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Design of self-paced blended-learning computer programming courses for maritime students

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Abstract. Digital competencies are an important part of the education of future engineers. The maritime industry demands solid and advanced digital competencies. Developing them with traditional methods is difficult and inefficient due to the heterogeneous high-school background of students. Blended-learning approaches can turn the learning curve from steep into a gradual one, while self-paced approaches allow students to adapt the learning rhythm according to their needs. In this paper, we discuss the design of computer programming courses for maritime students, which use both blended-learning and self-paced to achieve maximum educational impact.

1. Introduction

Technological literacy is an essential competence for all future engineers. Millennials (people born in late 1990s and early 2000s) already have the reputation of being tech savvy and having some degree of technological skills [1] [2]. However, these skills were acquired mostly in an ad-hoc manner, while trying to solve narrow-scoped, very specific challenges (e.g. searching information online, staying in touch with friends via email or instant messengers, posting status updates in social media, etc).

High-school graduates from many countries, including Romania, attended (at least formally) computer literacy courses, focused on word processing, spreadsheets or presentation software. Although these courses increase the competency levels in software usage, they are entry level courses, limited in focus [3] [4]. Therefore, many of their graduates are not able to use computers efficiently for solving complex problems [5]. This statement holds true for first year engineering students, too.

As a result, most maritime universities have added to their curricula one or more courses on algorithms, computer programming, CAD/CAE software, etc. The purpose of these courses is to refresh and consolidate digital competencies and develop new ones, raising the students' computer skills level from computer literacy to computer fluency [6].

Maritime students come from a broad range of high-schools, with different study programs, ranging from arts and linguistics to technical, math and informatics. Each program forms different competencies. Even within same program, following the same curricula, the competencies levels vary from school to school. As a result, the digital skills of first year maritime students cover a wide range, from skillful to beginners.

One of the main problems junior students face during introductory/refresh courses on computer knowledge, algorithms and programming is the skills gap between them and their peers. Skillful

students might find lectures and practical exercises too easy, possibly boring. Beginner students might find the learning curve to steep to follow along the rest of the crowd. In both cases, the outcome is students losing interest in the matter – the worst possible outcome. A student-centered learning approach can narrow the gap by developing students' autonomy and independence with respect to study, allowing them to control their learning path and pace, according to their learning styles, interests, and abilities [7] [8] [9].

Blended-learning is an educational philosophy that combines traditional classroom methods with online digital media. It enhances the traditional face-to-face meetings between teacher and student, with the help of digital technology, but it also introduces remote group or individual activities using computer-based activities and content [10] [11]. In this way, blended-learning methods provide excellent support for student-centered learning approaches, offering the tools that teachers need in order to guide along students on their learning path [12] [13].

Due to the reasons expressed above, at the "Mircea cel Bătrân" Naval Academy (MBNA) in Constanta, we designed the Applied informatics course maritime students as a self-paced blended-learning course. This paper presents the design of the course, its structure and technologies used.

2. Computer programming courses in MBNA

The curricula of the Maritime and River Navigation and Transport study program of the "Mircea cel Bătrân" Naval Academy in Constanta, Romania, includes introductory and refresh courses focused on digital skills: Computer Programming and Programming Languages 1 & 2, and Applied Informatics 1 & 2. The courses are scheduled for 1st year students, in fall (course 1) and spring (course 2) semesters, and they are part of the optional packs that students chose to enroll in (i.e. they select one of the two courses packs). Similar courses and planning can be found in the curricula of other maritime universities from Bulgaria, Poland, Turkey, Lithuania, Latvia, etc.

The Applied Informatics courses have as pre-requisites a basic level of digital competencies (e.g. internet browsing, email communication, basic operations with files/folders, and basic office software skills). In addition to refreshing and enhancing students' existing digital competencies (e.g. office software), they include new topics like PLM engineering software and a computer programming topics and algorithms of simple and medium complexity (using runable flowcharts and Matlab).

The Computer Programming and Programming Languages courses have as pre-requisites a higher level of digital competencies (e.g. operations with files/folders, advanced office software skills), as well as logical and math knowledge and skills. They provide in-depth computer algorithmic and programming knowledge (theoretical) and skills (practical), using C++ and Matlab programming languages. They are recommended to students with good digital competencies and, optionally, some previous contacts with computer programming topics.

Due to their study background, most junior students opt in for the Applied Informatics courses, with only a few of them choosing Computer Programming and Programming Languages. Even so, learning algorithms and computer programming can be a challenging task when the learning curve is too steep. Blended-learning can turn it into a gradual learning curve, while a self-paced approach gives students the flexibility to use the study rhythm they feel comfortable with.

3. Blended-learning methods

Since 2005, MBNA operates an e-learning website called ANMB Distance Learning, or ADL for short. It is implemented using Moodle and was introduced initially as an optional tool for teachers to use in their classes [14]. Since 2010, it became mandatory for all teachers to publish their textbooks and course lectures on it. In addition, while still optional, many teachers also publish additional resources (e.g. quizzes, projects samples, homework requirements, etc) which are used by students in practical or outside the class activities. The site currently features around 630 courses, covering the entire curricula of the MBNA (see Figure 1).

The staff of the Information Technology Center within MBNA manages the hardware and software used by e-learning website, but the actual layout and content published for each course is managed by

the teacher (although there are some guidelines regarding the minimum content that needs to be published for student use). For the courses we mentioned in the previous section, we decided to use blended-learning methods to improve the academic performances of students in these classes and effectively reach the instructional goals of these courses. Some of these methods are presented below.

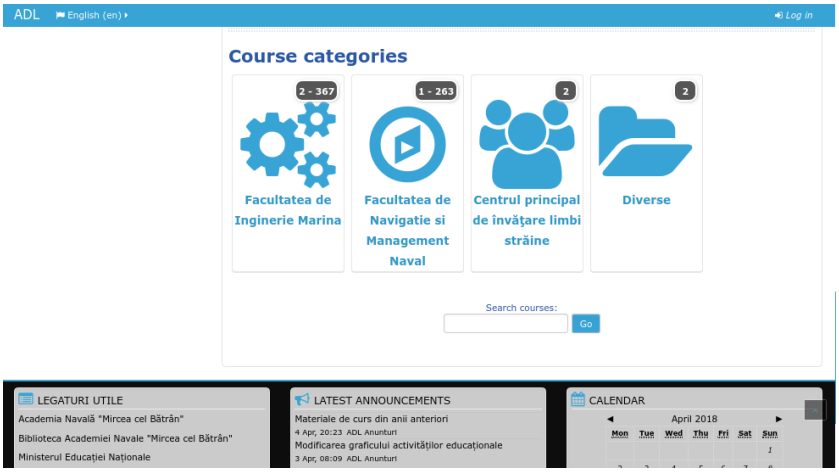

Figure 1 Partial view of the e-learning website of "Mircea cel Bătrân" Naval Academy.

The syllabuses of the courses impose weekly or semimonthly course lectures, which take place in auditoriums with more than 100 seats, equipped with internet connection and video-projectors. Each lecture typically alternates presentation of theoretical aspects (using PowerPoint slides) with live demonstrations of their practical applications. Course slides and/or course handouts are published on the course page (within ADL), so students can print them out in advance and bring them in class during the lecture. Each live demonstration is designed around a particular topic, but through active student participation, they can evolve in various directions (e.g. case studies, "do's and don'ts", alternative solutions, etc) and touch related topics that students consider interesting.

The syllabuses of the courses also impose weekly practical classes (laboratories), which are scheduled in computer labs with 20 seats, equipped with high-speed FTTC/N internet connection and desktop computers. For each lab class, students log onto ADL, using their personal accounts and access the course page (see Figure 2). The course page is divided into topics according to the syllabus. Each topic includes:

- slides and/or handouts for the PowerPoint presentations used during course lectures;
- work assignments with (optional) directions on solving them;
- complete solutions for the work assignments;
- a quiz related to the topic contents.

Students frequently start their lab classes by reviewing and discussing with their peers previous work assignments and/or submitting in postponed quizzes. Afterwards, they move on to work on the next unsolved assignment. Depending on the complexity of the exercises, the assignments pages are a mix of textual requirements, support data files, and videos that showcase the desired outcome.

While working on assignments, students have unlimited access to lectures notes and examples, are allowed to Google similar solutions, and are encouraged to share and discuss their own ideas with their colleagues (while following academic ethics).

Finally, students are required to take the topic's quiz, which is the only activity that students must complete inside the lab class (i.e. they cannot complete them at home).

All assignments are accompanied by solving guidelines or even complete solutions, which are particularly useful for self-paced courses.

Figure 2 Partial view on the main page of a programming course.

4. Self-paced design

Our students come from various high-schools study programs and they their digital skills cover a wide range, from beginner to experts. Due to this heterogeneity, it is important to develop learning paths that are flexible with respect to complexity and timeframe that best suit each student's learning style [15] [16]. We implemented this by using built-in Moodle features, like availability options, completion tracking, and access restrictions.

Figure 3 Partial view of an assignment page

Each course is divided into topics (according to the syllabus). Topics contain various learning resources and practice activities (assignments and quizzes), as presented in the previous section (see also Figure 3). Students can work on assignments in advance, before their opening date and, they have 1 week to complete them after the ending date, which gives them in total 2 weeks to complete each

assignment. This time span was selected in order to avoid procrastination, but other options can be used, too.

All assignments are accompanied by videos explaining on possible solutions for the exercises [17]. These solutions are available to students after the corresponding assignment's end date. We also experimented with other options, including solutions are always available, and solutions become available right after the student submits his/her solutions.

5. Results

We started experimenting with the course structure presented in this paper in 2014, introduces it 2015, and after going over various revisions, we achieved the current design/structure (although we strive to constantly improve the content). After each semester, the QA office of MBNA measures the students satisfaction levels (from 1 – not satisfied, to 5 – very satisfied), using anonymous online questionnaires. Figure 4 shows the evolution of the average student satisfaction (in fall and spring), for the programming courses we presented in Section 2, The chart shows the 2014 change point, when student satisfaction levels raised as a result of the new instructional methods used in these courses.

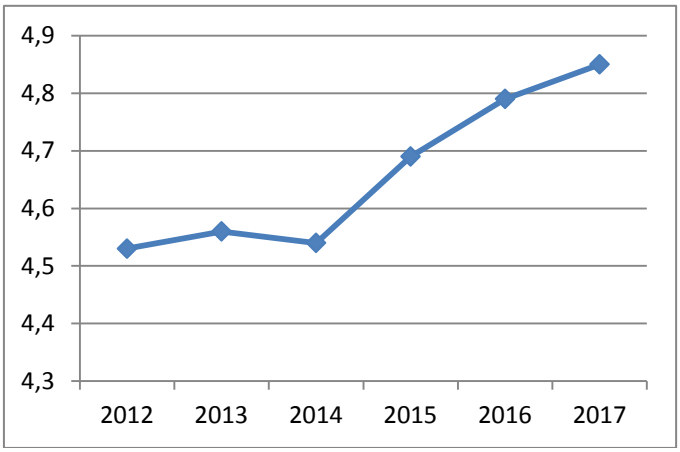

Figure 4 Student satisfaction levels (based on student anonymous responses)

6. Conclusions

For future engineers, digital competencies are an important part of their education. Developing such competencies to the advanced level required by the maritime industry is challenging, especially considering the heterogeneous high-school background of students. Blended-learning supports students to narrow the digital knowledge gap between them and their colleagues, by providing access to a large set of educational resources and activities. Self-paced approaches allow students to adapt the learning rhythm according to their needs.

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