Improving online and blended Learning with Educational Data Analytics

\<Pedagogical methods and innovative practices suitable to support both blended and online learning\>

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1 Introduction

Product Result 2 aims to prepare pedagogical approaches and to adopt a framework for integrating learning analytics with developed innovative instructional teaching models. As part of it, Act2.2 purpose is to define pedagogical methods and innovative practices, which are suitable to support both blended and online learning. In order to achieve increased activities and student monitoring the current report offers a set of innovative instructional methods that will increase the activity and motivation of students while learning. First, a brief description of instructional methods that will increase the activity and motivation of students while learning is presented; second, best practices from each partner university to support both blended and online learning, and third, a model for blended learning and education as an overall framework.

2 Active Methodologies

Active methodologies are shaping other models for supporting the learning process. In active methodologies the student has a pivotal role, as the student is mainly responsible for the learning process. Thus, encouraging and supporting the increase of the ability to absorb content in a participatory manner, is most important in the teaching model. Among different assimilation methods, a theoretical model by William Glasser, presents how people learn and measures efficiency of learning methods (Diachun et al. 2006).

Figure 1. William Glasser learning pyramid

According to that theoretical model, students learn about: 10% by reading; 20% by writing; 50% by observing and listening; 70% discussing with other people; 80% by practising; 95% by teaching. The breakdown shown in Figure 1 shows that the most effective methods are largely used in active methodology.

Active learning could be delivered in blended and online learning. Blended learning is a combination of face-to-face and online teaching and learning and it's part of the innovative and active learning environment. Despite the fact that it is beneficial for the

student, there are a number of important factors for maximizing its effectiveness. These factors are outlined as technology, organizational and instructional/design challenges (Hofmann, n.d.). All of them could be addressed as early as the planning stage in order to implement blended learning successfully. The blended learning utilizes critical thinking and improves students' subject understanding, discussion and interaction during face-to-face sessions.

Below follows the review of some of the active methodologies to be included in the framework for integrating learning analytics models.

o   2.1. Flipped classroom

The 'flipped classroom' defines a pedagogical model in which traditional lecture and homework elements are reversed (Singh et al. 2017).This model was introduced for students who had missed class and used live video recordings and screencasting software to record lectures, demonstrations and slide presentation with annotations. In the flipped classroom model class time is used more for activities and problem-solving, which creates active learning, rather than lectures. The engagement of students with interactive content prior to class provides more time for collaboration, clarification of concepts and contextualization of knowledge.

A study on the effectiveness of students' interaction through "flipped classroom" (Phillips and Trainor, n.d.) showed that both learning and student satisfaction were better. The engaging teaching experience and flexible assessment are pointed out as positive aspects, while the lack of institution support and confidence, as a down-side of the approach. An inclusion of flipped classrooms in the curriculum design is important for increasing its effectiveness.

o   2.2 Project-based learning

Project-based learning (PBL) is an active student-centered form of instruction, which allows students' autonomy, constructive investigation, goal-setting, collaboration, communication and reflecting within real-world practices. Among others, the most important factors, which facilitate the implementation of PBL are: modern technology, high quality group interaction, teacher's ability to support student's learning and provision of guidance and support (Kokotsaki, Menzies, and Wiggins 2016).

The students explore different solutions by using technology or other resources, which supports the student's ability to investigate and improves their critical thinking. The teacher provides partially its methodology in support to students' efforts to find solutions and also feedback on solutions and projects.

o   2.3 Problem-based learning

Problem-based learning (PBL) is a pedagogical approach, which enables students to learn through engaging actively with meaningful problems (Yew and Goh 2016). It provides an instructional framework, which supports active and group learning. From

the student's perspective it is characterized by a problem analysis phase, followed by self-directed learning and lastly a reporting phase. From the teacher's perspective it provides guidance to scaffold student's learning and facilitates the inquiry process.

Studies on the effectiveness of PBL demonstrate that students, who have been involved in PBL learning, in short term achieve similar or less learning gains in comparison to traditional learning, while in long term PBL is significantly more beneficial to learners (Pourshanazari et al. 2013).

o   2.4 Collaborative and group/teamwork methodology

Collaborative learning is an educational approach defined by the involvement of groups of learners, who work together to solve a problem, complete a task or create a product (Laal and Ghodsi 2012). It provides an opportunity for students to collaborate and form critical thinking. Beyond that there is both a sharing of authority and acceptance of responsibility in a group environment through consensus building and cooperation.

3   Innovative practices

Following the theoretical settings of active methodologies, some practical implications and best practices are outlined by each partner university:

4.1 Active learning methodologies by University of Leon, Spain

Active learning methodologies are applied in several subjects of the University of León. For the context of this project and related with subjects on the Computer Science Degree course we are describing two examples:

Operating systems. It is a second course degree subject with more than 100 students. The classes are developed following a mixed approach, lectures in theory classes and a Project Based Learning Methlogy for the practical part. PBL is applied specifically for a project that students should address in groups at the end of the subject. It consists of developing a project following CTMTC methodology. The evaluation explores not only the summative assessment but formative assessment, that is to say not only the final result but the process. In fact we use a Learning Analytics tool to explore students' interaction which facilitates assessing how teamwork competence is acquired by the team members of each group.

4.2 Flipped classroom in e-Learning mode by Sofia University

Why Flipped Classroom?

The application of flipped classroom strategy in e-Learning mode gives the following benefits:

• A possibility to provide theoretical knowledge in advance, through the learning management system (LMS).
• Conducting courses in online learning mode – all learning materials are provided through the LMS, ensuring ubiquitous access, independent of time and place. This provides easy updating of the course content, supporting course archive and recording as well as ease of reuse;
• A possibility to use the virtual classroom (i.e. BigBlueButton (BBB) in Moodle) for virtually mediated face-to-face discussions, practical exercises, case studies, problem solving, and simulations of real situations. These activities enable the achievement of the course goals to acquire not only theoretical knowledge, but also practical experience (Zafirova-Malcheva et al. 2019).

Context

The experience of the authors described in this good practice is related to teaching in online learning mode of several elective courses for bachelor students at FMI – "E-Learning", "Design, Development, and Evaluation of Educational Software"(Mihnev and Zafirova-Malcheva 2015), "Instructional design for Technology-Enhanced Learning (TEL)", "Digital design and multimedia – graphic design".

The purposes and general aims of the courses are related to acquisition of knowledge and development of skills and understanding of the participating (mostly) Computer Science students to design and develop technology-based complex learning products of specific types – e-learning courses, educational software, TEL study units, and graphic design learning artefacts. The desired learning outcomes aim at preparation of competent and complete members of professional learning products' development teams, who know and can apply well not only the necessary software tasks, but can understand well, and be comfortable with, the learning design requirements and tasks of the respective educational products (Mihnev and Zafirova-Malcheva 2016).

Application of flipped classroom methodology

The theoretical knowledge of the courses is acquired by means of flipped classroom methodology by providing in advance of the lecture materials (lecture notes, presentations, short preliminary quizzes, and external web readings and video materials).

The courses contain 15 themes. To each new theme we add one short preliminary quiz (usually about 10 questions) to ascertain whether the students studied the lecture and presentation materials for the new themes in advance. The short preliminary quiz is an "open textbook" quiz, the students can use all topic materials, they have the right to perform the test 3 times, and can see their marks for each attempt. The highest mark is their final mark for the quiz (Mihnev and Zafirova-Malcheva, n.d.).

In class, we conduct a short discussion on the new theme and answer questions for about 10 minutes (discussions on the new material). The rest of the lecture time we use for interactive learning activities and exercises (group and individual – active learning sessions, group work on different new topic tasks, in-class exercises, and assignments). Each online study lecture and exercise are video recorded (Mihnev and Zafirova-Malcheva, n.d.).

After the class students receive home assignments on the studied topic, and a new short quiz for the next topic is open alongside with the materials for the new, next week, theme. Every student can track the video records for later use (Mihnev and Zafirova-Malcheva, n.d.)

The following innovative teaching methods are used within the flipped classroom:

- Each online study lecture and exercise are video recorded. The video lectures are uploaded – assuring easy access for students in LMS;
- All the materials are available online;
- Division of students into small groups for online discussion;
- Division of students into small groups for short assignments in the online class;
- Division of students into small groups for homework assignments;
- Work in teams on particular parts of the course final group project;
- Short preliminary quizzes prior to each theme;
- Short homework writing assignments to hold students accountable.

The use of flipped classrooms leads to some changes in the students' assessment. In general, the final exam of all courses is the development and presentation of a project by the students, which is not a traditional form of exam (a combined exam). This format of the exam was retained, but the formation of the final course grade was modified to include some new elements.

The course evaluation scheme consists of grades from:

- Home assignments (40% of the final grade)
- Final theoretical test OR the summary grade from the preliminary short quizzes (10% of the final grade)
- Online sessions attendance and active participation (10% of the final grade)
- Final project developed in teams (40% of the final grade)

Small preliminary quizzes were included with little weight (10% of the final grade) in forming the final course grade. Students who had taken all preliminary tests with a grade mark higher than 5.00 (out of 6.00) were entitled to be freed from the final course theoretical test.

Online tools used within the flipped classroom

For the purposes of the online learning FMI and SU installed in Moodle the additional Moodle plugin BBB (BigBlueButton) – "an open-source web conferencing system for online learning". As authors of the plugin say in ("Moodle Plugins Directory: BigBlueButtonBN" n.d.), "BigBlueButton supports real-time sharing of slides (including

whiteboard), audio, video, chat, emojis, breakout rooms, and screen. It also records all content for later playback." The plugin also supports a "Shared notes"sheet, where all BBB session's participants can write down their notes simultaneously and can subsequently download them in different text formats. The list of active participants is always on the screen, and a teacher can download the list of participants at any moment. The system also supports public and private chat, which allows users to send group and private messages. Our practical experience shows that public chat is one of the preferred ways for students to communicate with the teachers. Besides, there is a voting poll with customisable options for answering. The teacher can ask orally pool question and requests immediate answers to the question by voting via available answers or can write down the question for voting (Mihnev and Zafirova-Malcheva, n.d.).

Due to the necessity to compensate more intensively for group- and team-work in online mode, the Moodle instruments that support collaborative work are becoming more frequently used. For these purposes the Moodle "standard" collaborative activities wiki, database, and forum were used far more extensively in the synchronous mode of the online study process + (Mihnev and Zafirova-Malcheva, n.d.).

In BigBlueButtonBN (BBB) we use intensively:

- breakrooms for collaborative work in groups
- group and individual chats
- "Shared notes"
- students' presentations and discussions with shared screen

Summary

Our conclusions for using the flipped method are that we gain the following benefits:

- More time in class to deepen the student understanding;
- More personal interaction with different students – more or less advanced;
- More groups and teams' interactions and collaborative work;
- More time for teacher feedback to the students;
- More time for in-class discussions;
- Improved communication with students and between students.

4.3 Collaborative work and group/teamwork in e-Learning mode by Sofia University

Context

The experience of the authors described in this good practice is related to teaching in online learning mode of several elective courses for bachelor students at FMI – "E-Learning", "Design, Development, and Evaluation of Educational Software" (Mihnev and Zafirova-Malcheva 2016), "Instructional design for Technology-Enhanced Learning (TEL)", "Digital design and multimedia – graphic design".

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Application of collaborative and group/teamwork methodology in e-Learning mode

In e-Learning mode one can use for collaboration and especially for simultaneous groupwork the features of the virtual classroom platforms like BigBlueButton (BBB), Zoom, and other similar virtual classroom platforms that support the so-called "breakout rooms." Breakout rooms are independent group spaces that can be created for a limited time period within the virtual classroom system. Their purpose is to realise the simultaneous work of different groups in "their own" group spaces – one separate for each group, where the group can use all the features of the virtual classroom system independently of the other groups for in-advance defined limited time. The breakout rooms mode works as follows:

- The instructor:
  - gives the task for in-class groupwork;
  - defines the number of breakout rooms, depending on the number of groups that will work on a given task;
  - distributes the whole class participants in each of the created rooms – it can be done either by appointing individually each class member to a certain breakout room (drag and drop from the whole class list to particular breakout room list), OR randomly automatically by the system on an "equal number of room participants" basis;
  - defines the time limit of the group task – each breakout room will be ended after the scheduled time-limit and all the group participants will be automatically returned to the whole class virtual session;
  - starts the breakout rooms virtual session – each participant disappears from the common virtual classroom list and appears in the respective breakout room for working in their group
- the instructor can visit by his/her choice each of the created breakout rooms and can just listen, monitor, or actively participate in the work of the group s/he is visiting;
- a group of participants can ask questions to the instructor only when s/he is visiting their group;
- after the time for groupwork is over all participants are automatically dismissed from their breakout rooms, the breakout rooms close, and the

                 participants are automatically returned to the common virtual classroom space;

- after returning to the common virtual classroom the groups can report and discuss the results of their independent work by using the tools of the virtual classroom

Online tools used for collaborative and group/teamwork

We have used the same online tools as in flipped classroom best practice, described on p.9.

Summary

The conclusions for using the online group/teamwork are that one can gain the following benefits:

- More time in class to deepen the student understanding;
- More personal interaction with different students – more or less advanced;
- More groups and teams' interactions and collaborative work;
- More time for teacher feedback to the students;
- More time for in-class discussions;
- Improved communication with students and between students.

4.4 Flipped classroom models by Belgrade Metropolitan University

One of the implemented flipped classroom models at Belgrade Metropolitan University was inspired by active learning strategies used both in class and online (Vejar and Silvana 2015). In this model, students were asked to complete part of the instructional teaching material at home. The assigned online components of the lesson dictate the design of in-class activities. The goal of assigning a portion of the teaching material to be completed before the in-class is to enrich in-class activities with more active learning, which typically when following a strict curriculum does not always leave enough time in class.

Unlike traditional classrooms, where instruction is heard from the instructor in class and there is homework to solve problems at home, in the flipped classroom the tendency is on flipping these activities, and focus more on solving problems in class. Having this in mind, it is necessary for students to demonstrate a certain mastery level, which in the flipped classroom model requires certain student evaluation using appropriate assessment methods throughout the semester (Figure 1).
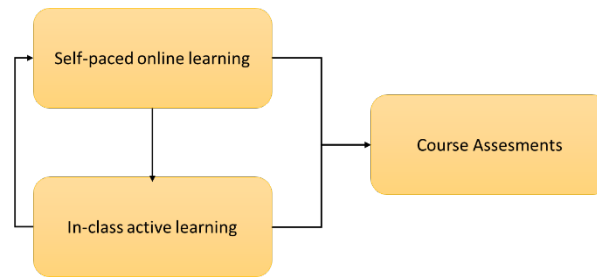
Figure 1. Flipped classroom model

Online learning components in flipped classrooms include a rich mixture of instruction-based, game-based, inquiry-based and problem-based learning content and activities. Self-paced interactive online learning is structured so that students cover foundation topics, advanced topics, and they complete "ticket into class" assignment, as a check whether the students have completed their online learning tasks.

In order to ensure that students complete online assignments and readings prior to class, different strategies can be used. Here, only a few are listed:

1. Students are asked the following: (i) if they completed the online assignment, (ii) to give a small summary of the lesson, and (ii) to provide comments or questions about the lesson.
2. Students are given specific tasks each week that relate to reading material, solving problems, watching videos, or searching for information. These tasks are typically assigned in the form of questions, and when necessary with detailed instructions. Students are required to write down their answers, opinions, thoughts, solved problems, in their course notebook (depending what was assigned for each class). At the beginning of each class, students show their notebook to the instructor and all tasks are discussed at the beginning of the class.
3. Students are asked to read certain instructional material and have an assessment prior to class where they demonstrate their understanding about the online materials/assigned tasks.

These strategies help the instructor to gauge students' progress and content understanding. The content should gradually progress from basic to advanced topics.
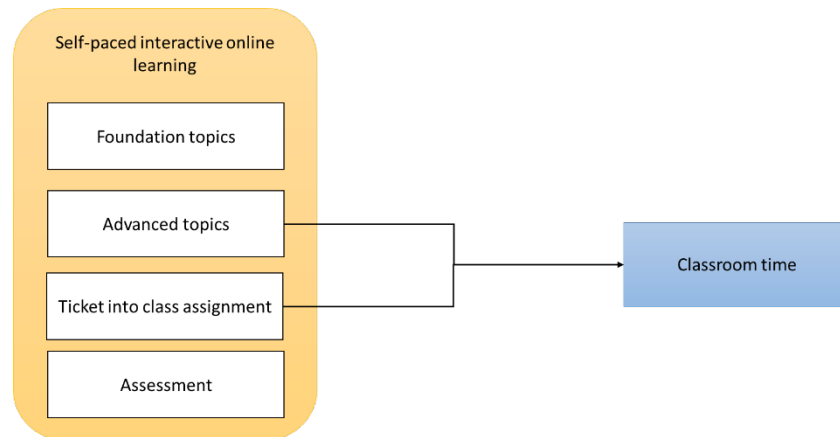
Figure 2. Online learning portion of the flipped classroom

Because a flipped classroom is a learner-centered model, each student is responsible for coming to class prepared. At the beginning of each class, the instructor is able to quickly address any misconceptions or confusion about a particular topic apparent in the assessment feedback (Figure 3).
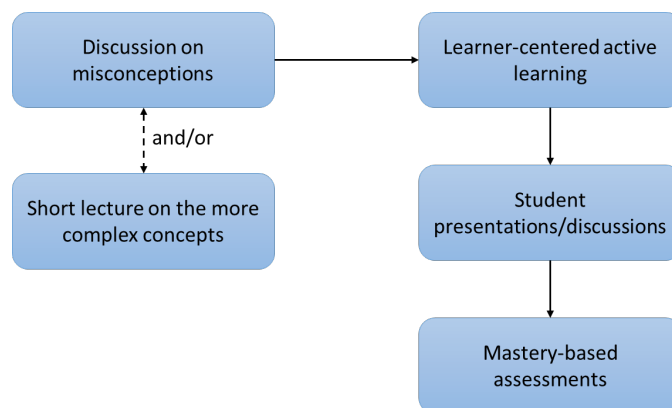

Figure 3. Classroom portion of the flipped classroom

Learner-centered active learning design in the flipped classroom model enables students to develop critical thinking and problem-solving skills. The goal is to provide students with fundamental concepts, motivate them to learn more about these concepts, and create opportunities for them to further explore these concepts through different active learning strategies (problem solving, experiments, discussions, presentations, simulations, etc.). At the end of each class, students report their findings or summarize their discussions for the whole class. The in-class lesson begins with a brief review and summary topics from the previous class, followed by an overview of the new lesson. Students should provide feedback and ask questions. The feedback can be used to informally determine students' prior knowledge and overall understanding of the topic. After the lesson overview, students are then given activities tailored for each specific lesson such as to solve a problem, find information, and work in groups, after which students report on their results through presentations or discussions. An example of activities given to students should encourage them to

apply different concepts they learned about at home or in-class, explore application of problems, solve assigned problems, etc.

In order to determine whether students have achieved necessary learning outcomes for the lessons, a certain mastery-based assessment should be conducted at the end of the lesson. These assessments should be diverse, and can be used not only for grading, but also to determine which students have mastered the concepts, and which have not. In such a way, the instructor is able to identify any common gaps or misconceptions and use this information to guide planning of lessons, assessments and activities. For the students, assessments provide concrete evidence of progress and standing in the course.

Course participation can be used as a tool to help encourage students to actively participate in classroom activities. Participation grades can be measured through the following categories: answering questions in class, responding to instructor feedback, quality of group work, in-class contribution, feedback for instruction, and feedback for fellow students. Informal assessments are based on observations of students' interaction and engagement within their group and in the classroom. Verbal questions can be also posed during the class session to help monitor students.

4.5 Innovative methodologies experience at University of Eastern Finland

Innovative methodologies at UEF are applied in several ways and aim at engaging the students with collaborative active learning methodologies using modern day technologies. Notable is our collaborative group work. This is a project-based learning that uses Discord – the popular gaming platform – to engage students to design a learning analytics project together. Discord enables synchronous interactions, in a way like traditional instant messaging apps and similar to the more professional apps like Slack. As such, students learn team-work skills, modern collaboration tools, initiative and building together. The evaluation of the experiment has revealed that students are more responsive, the platform is more collaborative and distributed and less centralized compared to traditional form interactions. The experiment has been extended to other courses, and Discord is also used to manage more communicative activities and support students in real-time when possible. It is obvious, that instant messaging apps are part of our present and possibly, will continue to power our professional life and such skills are needed.

4   Model for blended learning

Below is presented one of the possible institutional models for successful blended learning: Maturity Model. Maturity Model for blended education is a framework, which can be used to tackle any conceptual or implementation issues regarding

blended learning, teaching and education. It indicates which dimensions are relevant for lecturers and educators, but also institutions, policymakers and educational centres. It aims to help, inspire and guide anyone who wants to implement or improve blended learning in their institution.

This model consists of three levels: course level, programme level, and institution level."(Van Valkenburg, Dijkstra, and de los Arcos n.d.). The institutional level refers to the formal context of blended learning and education. This is determined by policies and conditions with regard to the organization and support of blended learning. At the institutional level different key actors, teams, or bodies play a role in the decision-making process. Among others, programme coordinators and heads of teaching and learning centres are involved.

The institution level consists of the following eight dimensions:

- Institutional support
- Institutional strategy
- Sharing and openness
- Professional development
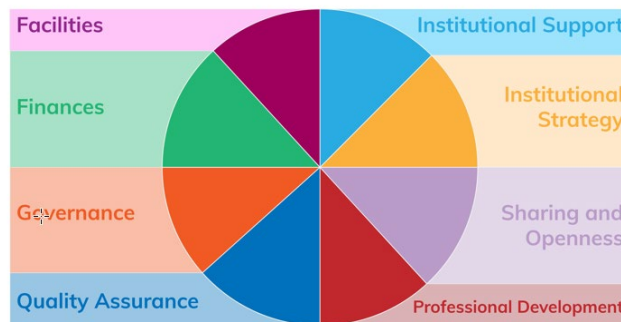- Quality Assurance
- Governance
- Finance
- Facilities

Figure 4. Institutional level dimensions (Van Valkenburg et al., 2020)

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