

Increasing Classroom Interactivity at Unicorn College Using Advanced Learning Techniques

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Abstract: In this paper we describe our efforts at the Unicorn College in Prague, Czech Republic to support student learning using modern advanced learning techniques that include Interactive Textbooks, Podcasts, Nearpod software applications, and use of Ozobot in programming classes. Various interactive learning environments are becoming an integral part of university education and there is increasing evidence that interactive learning has the potential to improve learning outcomes. There is also increasing evidence that the availability of study materials online does not automatically lead to improved learning outcomes. While our experience with using an interactive learning platform is still relatively short, we are strongly convinced that interactive classroom environment can make the learning experience more rewarding for the students and at the same time rewarding for the teachers.

Key-Words: Advanced Learning Techniques, Interactive Textbook, Podcast, Nearpod, Student Engagement, Ozobot

1 Introduction

Numerous recent publications deal with problems related to improving the quality of the educational process and describe new approaches that aim to increase the effectiveness of higher education [1, 2, 3, 4]. At the same time governments are continuously reform higher education attempting to manage rising costs and improve the accessibility of university education to a wider range of the population. As the new generation of Internet savvy students enters the higher education system, they often find traditional methods of delivery of courses using lectures with heavy assignment load difficult to adjust to, resulting in poor educational outcomes and high attrition rates. Furthermore, there is evidence that while students are spending increasing amounts of time online, they are devoting less time to university related activities.

Tab. 1 Breakdown of student activities in 2005 and 2015 [1]

Activity	2005	2015
Sleep, rest, travel	9,5	9
Meals	2	2
Personal interests and sports	2,5	2
Part time jobs	1	2
Online: web, chats, etc.	2	5
University related activities	7	4

A recently published survey of more than 1,200 students at technical universities followed over a period of ten years (2005 to 2015) indicates that the average time students spent online each day increased from 2 hours in 2005 to 5 hours in 2015, with a corresponding reduction of time spent on university related activities, from 7 hours to 4 hours per day [1] (Table 1).

Fig. 1 illustrates the shift in the distribution of the breakdown of student activities through the investigated period. There is a notable turning point in the time spent on online activities and the time devoted to university related activities around 2014.

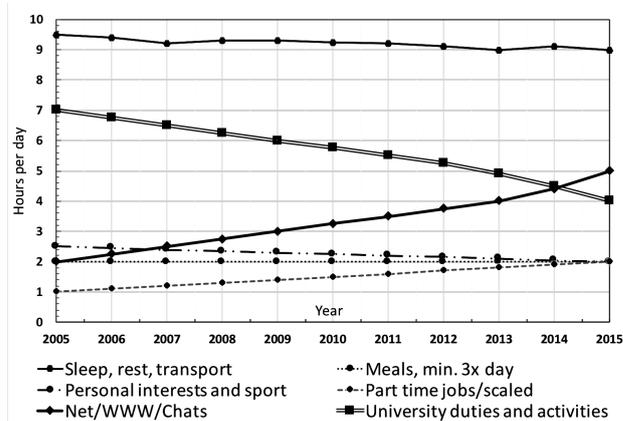


Fig. 1 Change in students' daily activities over a 10-year period: 2005 to 2015 [1]

It can be argued that as more student activities take place online, university education must follow this trend to remain attractive and relevant.

In this paper we report on our efforts at the Unicorn College in Prague, Czech Republic to make the classroom more interactive and to make the delivery of teaching material more effective and more attractive to students. In the following section (section 2) we review related literature. In section 3 we describe our current activities to provide a modern and an effective learning environment that meets the expectations of our students, including the implementation of Interactive Textbooks (section 3.1), Podcasts (section 3.2), Nearpod application (section 3.3) and the use of Ozobot in programming classes (section 3.4) that represent. In section 4 we present our conclusions.

2 Related Work

Improving learning outcomes using Information Technology to provide instant feedback and to facilitate more interactive learning environment has been an active area of research for more than a decade. In early work Anderson et al. [5] use a PC-based tablet system that facilitates active and collaborative learning in the classroom. The system was piloted in eight Computer Science courses at the University of Washington, and the authors report that the students have responded very positively to the system resulting in increased student engagement.

In a more recent work Jonsdottir and Stefansson [6] describe a system for web-assisted education that is used to deliver on-line drill questions tailored to individual students. As system focuses on learning rather than evaluation, the students are allowed to continue requesting drill items until the system reports a grade that is satisfactory to the student. The authors provide experimental results to show that the students improve their knowledge while using the system. Jamwal [7] evaluated the impact of using interactive learning modules with classroom lectures compared to traditional methods of teaching and found that interactive learning modules were preferred by students over alternative methods of learning, and that students reported that quiz activities were helpful in learning the material and in correcting their mistakes. Baepler et al. [8] examined the effect of reducing the “seat time” of a large lecture chemistry class by two-thirds and conducting the class in an active learning classroom. The authors demonstrated experimentally that student-teacher contact could be reduced by two-

thirds with students achieving learning outcomes comparable with the traditional classroom approach. Other researchers have used commercial platforms (Nearpod) to study the effect of interactive classroom applications on student learning outcomes [9, 10].

According to Bergmann et al. [11], another effective technique that leads to improved learning outcomes is Flipped Learning or Flipped Classroom. This concept is based on a principle of “inverted classroom” and involves recording lectures which are traditionally done in the classroom, and so that the students can follow the lectures at home, and doing the “homework” exercises in classroom. Harraf [12] reported they use this technique at the University of Northern Colorado resulting in better scores and improved learning outcomes.

Engaging students in the learning process, particularly in programming, is a current topic of interest. There are many approaches used by different universities. Swamidurai and Umphress [13] have successfully implemented a practitioner-center based undergraduate software engineering course. The objective of PCSE (Practitioner-Center Software Engineering) is to have individual students enact engineering activities at their own skill level. Shankaranarayana and Amaldas [14] describe their experience with the use of Gamification in their classes. Sahagian [15] mentions use of Ozobots and Scratch as suitable technologies that develop cognitive capabilities and practical skills, and at the same time encourage students to code and build something new.

3 Advanced Learning Techniques

Students entering universities are representatives of Generation Y also known as “Millennials”, “Snowflakes” or “Screenagers”. They tend to spend significant amounts of time each day on social networking and other online activities that are significantly impacting on their social behavior and raising the expectations of the students beyond simply providing materials online, and communicating via email. We have been making sustained efforts to meet these expectations taking advantage of recent developments in mobile technologies and applications.

In this paper we describe the application of four techniques that support advanced modes of learning: Interactive Textbooks, Podcasts, and Nearpod Application and the use of Ozobot in programming classes in the following sections.

3.1 Interactive Textbooks

An Interactive Textbook is a type of electronic book (e-book) that allows the user to interact with the textbook using embedded dynamic components. Books can contain videos, quizzes, image galleries, discussions and other dynamic components. There are a number of technological platforms for the development of interactive textbooks, including Active Textbook, iBooks and Inkling. Alternatively, an interactive textbook can be implemented using a dedicated mobile or web application.

We have selected Apple iBooks as a convenient tool for an interactive textbook and Apple iBooks Author software which enables the creation of interactive textbooks at our college [16].

Interactivity in textbook created using iBooks Author, is implemented by HTML5 widget [17]. iBooks Author contains predefined widgets including Keynote presentations with custom animations, interactive image and galleries, scrolling sidebars, pop-over, media as video and audio, chapter reviews, 3D images or HTML modules [18].

TEST 3.1

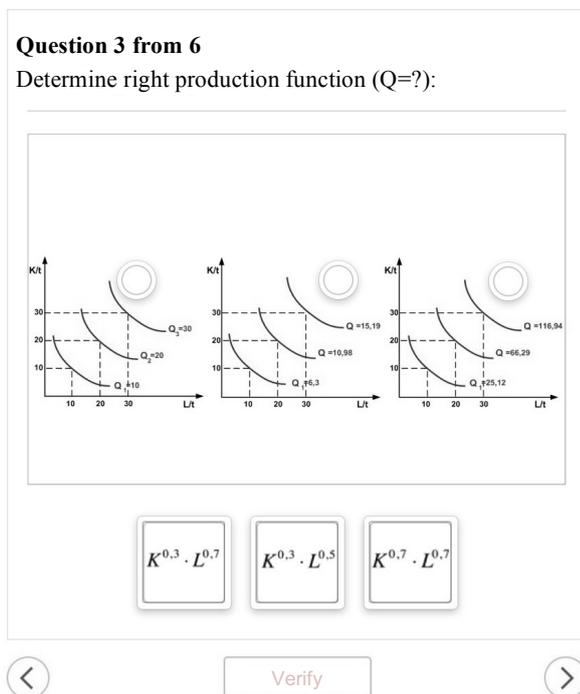


Fig. 2 A sample page from Microeconomics [19]

Book creator can insert any HTML5 widget that meets the HTML5 technical specifications [17]. Authors can develop their own widgets or can choose widgets from a wide range of already

developed widgets offered by different companies, e.g. Bookry (www.bookry.com) or BookWidgets (www.bookwidgets.com). Available widgets include: flash cards, quizzes, timelines, crosswords, memory games, frame sequences, before/after, YouTube / Vimeo player, interactive charts, spreadsheet, PDF viewer, web embedding, form / survey, code viewer, Instagram gallery, Twitter, widget for opening existing iOS App, etc. [21, 22]. Following the release of iBooks Author we have decided to start creating interactive textbooks for our students, and as a pilot iBook we chose the Microeconomics textbook in 2012. The publication of the iBook was realized as a project where the project team consisted of students, lecturers, instructors and graduates. The final version of the Microeconomics iBook [19] was published in the iBooks Store in April 2013 and is freely downloadable. An example of a page that contains a chapter review widget is shown in Fig. 2. The Microeconomics iBook was downloaded from 15 different countries with total downloads exceeding 4,600 between April 2013 and August 2016. Following the success of our first interactive textbook we have published a second iBook in 2015 entitled Macroeconomics [20]. We have integrated two widgets (form/survey and frame sequence widgets) from BookWidgets into the iBook. The iBook was completed and published on December 15, 2015. Similar to our earlier publication of the Microeconomics iBook we have received a very positive feedback from readers of the Macroeconomics iBook. The total number of downloads between December 2015 and August 2016 exceeded 400.

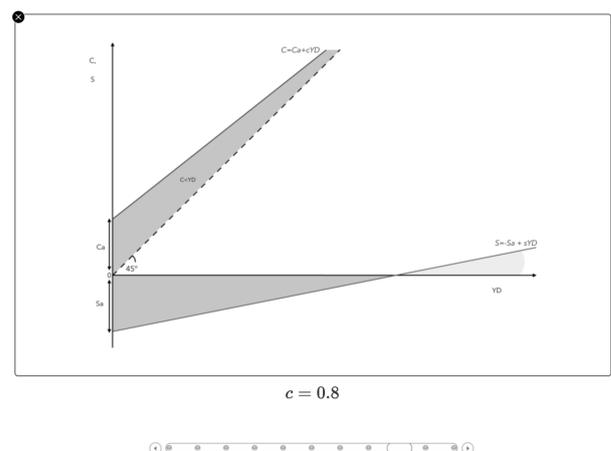


Fig. 3 A sample of page from Macroeconomics iBook [20]

An example of a page from the Macroeconomics iBook that contains frame sequence widget from BookWidgets is depicted in Fig. 3. The user can

interact with the graph in Fig. 3 by clicking on the graph changing the value of the variable "c". This dynamically changes the shape of the graph, so that the reader can easily visualize the impact of changes to the variable "c" on the chart.

3.2 Podcasts

Podcasts are widely used across different levels of education (primary, secondary and tertiary). Leading universities, including Harvard University, Stanford University, University of Oxford, and Yale have been using podcasts to support their teaching activities for some time. At Unicorn College we have been producing podcasts since 2010. During the first phase (April 2010 and March 2011) we produced 160 podcast episodes, with total duration of 9,600 minutes (160 hours) [24].

We assume that podcast contains both video and audio in this paper. Most of our subjects have extensive set of study materials including study texts, presentations, illustrative examples and exercises. We support (not replace) these materials with podcasts that offer additional clarifications of the issues that students may encounter. To start with we captured the entire lecture as a podcast with an average duration of 60 minutes, but later (starting in 2015) we reduced the duration of podcasts to 10-20 minutes focusing on specific topics. We use the podcasts to show how to improve program structure, how to create a more complex program, how to compute complex equations, or to provide further explanation of the underlying theory.

Feedback from our instructors indicates that mostly students who are complete beginners benefit from the podcasts.

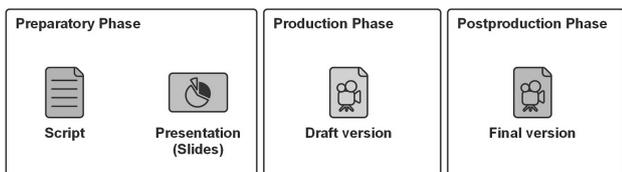


Fig. 4 A typical podcast creation process

Our podcast creation process has three phases as is depicted in Fig. 4. At the preparatory phase we create a script in a text form, where we describe what the podcast creator should do step by step. Concurrently we prepare presentations in commonly used tools (Microsoft PowerPoint, LibreOffice Impress, etc.) if it is required.

When the preparatory phase is done, a production phase can start. The creator of the podcast starts the presentation on his computer and using a screen capture tool

records his presentation as if it were a standard lecture. Some podcasts are captured on iPads using Explain Everything application. Our approach enables to create a podcast with a screen capture tool and provide a commentary on a standard notebook with a microphone or tablet.

During the last production phase we edit the podcast, add intro and outro sections and produce the final version of the podcast. Our typical podcast starts with a brief introduction or revision of the pre-requisite theoretical knowledge required to understand the exercises. The podcast may, for example, present a new version of program code, with the main part of the podcast explaining how the program works and describing the program structure that solves a specific problem. At a suitable moment the program is run and its result commented on by the instructor. The instructor can explain how to solve typical problems that students encounter during the learning process, for instance how to write the program more effectively to achieve a solution for a specific programming task. At the end of the podcast the creator summarizes what students learned and gives some hints for self-study.

Student feedback indicates that our podcasts have been very useful for supporting the learning process. Students typically appreciate the opportunity to observe how the lecturer creates the program step by step. In particular, students who are programming beginners consider this approach to be very effective when compared to using a textbook alone.

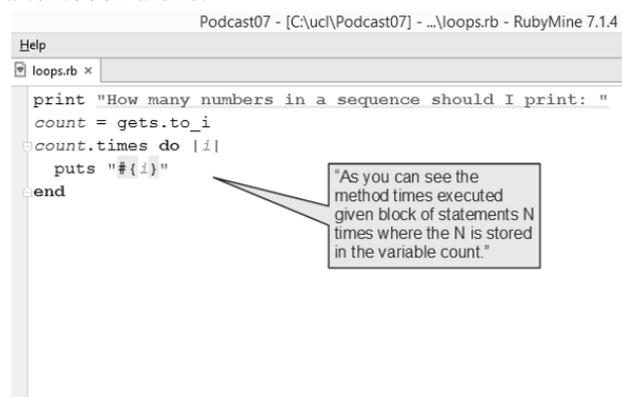


Fig. 5 Example of source code with an audio comment [1]

Podcasts help students to understand advanced topics, to illustrate how to solve complex tasks or show how to install and setup software required for the lessons. The extensive use of podcasts allowed us to start implementing the Flipped Classroom approach into our university teaching.

3.3 Nearpod software applications

The Nearpod (www.nearpod.com) is a software tool accessible via Internet which enhances student engagement during lectures and allows lecturers to have continuous and instant insight into the students' learning progress through formative assessments. The Nearpod tool can be used in several ways, and we will discuss our experience with its use during sessions that teach programming. A typical session begins with a brief revision of the previous lecture, and then focuses on exercises that students should solve individually. Lecturer typically selects one student who tries to solve the exercise on lecturer's computer with the screen displayed for all students via a projector. The instructor guides the student to the desired solution, and other students are asked to solve the exercise by themselves. They can check their individual solutions with the instructor or help the student who is working on the instructor's computer. The instructor's role is to tutor the students, not to solve the exercise himself. Some more advanced students may complete a given exercise quicker and can be given additional exercises, or they can be asked to assist other students. Our programming sessions focus on collaboration by applying this approach and stress student active engagement and participation.

Let us now describe how we actually implement Nearpod teaching sessions. The lecturer prepares a few revision questions or assignments using Nearpod before the seminar. This is done via Nearpod, which is accessible using a browser. It offers interactive and intuitive user interface, used to create quizzes, assignments, etc. Fig. 6 shows Nearpod screen with a quiz that includes one question, allowing participating students to show their understanding of the source code by answering this question.

The instructor can run Nearpod applications with prepared quizzes and assignments during the session, solving exercises on a specific topic. Nearpod generates a unique identifier for the session, so that the students can connect to it. Students can connect to a Nearpod session via a browser using various devices, e.g. tablets, laptops, etc. Nearpod is very intuitive and student feedback indicates that they prefer it to written tests. Using a Nearpod the lecturer can give fast quizzes during the lecture and receive instant response from the students. Since the lecturer receives the responses instantly he can immediately react to situations where too many students do not understand a given programming construct or algorithm.

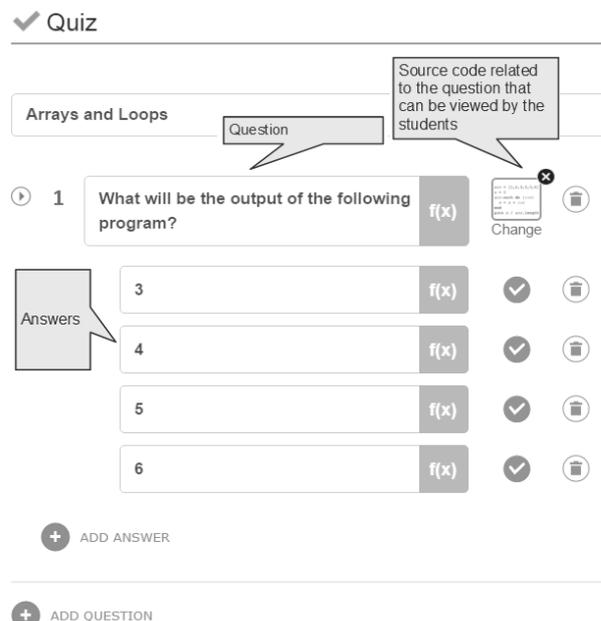


Fig. 6 Example of Nearpod quiz creation

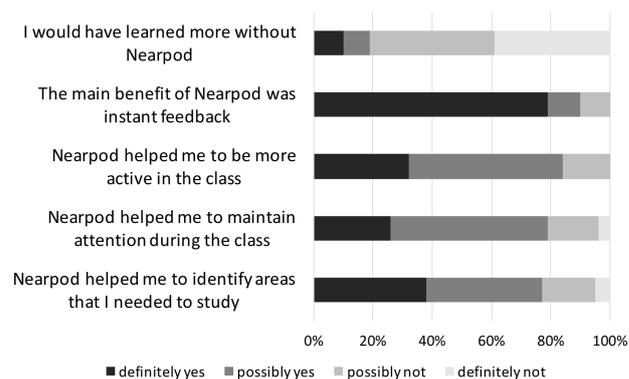


Fig. 7 Students responses to survey questions [25]

Based on student feedback during teaching sessions we regard Nearpod as an excellent tool for student engagement and motivation during lectures. The instant feedback provided by the Nearpod application was rated positively by 90% of the students, 84% of the students found that the use of Nearpod helped them to remain active participants in the class, and 77% of the students felt that the use of Nearpod helped to identify problem areas that required additional study [25].

In addition to analyzing student feedback we have compared student scores during periods when Nearpod was used with periods without the use of Nearpod. As a measure of the impact on student learning outcomes we used the grades that students obtained in selected courses. Fig. 8 shows a box plot illustrating a positive shift in student grades for aggregated results across selected courses [25].

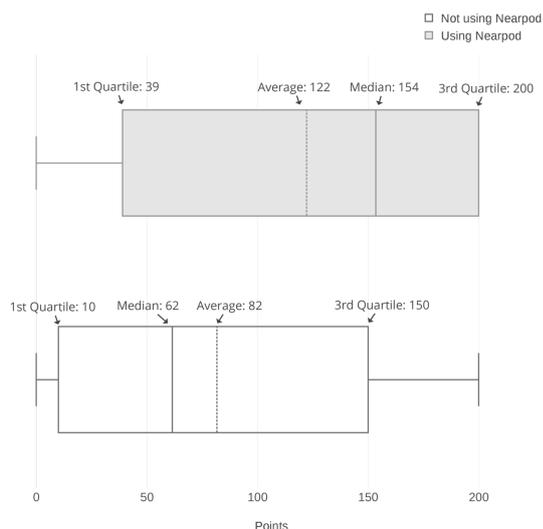


Fig. 8 Comparison of the distribution of aggregated student grades [25]

3.4 Use of Ozobot in Programming classes

Ozobot depicted in Figure 9 (www.ozobot.com) is a small robot that contains a main board, friction drive, optical sensors and a Li-Po battery. It can be programmed with colors simply by drawing lines with color markers. OzoBlockly (www.ozoblockly.com) is a web-based application and a program editor. OzoBlockly enables full control of the Ozobot’s movements and behavior. It is powered by Google’s Blockly (developers.google.com/blockly), which is a library for building visual programming editors. OzoBlockly enables to create a block-based program and load it into Ozobot. Students do not need to know syntax of any programming language, and they still can compose a program.



Fig. 9 Four Ozobots standing on an iPad

The OzoBlockly application provides several types of instructions grouped by type as movements, light effects, line navigation, timing, loops, logic, math, and termination. In addition, users can read or set variables values and define custom functions. A typical example of the program created in OzoBlockly editor is shown in Fig. 10.

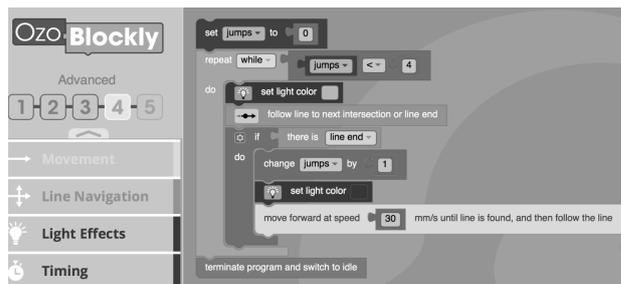


Fig. 10 Example of OzoBlockly program

Using the Load Ozobot function the program is loaded into the device through optical sensors. The JavaScript Preview function enables transformation of the block-based program into Javascript code as is depicted in Fig. 11.

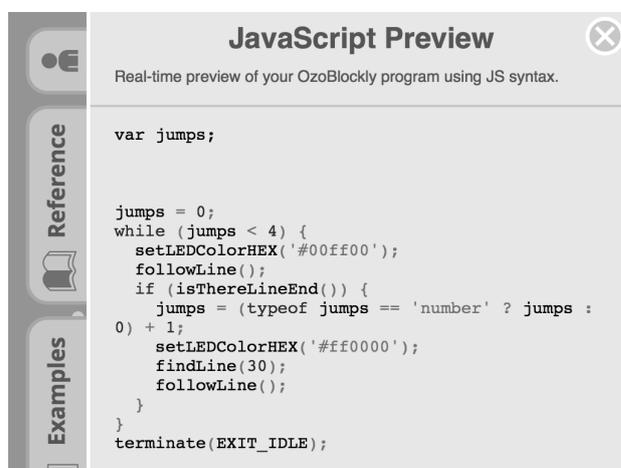


Fig. 11 Example of real-time preview of OzoBlockly program using JavaScript

We are planning to use the Ozobot device and OzoBlockly software in our course “Essentials of Programming”. The primarily aim of the subject is to teach students *good habits* when designing basic programming structures using Ruby as a programming language. Students will have an opportunity to practice basic algorithms and techniques such as conditional execution of code, loops, working with variables initially with Ozobot and OzoBlockly and then using Ruby. The JavaScript Preview feature provides a guideline for the students how to transform an algorithm into programming language code. We believe that Ozobot use will help us to engage students in the learning process and increase their interest in learning to program.

4 Conclusion

We have described four alternative approaches used to enhance efficiency of our learning environment at the Unicorn College. Notwithstanding our

relatively short experience with using interactive learning platforms, it is evident that interactive classroom environment can make the learning experience more rewarding and enjoyable for the students, and at the same time improve learning outcomes.

Our main motivation for the implementation of the advanced interactive learning methods was fast changing student attitude to traditional learning methods and techniques. The change is driven by extensive exposure to various types of applications, services and new technologies. The effectiveness of the four methods (Interactive Textbooks, Podcasts, Nearpod applications, and Ozobots) described in this paper is being continually evaluated. All our interactive textbooks have been very successful and their download statistics clearly show that the textbooks are used by a large number of students, including many students from other universities. The podcasts are highly appreciated by our students, in particular by new IT students. Both students and lecturers have found Nearpod software to be very useful, in particular its attention generating features. We have also noted a significant reduction in failure rates (decreasing by 13%) and increase in the number of students who achieved the highest grade (excellent), increasing by 19%. We anticipate that the use of Ozobot will result in an improved engagement of students in learning to program and better understanding of basics algorithms.

We believe that the use of advanced learning techniques will enhance student interest in subjects taught at our college, improve their engagement in the learning process, and ultimately lead to significant improvements in their academic performance.

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