Implementing innovative teaching methods in the digital environment

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Abstract. The article examines the issues of adopting the innovative teaching methods to effectively organise the educational process within blended and distance learning and teaching. The examples of curricula design using modern information technologies and elements (resources and activities) of the digital learning environment of Penza State University are given. The teaching methods and features of their employment are described. The authors highlight the need for further elaborating the issues of ongoing methodological support for teachers in the field of information and pedagogical technologies.

1 Introduction

The global transition of all educational institutions to distance learning has prioritised the adaptation of teaching methods and approaches to manage the educational process in an effective way. The analysis of transferring higher education to the distance learning mode (spring semester of the 2019/2020 academic year) and blended learning (autumn semester of the 2020/2021 academic year) combining different formats and changing over time primarily indicates the decreased quality of training due to the lack or insufficiency of traditional face-to-face communication. Direct communication between students and teachers in the existing learning environment cannot be overestimated in terms of managing and governing quality education. However, in the context of distance learning, the university curricula should be modified by including innovative information and pedagogical technologies, adopting active and interactive learning methods in the digital learning environment, developing and employing additional feedback tools.

2 Relevance and background

The survey of publications of this period shows that the search for the effective methods of teaching and managing the educational process using e-learning elements and distance technologies is highly relevant for various study fields and educational institutions. The authors of the article focus on organising independent work of students enrolled at Penza State University (PSU) and on applying active and interactive learning technologies [1]

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within the digital learning environment of the university. Following the questionnaire conducted among PSU students, the specific methods (project method and case method) were defined and the identified innovative methods were tested using the capacities of the university digital learning environment. The article suggests that each of the presented directions to adopt active and interactive learning methods using distance learning technologies has its own didactic and methodological advantages and their choice depends on the aims and objectives of a particular teacher. However, the authors mostly examine the management of students' independent work and the indicated methods regardless of the specific features of the disciplines studied. The opportunities and benefits of PSU digital learning environment in developing interactive content are presented in terms of the project activity of students [2]. The article details the practice of employing active learning methods in the digital learning environment, which is exemplified by the use of interactive "Lecture" element for delivering lectures and "Forum" element for organising mutual assessment of students within the e-course Electronics 1.2 [3].

The article considers managing the contact work with students in higher education [4] and proposes an algorithm for giving interactive classes as an element of methodological support. This algorithm is not implemented in the digital learning environment. The promising directions of applying distance learning methods and technologies are analysed in several publications [5, 6], but the specific use of active and interactive learning methods is not considered. The study guide [7] classifies innovative methods of teaching and comments on the possibility of employing them under distance learning. The authors address the issues of introducing methods of active and interactive learning in PSU digital learning environment, provide the examples of curricula design and characterise the distinctive features of the disciplines studied at the university.

3 Teaching methods and their implementation

The adoption of teaching methods depends on many factors, including the target audience, type of teaching activity, available resources, as well as course content [8]. It is generally accepted that such classes as lectures have a low degree of interactivity. They mainly aim at transferring and assimilating knowledge and presuppose using demonstrations as a teaching method. However, even online lectures can be saturated with some innovative techniques. At Penza State University, teachers apply such online platforms as Zoom, Google Meet, Microsoft Team and others. These platforms make it possible to successfully implement the so-called lecture visualisation [9], which is accompanied by showing slides, tables, figures, diagrams, videos, etc. Students commonly give positive feedback on lectures with intentional mistakes or lectures with missing data. When holding such lectures online, the teacher informs students about a certain number of different mistakes beforehand, and at the end of the lecture, students must enumerate mistakes or insert missing data in the text of the lecture. Another method is delivering one-on-one lectures that activates the interaction between teachers and students and increases their interest in the study field. This method entails online dialogue between teachers and students, during which the problem is posed, the case is analysed, the hypotheses are formulated, rejected or proved, the emerging contradictions are resolved and the solutions are found. In the press-conference lecture, the teacher asks students to pose questions in writing (via chat) for 2 – 3 minutes. At that, these questions should interest them and focus on the announced topic of the lecture. Further, within 3 – 5 minutes the teacher systematises the questions according to their content and begins the lecture, including the answers to the questions asked.

The activating methods are used at the very beginning of the class. Their functions may vary: to attract students' attention, to arouse interest, to test knowledge and skills in order to ensure the transition to the next step or stage of training. This group of methods include a

blitz survey, a mood barometer, and a filter for moving on to the next topic. These methods can be employed in the digital learning environment through the capacities of learning management systems, social networks, software environments for video conferences and webinars. Practical experience of the authors shows that most effective activities of PSU digital learning environment are "Choice", "Quiz" for two or three questions and "Forum" of the question-and-answer type, when the student sees the answers of his/her fellow students only after the submission of his/her own. The choice of element depends on the type of questions and the planned accuracy of the answer. Within "Forum" element, it is also possible to introduce gamification, for example, giving a reward badge for the best answer. Such badges will be converted to additional points for the discipline under the point-rating assessment system.

Practical classes can be conducted online using the discussion method. This method enables students to assimilate knowledge in an active, profound and personal way. Discussion is designed for increased interaction and engagement of students. It provides a vision of how well students understand the issues under discussion and does not require more formal assessment [10]. The discussion method is a way to freely express opinions and exchange different viewpoints on the topic under consideration. This method enables highlighting the topic in various aspects and considering the differences and similarities that increases interest in the topic, thereby deepening students' understanding and stimulating the study of various issues. It is well suited for the completion stages of exploring the specific topics, sections and the course as a whole. The discussion method is naturally included in the implementation of the research method and the project method.

In the distance learning mode, the discussion method is one of the most difficult teaching methods for following and using effectively, since almost always the benefits of cooperative learning will be less compared to the traditional (face-to-face) mode. However, discussions help to create the collaborative learning environment. This method in various versions is essential for designing quality training courses in case of distance or blended learning. Different ways of applying the discussion method under these modes of learning are considered in some publications [7, 14] highlighting the face-to-face and online phases of generating a discussion, while both synchronous and asynchronous modes of information exchange are possible. Thus, the World Cafe can be organised online in a forum or chat, providing a platform for discussion.

Brainstorming is the most available form of discussion. It is a good way to quickly engage all students in group activity based on the free expression of their thoughts on the issue under consideration. There are no criticism or long discussions. Brainstorming is particularly relevant for starting or completing a topic, as well as for finding multiple solutions. The interaction of students may be facilitated both on forums and in chats.

Jigsaw as a cooperative learning method can be successfully implemented in the digital learning environment. When using the method, the main topic is subdivided into sub-topics. After the phases of group work, they are again united in one topic. Group communication of students may take place online, where information is processed and discussed. In this case, both synchronous and asynchronous forms for exchanging and disseminating information are possible. It is proposed to arrange Group Jigsaw in a combined way: dividing students into groups divided by topics or concepts (first phase), initiating group discussions and information synthesis (second phase) and reconvening groups to share findings produced following topic-specific group discussions (third phase). In the absence of face-to-face communication of students, the effective adoption of this method requires establishing online communication in a synchronous mode, preferably in the video mode. To ensure active participation of all students it is essential to thoroughly plan the activity, engage a reasonable number of participants and have good skills in moderating discussions. In the digital learning environment, this method can be employed using tools for organising

forums, chats, wikis, and collaborative documents. PSU digital learning environment recommends providing a passive "Forum" at the initial stages of delivering courses, and later, as experience increases, facilitating discussions in forums, asking questions, and guiding [13].

Under digital learning, mind mapping is an indispensable tool for structuring and organising knowledge. Students can create their own maps and also use multiple presentation software. A mind map allows examining the content structure of a topic area. This method can be used for knowledge organisation, where the content is presented systematically in the form of conceptual links in order to clarify its meaning and relationships.

When conducting laboratory classes within the courses in Chemistry, Physics and Biology, teachers can use virtual laboratories, which are an interactive environment for designing, performing and describing experiments. According to experts, virtual laboratories cannot replace the real process of conducting experiments, but they are gaining momentum in higher education institutions in many countries around the world [11]. The alternative to virtual laboratories is learning through open educational resources. Performing experiments in a virtual laboratory can be replaced with watching available videos or animations.

In the digital learning environment, the portfolio method is well employed by means of automating the collection of completed assignments (using "Task" element in PSU digital learning environment) and unlocking the potential to evaluate assignments and comment on them. Moreover, it is possible to further automate drafting of an electronic student portfolio for employers and to produce a graduate portfolio. This method is used in the digital learning environment of the university to foster relationships among graduates and employers.

The role-playing method is used to familiarise students with the selected topic (professional task, problem, conflict) in the form of a game. Role-playing initially aims at accelerating and encouraging face-to-face interaction, increasing communication skills, adapting students to team work and stimulating professional problem-solving. The role-playing game can be arranged in the digital learning environment in the text mode of "Forum" element using colour highlighting or profile pictures depending on the role of students. It is preferable to hold such games in the video or audio conference mode. This method can be further upgraded through virtual or augmented reality and computer games.

The journaling method is used for knowledge assimilation control and self-evaluation in the final phase. Under journaling, it is not the content, but the distribution of topics that is assessed. This method provides teachers with relevant feedback to understand the learning path of a particular student. The method is well implemented in the learning management systems, e.g. in PSU digital learning environment, the teacher can configure the assessed assignments within the course in such a way that both the student and the teacher see necessary information for analysis in the form of a transcript of records.

The student peer feedback method is widely used in mass educational e-courses to check the completion of assignments by students with no teacher involvement. The effective adaptation of this method requires formulating assignments in a methodologically correct way, laying down assessment criteria and defining rating scale. PSU digital learning environment includes "Workshop" element of PSU digital learning environment for mutual assessment with a wide range of customisation options, but the mutual exchange of views among students and groups is also possible using standard "Forum" element. The three-colour quiz method [12] can be effectively employed for formative assessment. Students are divided into small groups to jointly work on a document or communicate in a forum. At that, actions should be described for each student.

4 Case studies of course design and implementation

Below are the examples of designing curricula by means of modern information technologies and elements (resources and activities) of the digital learning environment at Penza State University.

The discipline Computer Science (1st academic year, Bachelor cycle) is offered using the following teaching methods: learning activation; blitz survey within such elements as "Choice", "Quiz" and "Forum"; portfolio for combining assignments into term project on developing a database application; interactivity within "Forum" element to answer students' questions on the term project and give feedback, which are available for students of the upcoming years; role-playing for the defence of term projects with black and white opponent roles. Students submit their term projects to "Forum" element in advance for their further evaluation by the opponents, then students present reports, deliver presentations and answer questions during a synchronous video or audio conference and demonstrate the developed application via the Zoom platform.

The discipline Computer Data Processing Structures and Algorithms (2nd academic year, Bachelor cycle) is delivered using the strategy of a flipped classroom. The teacher places materials for preliminary study in PSU digital learning environment in the form of pre-developed presentations, electronic textbooks and links to videos and animations from the open educational resources and MOOCs. The activating methods are introduced for starting classes and initiating reflective practice. The journaling method is used to conduct laboratory and review works. Automatic testing (tests for formative and summative assessment) and students' mutual assessment of laboratory works are organised in the digital learning environment of the university. The teacher employs the project method to organize the course work of students.

The discipline Information Systems Engineering Methodology (1st academic year, Master cycle) is taught using the research method, project method, discussion method, and the strategy of a flipped classroom. Students study materials placed in PSU digital learning environment and explore research articles on course-related topics. The pro- and contra-discussion method or the Think-Pair-Share (Think-Square-Share) method are applied for examining the material of articles. Within these methods, findings are rendered in standard "Forum" element of the digital learning environment as short abstracts of articles, questions and answers of students. It is maintained in the asynchronous mode. Further discussions shift to the face-to-face or videoconference mode. In practical classes, students develop their projects, applying theoretical knowledge gained. Technical solutions of projects are presented for expert discussion, while project schemes and diagrams are uploaded to "Forum" element for discussion in both synchronous and asynchronous modes. To implement their projects, students explore possible models, methods, and software tools. Organising discussions to complete an extensive topic on design patterns, when each student is responsible for a specific pattern, makes it possible to deeply understand the features of each pattern, compare the advantages and disadvantages of using it in a specific project. The results of the course are summed up using the round-table discussion method. The method was tested under traditional (face-to-face) learning, and later transferred to the distance one. This requires demonstrating the discussed topics in the form of electronic presentations and moderating student communication (managing the process of asking questions). Students are highly engaged in the discussion process, and as a result, they comprehensively study the topics of the course.

5 Conclusions

Nowadays, considerable effort is devoted to developing and adopting innovative teaching methods and integrating modern information and pedagogical technologies. It should be noted that the implementation of innovative methods in the digital learning environment tends to reduce their effectiveness, compared with their use in traditional teaching. However, following these methods in a methodologically correct and timely way can still significantly increase the performance of courses delivered in the context of distance and blended learning. In addition to time and labour costs, the effective use of active and interactive teaching methods requires high qualifications of teachers and their awareness of pedagogical and information technologies. Therefore, it is necessary to offer professional development courses for teachers and familiarise them with the best teaching practices. It is important to explore the issues of ongoing methodological support for teachers in the field of information and pedagogical technologies.

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