

Methods used for Effectivity Improvement of Learning at Unicorn College

M. Beránek, P. Bory, V. Kovář and V. Vacek

Abstract—Comprehensive information systems that manage student administration and support everyday student activities have been implemented in most universities today. This helps to supports all business processes that are required for the day-to-day running of the College and helps usually manage the institution more effectively. On top of that properly design system provides students to access study materials online from any location with an Internet connection and allows a prompt change of such materials reflecting very dynamic development of IT technologies nowadays. However, there is increasing evidence that the availability of study materials online does not necessarily lead to improved learning outcomes. We are pointing out some shifts in student behavior and their time management that might indicate that we should take it in account when we modify means of learning process. In this paper we describe our efforts at the Unicorn College in Prague, Czech Republic to support student learning using modern techniques that include Interactive Textbooks, Podcasts, and Nearpod software applications. We finally also give some data from feedback based on an evaluation of such techniques implemented in our learning process recently.

Keywords—Educational Process, Cloud Computing, Modern Teaching Techniques, Student Activity, Impact Evaluation

I. INTRODUCTION

Numerous approaches that aim to improve communication between students and lecturers and to create an effective teaching environment have been documented in the literature [1, 2]. Comprehensive information systems that manage student administration and support everyday student activities (i.e. course enrolments, delivery of lecture and tutorial materials, student assessment, etc.) have been implemented in most universities today. This allows students to access study materials (typically handout and lecture overheads) online from any location with an Internet connection.

However, there is increasing evidence that the availability of study materials online does not necessarily lead to improved

learning outcomes. While the students can follow lectures at the time of their choosing, the availability of lectures online can lead to poor lecture attendance and reduced interaction with the teaching staff. Furthermore, there is evidence that while students are spending increasing amounts of time online and devoting less time to university related activities. A recently published survey of more than 1,200 university students 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 [5].

Fig. 1 and Fig. 2 give a comparison of a breakdown of student activities during a 24-hour period, showing clearly the increase in online activities, with a corresponding reduction of time spent on university activities. To recapture students' attention and to increase the time devoted to university related activities, course materials and the mode of delivery of courses must take into account student preferences and support student-lecturer interaction more effectively. This requires more appealing form of learning materials and more effective teaching tools than those that are currently used by a majority of educational institutions.

Fig. 3 demonstrates the main shifts 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.

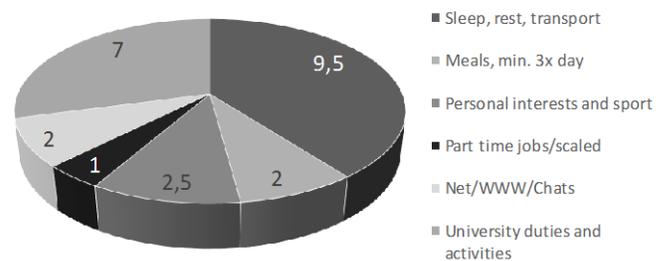


Fig. 1 Breakdown of student activities during a 24-hour period in 2005 [5]

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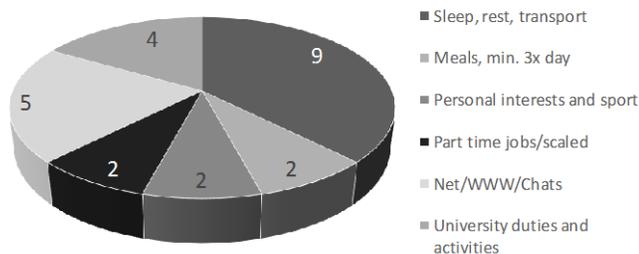


Fig. 2 Breakdown of student activities during a 24-hour period in 2015 [5]

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

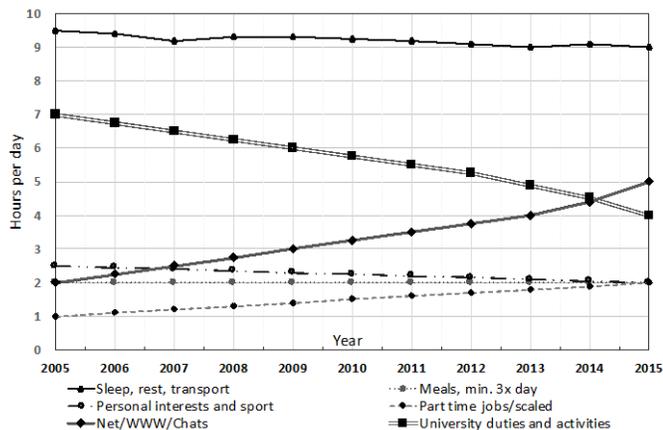


Fig. 3 Change in students' daily activities over a 10-year period: 2005 to 2015

In this paper we describe our efforts at the Unicorn College in Prague, Czech Republic to make the delivery of teaching materials more effective and more attractive to students. In the next section (section 2) we briefly describe the Unicorn College Information System (UCIS) and the underlying Unicorn Universe platform. In section 3 we describe the implementation of Interactive Textbooks (section 3.1), Podcasts (section 3.2), and Nearpod applications (section 3.3) that represent our current efforts to provide a modern and an effective learning environment that meets the expectations of our students. In section 4 we present our conclusions and plans for future enhancements of the Unicorn College teaching and learning platform.

II. THE UNICORN COLLEGE INFORMATION SYSTEM

The Unicorn College Information System (UCIS) is based on the Unicorn Universe cloud platform and supports all business processes that are required for the day-to-day running of the College. Fig. 4 is the UCIS schematic diagram illustrating the business processes needed to run a higher educational institution.

The UCIS system is a Unicorn Universe application (uuApp) implemented using the Unicorn Universe Operating System (uuOS) [3]. The Unicorn Universe Applications include a range of various solutions developed using the Unicorn Universe platform – a digital construction kit that supports the construction of applications from reusable components. Since the establishment of Unicorn College in

2006, we have been using the Unicorn Universe application platform to support all teaching and administration activities, continuously extending the functionality of the UCIS system, most recently by adding support for mobile devices. The functionality of uuApp applications can be extended by adding additional modules without the need to install different software products. The Unicorn Universe platform services are delivered using the Plus4U Internet service, which provides reliable access to the system on a 24/7 basis [4]. The UCIS System supports all business processes in our organization, facilitates communication between academic staff and the students, supports administration activities and sharing of various types of information, and enhances collaboration between lecturers and students. All information about students, including student results, teaching and research projects, and international internships is available online. Our students can also access learning materials online, view their results, communicate with their classmates and lecturers, submit their assignments, and perform various other activities using the UCIS. In effect, the UCIS system guides the students from enrolment to graduation. An important feature of the system are roles that are assigned to users (e.g. student, lecturer, administrator, etc.). Roles define privileges that users have to access information in the UCIS system and protect the consistency of the information. Assignment of roles defines who is responsible for the accuracy of each piece of information; assigning a different role to a person transfers all rights and responsibilities facilitating rapid changes in the organizational structure and temporary replacement of people when absent on leave. The UCIS system is being continuously enhanced, making major changes to the structure and content of the learning materials as described in the next section.

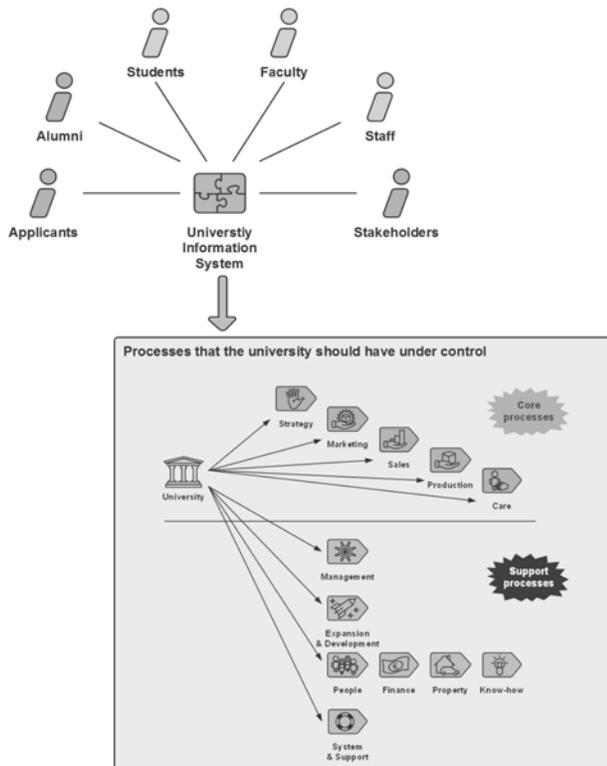


Fig. 4 Model of the Unicorn College information system

III. ADVANCED LEARNING TECHNIQUES

While most of our learning materials are in the traditional form, i.e. lecture handout, textbooks, and lecture overheads, we have made recent efforts to meet the expectations of students who are entering our College with extensive experience with various types of web applications and mobile devices. We have upgraded our teaching materials and methods to incorporate multimedia and advanced methods of communication. Social networking and other recent developments are significantly impacting on social behavior raising the expectations of the students beyond simply capturing lecture presentations, providing materials online, and communicating via email. Increasingly, universities, large corporations, as well as public institutions are adopting systems that enable the capture of lecture presentations and that enrich their internal communications by video-conferencing. There are many platforms designed to support advanced forms of collaboration and to facilitate sharing of data (e.g. Skype, WebEx, etc.) as well as video sharing services (e.g. YouTube, Vidyo, etc.).

In the following sections we describe three application platforms that support advanced modes of learning: Interactive Textbooks, Podcasts, and Nearpod software.

A. 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 launched iPad 1:1 classroom in 2012 with students using iPads that they were given at the beginning of their study by our College. We chose Apple iBooks as a convenient tool for an interactive textbook and the Apple iBooks Author software which enables the creation of interactive textbooks at our College [6]. Apple iBooks and iBooks Author constitute a robust platform that supports:

- Creating of interactive textbooks without any need for programming so that all of our lecturers can contribute to interactive textbook preparation.
- Authors do not need to code or to use complex software; only basic computer literacy is required (text editor skills, e.g. Microsoft Word, Apple Pages or presentation software such as Microsoft PowerPoint, Apple Keynote, etc.)
- Easy distribution of our interactive textbooks to readers (our students, or general public).
- Statistical information about the number of downloads of our interactive textbooks.

Interactivity in textbook created in iBooks Author, is implemented by HTML5 widget [8]. iBooks Author contains predefined widgets including:

- Keynote presentations with custom animations
- Interactive images
- Interactive galleries
- Scrolling sidebars
- Pop-over
- Media as audio and video
- Chapter reviews
- 3D images
- HTML modules [9]

Book creator can insert any HTML5 widget that meets the HTML5 technical specifications [8]. Authors can develop their own widgets or can choose widgets from a wide range of widgets available from different companies, e.g. Bookry [10] or BookWidgets [11]. There is a large number of pre-prepared widgets offered by the companies. Let us list some of them: flash cards, quiz, timeline, crossword, memory game, frame sequence, YouTube, Vimeo player, interactive chart, spreadsheet, PDF viewer, web embed, code viewer, Instagram gallery, Twitter, widget for opening existing iOS application, etc. [12, 13].

TEST 3.1

Otázka 3 z 6
Přiřaďte správně produkční funkce (Q=?):

Zkontrolovat

Fig. 5 A sample page from Microeconomics [14]

In 2012, following the release of iBook, we decided to start creating interactive textbooks for our students, and as a pilot iBook we chose Microeconomics. The publication of the iBook was realized by a project team that consisted of students, lecturers, instructors and graduates. The final version of the Microeconomics iBook [14] 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. 5. Figure 6 illustrates an interactive graph.

As shown in Table 1 the Microeconomics iBook was downloaded from 13 different countries with total downloads exceeding 4,000 between April 2013 and March 2016. Following the success of our first interactive textbook we have published a second iBook in 2015 entitled Macroeconomics [15]. 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.

TEST 7.1

Question 5 from 6
Describe a situation on the market:

Verify

Fig. 6 A sample page from Microeconomics [14]

Table 1 Microeconomics iBook download statistics

Country	Units
Czech Republic	3 820
Slovakia	458
United States	32
United Kingdom	7
Australia	2
France	2
Germany	2
Romania	2
Austria	1
Canada	1
Denmark	1
Ireland	1
Italy	1
Netherlands	1
Spain	1
Total	4 332

Table 2 Macroeconomics iBook download statistics

Country	Units
Czech Republic	314
Slovakia	12
United States	4
Slovenia	1
Total	331

Examples of a page from the Macroeconomics iBook which contains frame sequence widget from BookWidgets is shown in Fig. 7.

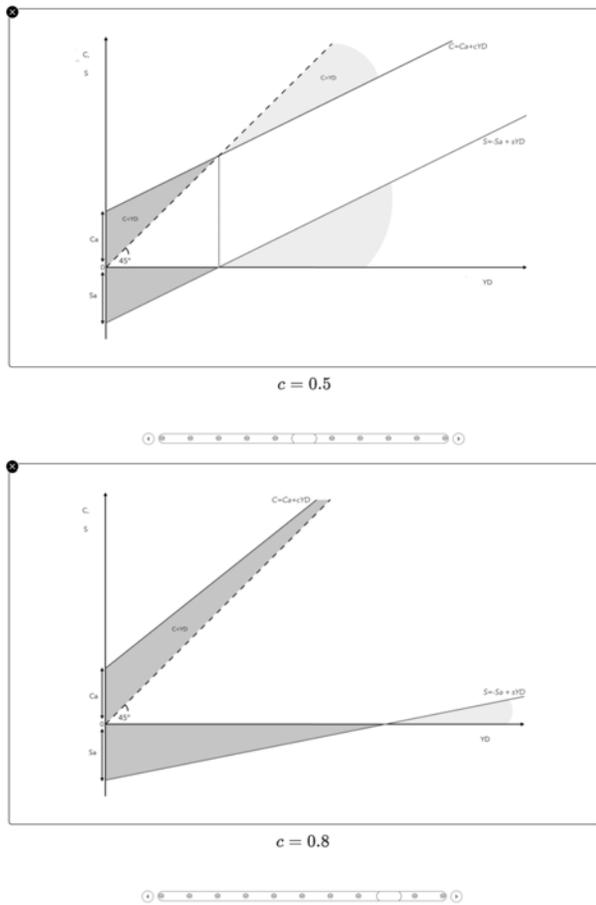


Fig. 7 A sample of page from Macroeconomics iBook [15]

The user can interact with the graph in Fig. 7 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. Similar to our earlier publication of the Microeconomics iBook we have received a very positive feedback from readers of the Macroeconomics iBook. As shown in Table 2, the total number of downloads between December 2015 and March 2016 exceeded 330.

B. Podcasts

A podcast was defined by the Oxford English Dictionary in 2005 as "a digital recording of a radio broadcast or similar program, made available on the Internet for downloading to a personal audio player". This definition was later expanded to include video podcasts that use video-clips designed to be viewed via a personal computer or mobile device [7].

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 (this equals

approximately to 80 movies) [16]. The technical solution is based on automated distribution of audio and video files called episodes stored on a web server. RSS feeds are used for podcast distribution [1]. A typical podcast content creation process is illustrated in Fig. 8.

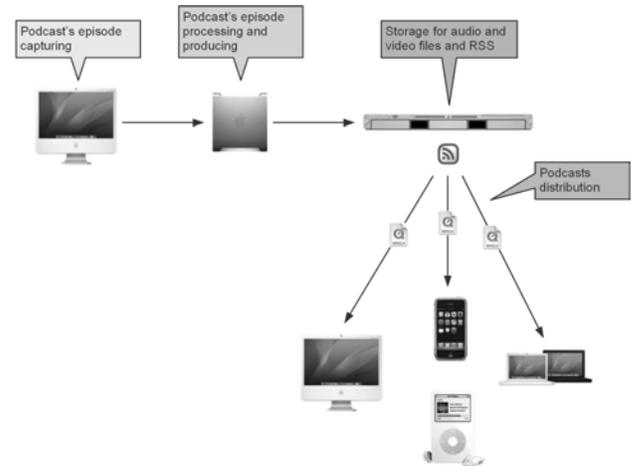


Fig. 8 Overview of the process for the creation of podcasts

We assume that podcast can contain both video and audio in this paper. Besides IT oriented courses we use podcasts in business courses including Business economics, Microeconomics and Statistics.

We illustrate the use of podcasts in the Programming Basics course further in this paper. Study texts that include sets of programming exercises where the instructor guides students to the correct solution, and exercises for self-study are commonly used to support learning of programming. We support (not replace) these traditional study materials with podcasts that offer an additional clarification of the issues that students may encounter. We use podcasts to show how to improve program structure, and how more complex programs can be created. The solution can be decomposed into separate parts with additional explanation, and then assembled using the graphical interface. Feedback from our instructors indicates that students who are absolute beginners in programming benefit most from the use of podcasts.

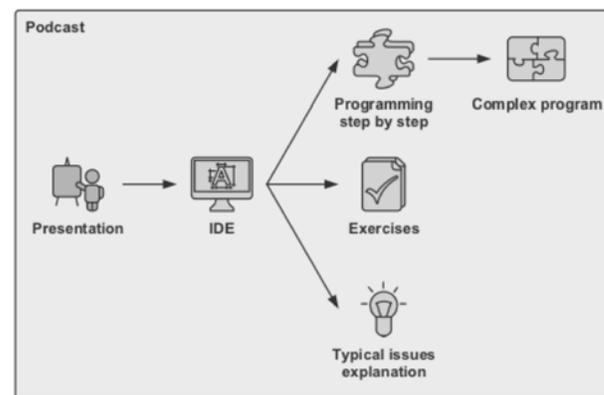


Fig. 9 A typical podcast content creation process

We use laptops or tablets for capturing podcast episodes and

applications such as CamStudioTM [19] or QuickTime [20], and Explain Everything [21]. For podcast episode processing and production, we use Final Cut Pro [22] and HandBrake software [23].

We use laptops and CamStudioTM software for podcast recording as a screencast to demonstrate the use of software applications or to demonstrate coding of an algorithm.

We use iPads and Explain Everything software for podcasts of business oriented courses in situations where we do not need to demonstrate a specific application. Lecturers can prepare a presentation using Microsoft PowerPoint, LibreOffice Impress, or Apple Keynote and export as a PDF file, which is then imported into Explain Everything. This approach is easy to use and enables recording of podcasts from anywhere. Our typical podcast in the Programming Basics course starts with a brief introduction or revision of the prerequisite theoretical knowledge required to understand the exercises (e.g. a new version of program code). The approach is illustrated in Fig. 9. If the podcast contains a brief theoretical introduction, then we prepare a presentation in commonly used tools (Microsoft PowerPoint, LibreOffice Impress, etc.). Then we create a scenario in a text form, where we describe what the podcast creator should do step by step:

1. The IDE (Interactive Development Environment) with an empty file is displayed
2. Comment: "Now we will solve the exercise, that converts between various number formats"
3. Implement the following code:
4. <PROGRAMMING CODE> see Fig. 10
5. Comment: "As you can see the method converted the integer to a floating point number"

The main part of the podcast explains how the program works and describes the program structure that will solve a particular programming problem. This part is fully documented and at an appropriate 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 compose the program more effectively to achieve a solution of a specific programming task.

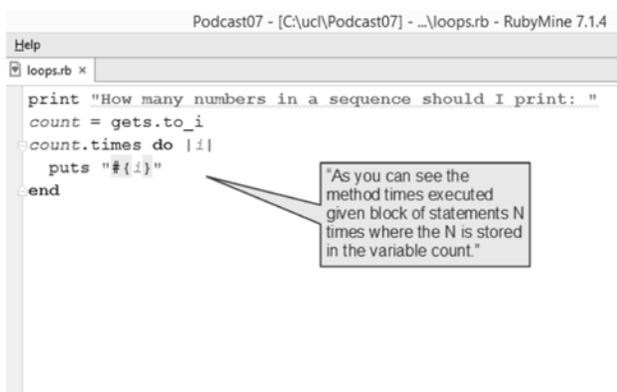


Fig. 10 Example of source code with an audio comment

Another benefit of this approach is that it is possible to create a podcast with a screen capture tool and provide a commentary on a standard laptop computer with a microphone. The lecturer starts the presentation on his computer and using a screen capture tool records the presentation as if it were a standard lecture. When the presentation is completed, the lecturer starts the IDE and performs actions specified in the scenario. For example, the lecturer could explain which exercise or programming construct will be used in the exercise and then demonstrate writing of the program explaining the approach. At the end of the session the lecturer 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.

C. Nearpod software applications

The Nearpod [24] is a software tool accessible via Internet which enhances student engagement during lectures and allows lecturers to have continuous and instant insight into 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 we focus on exercises that the students 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 consult their individual solutions with the instructor or help the student who is working on the instructor's computer. 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 session. This is done using a Nearpod, which is accessible using a browser. It offers interactive and intuitive user interface, used to create quizzes, assignments, etc. Fig. 11 illustrates the Nearpod screen where lecturer has prepared quiz that includes one question, and participating students 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 a few exercises on a specific topic. Nearpod also generates a unique identifier for the session, so that the students can connect to it.

Students can connect to a Nearpod 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 get instant responses from students. Since the lecturer is able to see students' responses he can immediately react to situations where too many students fail to understand a given programming construct or algorithm. Based on student feedback during teaching sessions we regard Nearpod as an excellent tool for student engagement and motivation during lectures.

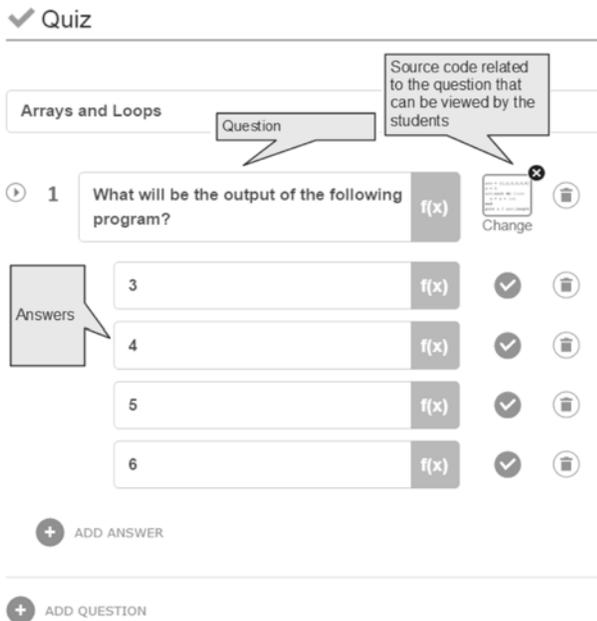


Fig. 11 Example of Nearpod quiz creation

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. 12 shows a box plot illustrating a positive shift in student grades for aggregated results across selected courses (Business Economics, Introduction to Accounting and Programming 1).

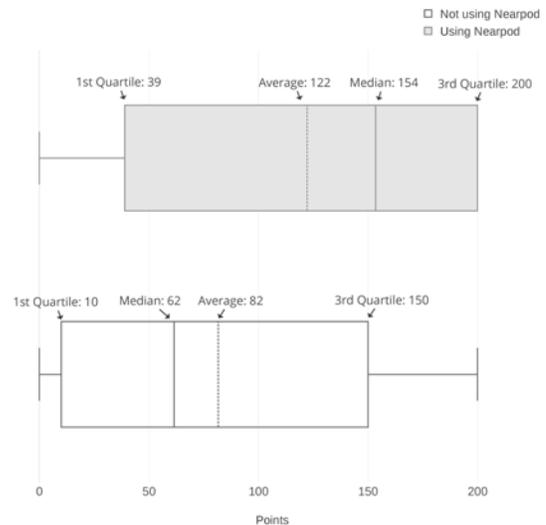


Fig. 12 Comparison of the distribution of aggregated student grades

Fig. 13 shows a more detail analysis of the aggregated grades for all students in the selected courses (we use the grading indicated in Table 3 to convert scores to grades). The use of interactive learning had a major impact on learning outcomes with the percentage of students who failed decreasing by 13% (from 56% to 43%) and the percentage of students who achieved the highest grade (excellent) increasing by 19% (from 7% to 26%). As illustrated in Fig. 14 the reduction in the percentage of students who failed is most evident for full-time students where failures decreased by 23% (from 61% to 38%). For part-time students (Fig. 15) the failure rate decreased by 6% (from 52% to 46%), and there was a significant increase in the percentage of students with excellent grades (from 8% to 29%). These results indicate that both full-time and part-time students have benefitted from the introduction of interactive learning using the Nearpod platform, with full-time students significantly reducing their failure rate, and part-time students reaching higher grades.

Table 3 Grading of results

Grade	Scores (%)
Excellent	88-100
Good	75-87
Pass	60-74
Failed	0-59

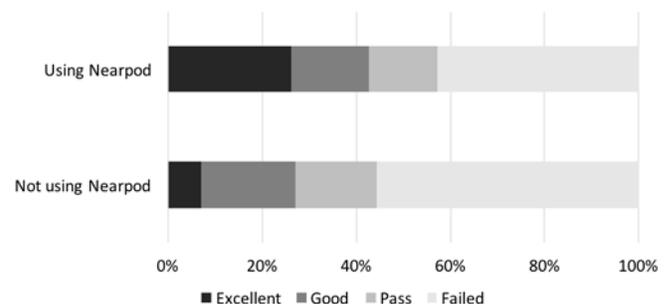


Fig. 13 Comparison of aggregated student grades for all students

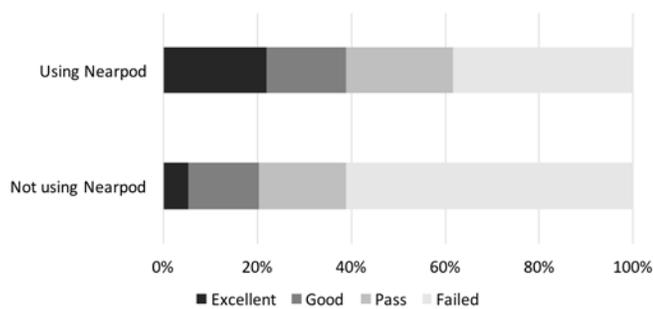


Fig. 14 Comparison of aggregated student grades for full-time students

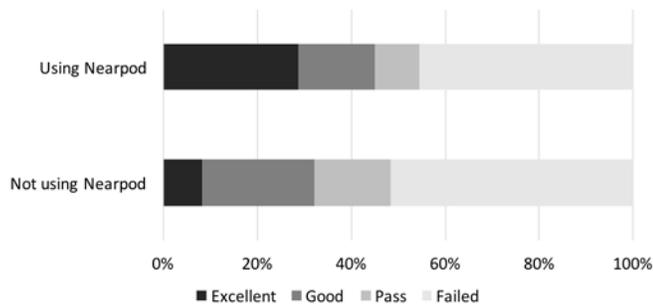


Fig. 15 Comparison of aggregated student grades for part-time students

IV. CONCLUSION

We have described three alternative approaches used to enhance effectiveness of our learning environment at the Unicorn College. Our main motivation was the rapid change in student attitude to traditional learning methods and techniques resulting from extensive exposure to various types of web applications and technologies. The effectiveness of all three methods (Interactive Textbooks, Podcasts, and Nearpod applications) is being continually evaluated. 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 some from other universities. The podcasts are highly appreciated by our students, in particular those in the first year IT study. Nearpod software has been found to be very useful by both students and lecturers, in particular the attention generating features. These applications can provide immediate feedback about the level of student understanding of the topic. We have noted a significant improvement in success rate in our introductory programming course (from 31% in 2014 to 70% in 2015) following the introduction of podcasts and Nearpod applications. Notwithstanding such improvements, there are many new challenges to supporting university education using advanced IT techniques. We are planning to prepare a new course in our curriculum that will teach our students critical evaluation of contemporary information resources and basic art of technical and scientific writing. We regard shortcomings in this area as one of the main problems facing university students, and we believe that the use of advanced techniques that improve student engagement in the learning process as described in this paper will result in a significant

improvement in learning outcomes.

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