing test and self-test grading lists, which prevent ongoing monitoring of the student's accomplishment – failure to become acquainted with the required options of the portal applications, which generally offer such processes.

Category B – Understanding the flow of communication on the Internet with the discernment of the used services.

The students would mostly encounter problems related to:

- Logging on to the LCMS portal – problems with account password recovery, reset or change, wrong log-out procedure used, or typos in entering the URL of the LCMS portal,
- Ways of using the forum – inability to handle a public and private discussion forum,
- Forum/mailbox – inability to differentiate between the two applications and their functions for communication in the learning process,
- Closing tests or surveys without a final confirmation of uploading data to the server – a warning message is generated,
- Replying to e-mail messages sent by automatic portal account – this type of reply will not reach the teacher.

Category C – Knowledge of basic HTTP protocol communication client applications (commonly known as browsers).

With the gaps in the students' knowledge in this area, the following problems would occur:

- Problems with connection breaking, learning materials crashing, tests "disappearing", and student registration to course "services". As a consequence, communication must be re-established and some tasks have to be repeated (e.g. filling different forms),
- Dealing with e.g. hotspot – there was the issue with pointing a cursor to a selected location on an image.
- "Invisible image" – the displayed image is incomplete (image size exceeds the page window size),
- Remembering passwords at public workstations,
- Problems with uploading files to portal resources (open-ended tasks for evaluation).

Category D – Installation and use streaming media client software, commonly known as multimedia.

The students would mostly encounter problems in the following circumstances:

- Video files would not open correctly for some students, for such reasons as missing codecs, etc.,
- Using mp4 resources – there were many questions and uncertainties while using them in the early stages of learning,
- Video does not stream – streamed media application in the client web browser does not work. Lack of sufficient competence to be able to install plugins in browsers.

Discussion

The table below presents the distribution of the problems observed at each of the three Universities under review. The Table 2 shows the percentages of problems in the given category within the whole group of problems reported in the study (total). Sometimes a single problem would incorporate certain component parts from two categories of ICT competencies. Some of the category B and C problems related to handling the application interface could be gathered into a new category – *Using online applications*.

Table 2 The distribution of the problems observed at each of the three Universities

Medical University	**Lack of ICT competencies**			
	Category A	**Category B**	**Category C**	**Category D**
Poznan	33%	67%	22%	11%
Bialystok	29%	29%	29%	13%
Zyrardow	0%	60%	60%	20%

Research confirms that medical university students have certain gaps in their ICT competencies, which makes it difficult for them to be efficient participants of e-learning courses. Analysis has shown that the Universities covered by the research project differ in terms of the source of primary problems diagnosed among the students. The differences thus revealed would be worth studying in the future in terms of determining their source.

5 LEARNING CONTENTS FOR ACADEMIC E-LEARNING - AUTHORS' PROPOSAL

Part 1: Proposal to broaden the learning contents of Information Technologies courses offered to university students

Distance learning requires the participants to have certain knowledge and skills which often extend beyond the range of ICT competencies they acquire during the earlier stages of their education. To prepare students to function as a conscious recipient of e-learning, their knowledge and skills should be developed to the extent to which they are necessary for using learning portals and other resources made available online. This would require updating the syllabus of the *Information Technologies* subject, which is classified as obligatory in most faculties. Here are the key areas of ICT competence development for students, particularly in humanities, economy, social studies, nature and medical science:

1. *Online communication methods, basic security principles for people using or sharing resources over the Internet.* Students' knowledge in this field is usually very limited, which can be demonstrated e.g. by personal account sign-in data memorized by Web browsers in public places; ending work with a portal without logging out; inability to interpret security certificate messages generated by browsers.
2. *Handling multimedia and interactive materials*. Despite that the use of YouTube site resources is common, the students' understanding of streaming or lack of such technology is at a very low level.

Their knowledge regarding audio/video stream encoding, which would help them understand problems with playing video or audio materials, is also very limited. Installation of a multimedia plug-in in an online browser exceeds the range of competence of an average student at a non-technical university.

3. *Synchronous and asynchronous communication tools, group work tools*. Group communication is an important component of distance learning, whether realized as e-learning or blended-learning. Students have no problems operating common messenger applications, such as chat, forum or e-mail. On the other hand, the ability to operate such group work tools as Wiki, a virtual board, or sharing resources from Google app is not common.
4. *Copyright protection and applicable laws*. The availability of resources in the global network is not associated with knowledge of copyrights and current copyright legislation. Students usually have little knowledge of the restrictions imposed on the user by licenses based on which resources from private or commercial websites are shared, or licenses for purchased software.

If the learning contents and skills are expanded with the matters discussed above, it will become easier for students to use the most advanced education support technologies and to safely operate the resources and tools helpful in the learning process, including distance learning.

An alternative to the above is to prepare a course offered at a university, to give students proper qualifications to participate in the various distance learning options.

Part 2: Distance training - a proposal for expanding the academic e-learning contents

In order to acquire knowledge of online tools and operating Internet applications in the course of academic education, and to develop optimized distance multimedia learning service user skills in the recipients of such education requires appropriate ICT competences. These can be improved through offering future knowledge recipients participation in 30-hour distance course, presenting the fundamentals of e-learning technologies and preparing them to participate in the learning process with the involvement of new technologies.

The subject-matter of such training must primarily present the perspective of an e-learning user; therefore, in order to prepare the training, adequate examples and practice will have to be created. Duration of training will depend on the participant's knowledge and skills in the field of ICT, ranging from 15h to 45h. Students' own work is very important here, as it will take more time than the presented learning materials.

It should be borne in mind that in case of any problems with a specific topic or exercise, the e-teacher should extend the training contents by creating additional materials or examples to clarify the problem. Preparing learning materials for such a course is a major challenge, which should be thoroughly analyzed and designed properly.

Below is a presentation of topics for distance courses, divided into areas A, B, C and D in terms of ICT competences necessary for the receiving end of distance education, which was proposed by the authors in 2012 and became the basis for the data analysis in Section 4. The last topical unit - category E is the result of the authors' further research (The process of publication in Internet resources), allowing students to effectively publish their findings and results on an LCMS portal.

The topics of an *area A* (*Launching processes and applications*) distance learning course should include:

- Using the LCMS portal being implemented;
- Evaluation of students' knowledge: graded closed-end tests, self-tests, written assignments (text, graphics) graded by the teacher, project group work;

- Learning simulations and animations - using various types of interfaces;
- Virtual learning environments set up on the basis of various process simulation software (e.g. virtual laboratories) in various technologies;
- E-coursebook (examples).

The topics of an *area B* (*Understanding the flow of communication on the Internet with the discernment of the used services*) distance learning course should include basic knowledge of:

- The communications standards followed over the Internet;
- Functional limitations derived from the communication standards applied in the Internet;
- Role of the sign-up process in an online application;
- Publishing materials in Web server resources (this topic is designed only for individuals who are not following the unit: The process of publication in Internet resources).

The topics of an *area C* (*Knowledge of basic HTTP protocol communication client applications, commonly known as browsers*) distance learning course should include basic knowledge in the following fields:

- HTTP communication standards, e-mail service standard and HTML communication (forms, file transfer, etc.);
- Synchronous and asynchronous communication services over the Internet;
- Account privacy and data security issues.

The topics of an *area D* (*Installation and use streaming media client software, commonly known as multimedia*) distance learning course should include:

- Multimedia streaming via dedicated servers, with web browser software used as client;
- Encoding and decoding data streams in practice, standards implemented in the browser used as streaming client;
- Audio and video materials handling practice.

Pursuant to an analysis of any problems diagnosed in distance education participants, the authors suggest that the course topics further include topics which would enable students to publish the outcomes of their work e.g. in project group resources, or as e-portfolio. This type of course would be designed for more advanced users, and as such should be recognized in a separate *category E – The process of publication in Internet resources*.

The topics of an *area E* (*Process of publication in Internet resources*) distance learning course should include:

- Editing text files for publication in Web server resources;
- Editing multimedia files for publication, including encoding and conversion to various formats on students' workstations;
- Embedding multimedia in HTML5 files, to be published in Web server resources;
- Testing to validate the publication process.

CONCLUSION

Academic distance education (particularly e-learning) requires its participants to exhibit certain knowledge in the field of information technology, and to acquire certain skills which are often beyond the range of ICT competences learned earlier on the education path (from elementary to secondary school).

To eliminate the problems thus caused, the authors suggest the following two complementary solutions (Kołodziejczak & Roszak, 2017):

1. To broaden the contents of the *Information Technology* (IT) course offered to university students in their initial years,
2. To prepare an e-course that would be mandatory for those faculties where *Information Technology* is not taught.

Re: 1. A compulsory course IT is offered to students in their 1st or 2nd year of study, at most faculties of the Polish universities, with 30 class hours. The primary purpose of this course is to present the applications of information and communication technologies to students of the given faculty in their future professional work. With selected area 1–4 topics included in subject syllabus, students' competences could be improved and students themselves could be prepared to participate in various forms of distance learning offered by the university. This type of arrangement does not entail any additional expenses and is beneficial for students as well as the university.

Re: 2. Mandatory attendance at a distance course proposed by the authors in Section 5 – Part 2 would enable students to bridge the gap in their ICT competences and to be prepared for functioning efficiently as knowledge recipients in distance education. However, this type of arrangement involves extra costs for the university to prepare and facilitate the course.

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