

ON THE AALBORG UNIVERSITY PROBLEM BASED LEARNING MODEL AND APPLICATION TO TEACHING COMPUTER GAMES

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Abstract: This paper gives a short overview of Problem-based learning, the pedagogical approach developed at Aalborg University in Denmark in early 1970s, and implemented and developed ever since worldwide. Media Technology (Medialogy) education is used as an example in this paper. Using novel media technologies, the students develop new applications, often dealing with mobile education, and educational or serious games. Several examples of students' projects are summarized. Some of pros and contras and experience of implementing this at Belgrade Metropolitan University are discussed and analysed.

Keywords: Problem based learning, Project oriented learning, Mobile learning, Computer games, Educational games

1. INTRODUCTION

Since its inception in early seventies by two newly founded Danish universities (Aalborg and Roskilde), Problem based learning has spread among many world universities.

In this paper we will very briefly present the main ideas of the Problem based learning and how it is implemented at Aalborg University in Denmark, which currently holds an UNESCO chair of problem-based learning.

We will illustrate this by describing PBL implementation to 9 years old, but now very popular and well-established Medialogy (Media technology) education, as well as the first promising experiences in implementing the PBL approach in teaching computer games in, Serbia.

Namely PBL is used with classical teaching approach for teaching Software Development for Computer Games at BMU (Belgrade Metropolitan University) in order to combine advantages of these concepts.

The paper is organized as follows:

- Aalborg model in PBL is sketched in the Chapter2
- Chapter 3 presents Media Technology education
- In Chapter 4 some examples of students' projects are given. The criteria for choosing the projects presented here was not that they were successful and well-executed, but that they deal with producing technology-based learning materials themselves - thus, the learners become producers for future learners;
- Metropolitan University Game line education description is in the Chapter 5, followed by some of games' descriptions that the students have developed during their project work in Chapter 6;
- In the closing, Conclusion chapter, we present some thoughts on transferring educational model from one environment to another, and give some ideas for future cooperation.

2. PROBLEM BASED LEARNING - AALBORG MODEL

PBL is an ambiguous concept in international teaching and learning practice and literature. It can mean both problem-based and project-based learning, which are both well-established concepts.

However, even if we look at problem-based learning only, in spite of shared basic ideas, there are differences in practice between Danish universities (Roskilde from 1972 and Aalborg from 1974) and other universities worldwide (for example, Linköping in Sweden and Maastricht in the Nederland).

This paper will concentrate on Danish model only [1], which builds on ideas of Illeris[2], among others, and works with the following principles:

- problem-orientation;
- project work;
- interdisciplinarity;
- participant directed learning;
- exemplary principle;
- team work.

Thus, Danish approach to PBL combines problem-based and project-oriented approach, using problems as a starting point for learning in groups. The same model is implemented for all study-lines at the Aalborg University, from the first semester of Bachelor studies up to the 10th, graduation semester of Master studies. The model is under constant development and adjustment.

At the beginning, there has been lots of skepticism among educators, employers and public, but over the years a solid reputation has been established. An interesting data was released by Danish statistics in June 2010:

Ten years after graduation, Aalborg University graduates, on average, earn more than any other university graduates

in Denmark [3]. This is taken as yet another strong indicator that problem based, project oriented pedagogical model is successful in practice.

As on other, more classical universities, each semester consists of 30 ECTS, but they are divided into courses (typically 3 different courses 5ECTS each, combining different teaching methodologies), and 15ECTS group project work, with a common group exam, but with individual grades. The students formulate the problem for their project by themselves, constrained only by the semester theme, back it up by the state of the art research, proving that their problem is a real problem worth solving, and then find the best possible solution to the problem, up to their skills and knowledge.

The question often raised by educators novel to PBL teaching is: "How do you assure that all group members give a significant contribution to the group work, learn enough and not pass the exam based on other group members' work?" The answer, proven by many years of practice and several research conducted among students [1], is that PBL is a real self-regulatory model: "Free-riders" (jargon for the members of the group who try to pass on the work of others) could survive the first, and, maybe, the second semesters - but then they have difficulties in getting accepted to any of the groups, as the students get to know each other very well. So the choice of those students is either to start working very hard for a semester, rebuilding a reputation, or quit the education, thus learning a very important life lesson.

So, in brief, the main characteristics of PBL are [1]:

- Learning is driven by challenging, open-ended, ill-defined and ill-structured problems;
- Students generally work in collaborative groups.
- Teachers take on the role as "facilitators" of learning.

3. MEDIA TECHNOLOGY (MEDIALOLOGY) EDUCATION

Aalborg University established Medialogy study line for the first time in fall 2002 at the faculty of Engineering and Natural Sciences. The idea was to offer a university education at bachelor, master and PhD levels in a combination of technical and humanistic subjects, like screen media, digital sound synthesis, sensor technology, perception, aesthetic, media sociology, computer graphics, human-computer interaction, interface design, etc., which would together enable the students to become "global problem-solvers in the technology world, independently on the problem"[6].

As it is stated on Medialogy web-presentation aimed for future students [5]:

"Medialogy focuses on education and research, which combine technology and creativity as means to design new processes and tools for art, design and entertainment – we do this to meet the requirements of our contemporary media industry. In authoring and designing Interactive Media, it is becoming increasingly evident that the largest challenge lies in bringing together different disciplines. Medialogy's interdisciplinary approach

acknowledges that mastering and combining such a variety of disciplines requires a strong technical foundation, both in theory and in practice."

The educational approach is Problem Based Learning, [1], [4], as at all other studies at Aalborg University.

4. MEDIALOLOGY STUDENTS' PROJECTS EXAMPLES

Because the topics of this conference is e-learning and technology based learning, among many different projects developed at Medialogy study line, those presented here will be dealing with application for learning. The first one is addressing mobile teaching of English for dyslectic adults, the second is a serious game challenging the concept of "First person shooter" games, and the third exploits challenges of technology-enhanced tools acceptance in the elementary-school classroom, and suggests the teachers' inclusion in development of such materials.

3.1. Mobile learning example: I-phone application for dyslectic adults learning English

This was a project on the first semester of Medialogy Masters studies in fall 2010. [7]

Introduction Danish dyslexic adults, learning English, need a tool that offers the possibility to practice the foreign language outside the classroom. This project introduces a mobile application, designed for the iPhone and iPod Touch, as a possible solution to the problem. The application's design approach is inspired by the multi-sensory Orton-Gillingham teaching method [8], which relies on combining audible, visual and haptic modalities to strengthen memorization. The iPhone and iPod Touch has been chosen as the interfaces for the application because they allow mobile multi-sensory interaction.

Method and Material The application has been developed in collaboration with Hovedstadens Ordblindeskole (The Capital School of Dyslexia in Copenhagen), where adult students are taught English with Holmberg's English Learning Program (HELP) [9].

HELP involves certain systematically structured spelling exercises and color codifications. At present, the students are unable to practice HELP outside the classroom without the teacher's participation. The design purpose of the application has therefore been to represent HELP and let the students continue the schoolwork by themselves in a natural and intuitive way.

A qualitative interview based field study, involving teachers and students, has been conducted at the school in order to examine the application's usability and representation of the HELP system.

An additional qualitative test has been conducted in order to examine how relevant video output, visualizing pronunciation, is for solving the spelling tasks.

Results and Discussion The usability test showed that the application interface is intuitive and amusing to work with. Overall the users felt comfortable and familiar with the application layout. Due to its quiz based tasks and systematic visual structure; it was obvious for us to convert HELP into an edutainment application for the iPhone/iPod Touch. Hereby the students are offered a so far unavailable opportunity to continue their learning ‘on the go’ outside the classroom.

Results from the second test showed that the majority of the test subjects found it easier to solve the tasks if provided with an additional video output.

However some subjects found the video distracting and irrelevant. Both teachers and students have emphasized the need for such a mobile application. Even in this early prototype state they showed strong enthusiasm towards the application, which indicates the relevance for further development.

3.2. Serious games: First person victim

This was a Master project defended in June 2010 [10]. Since then, it was presented at several conferences, for example [11], published as a book chapter [12], and used as a test-bed application for several experiments in virtual environments.

The problem statement is:

“What will you do when an air strike is announced, the attack is targeting your hometown, and you can hear the bombers coming nearer? How will you find your loved ones in the carnage after the explosions? What would it be like to be on the other side of the guns pointed at you by the invaders? What happens when we turn the roles around and the "First Person Shooter" becomes a "First Person Victim" experience?”

Scientific and psychological studies claim a variety of triggers in video games with violent content may promote aggression. To oppose the violent behavior of players in these games, this project investigates how the sources of aggression and first person shooter conventions could be exploited in the “First Person Victim” experience to create awareness about the consequences of war for civilians. An evaluation of the implemented experience indicated that the participants were engaged in the experience, despite the tragic theme, and that they were able to acquire an understanding of the theme being mediated.

3.3. School applications

Although there are many documented claims that educational games are beneficial for teaching, they are still not widely used in the classrooms.

There are many indicators that teachers’ attitude is crucial for technology acceptance/refusal in educational practice. This students’ project stated the problem

How to design an educational game with a didactic approach for pupils in elementary school, where the teachers are in focus of the development?

As a solution to this problem, a pilot study with local teachers from Ballerup commune was done during the cause of the semester. An user-centered innovation process was adopted.

The test shows that the approach of compiling empirical data from the teachers’ experiences has been a success when developing a product used by the teachers.

However, to make a conclusion upon a larger influence of increasing the use of educational games at elementary schools in Denmark, the students have concluded that there is a need for further tests. However, the prospective for using this approach for comply the lack of use of educational games are positive.

5. INTRODUCING COMPUTER GAMES COURSE AT METROPOLITAN UNIVERSITY

At BMU is applied classical teaching concept (fig 1), established in 2005 at Faculty of Information Technology (FIT) at a bachelor level (fig 1).

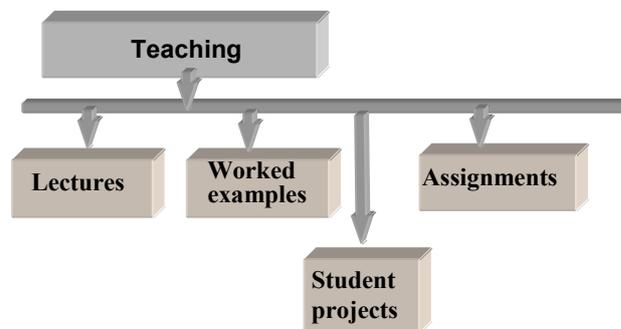


Fig 1 Traditional teaching model at BMU

Lectures are traditional presentation of facts, concepts and information about chosen subject.

Worked examples are step by step demonstration how to solve typical problems related to subject and concepts explained at lectures.

Assignments and student projects as forms of independent problem solving allow students verify and sharpen acquired knowledge.

Based on this concept FIT pioneered in Serbia introducing e-learning and enabling study to students not able to attend classes in a traditional way [14].

Recently, this study line was completed by master and PhD education levels, and successfully applied to other fields introducing faculty of management, faculty of digital arts and faculty of tourism and sport.

Also, few years ago (2009) a module for Software Development for Computer Games was introduced with the aim to fill in the gap (there were no similar education in the country),

5.1 Analysis of Teaching Approach for The CG Course

PBL is attractive learning concept since it enables positioning the students in the simulated real professional world, with the tasks often not well defined and requiring original, creative and multidisciplinary approach.

Students are active agents engaged in mutual work on common knowledge construction.

On the other hand, it is well recognised that this approach not quite effective for the beginners which should process a lot of new information in a limited time. For the well-defined problems, student may spend more the time than necessary since studying worked examples becomes more effective [15].

Thus, traditional approach works well at initial and introductory study levels. Computer games (CG) course is taught at final year where students are to be faced with real CG world tasks and thus, prerequisites for applying PBL exists.

On the other hand, unlike mathematics or programming languages and techniques, CG field is richer in various subjects and less structured for study.

In fact, games are imitations of what happens in real life [16]. Like simulations, they create illusion of reality often called virtual world.

For this reason there is not specific theoretical discipline specific to computer games. Even game theory is mathematical discipline exploited to model and solve the problems arising in economics, military and other fields which can hardly be considered as games.

But, CG borrows the knowledge and methodology from other scientific and engineering fields, like software engineering, artificial intelligence, robotics and others disciplines (fig 2).

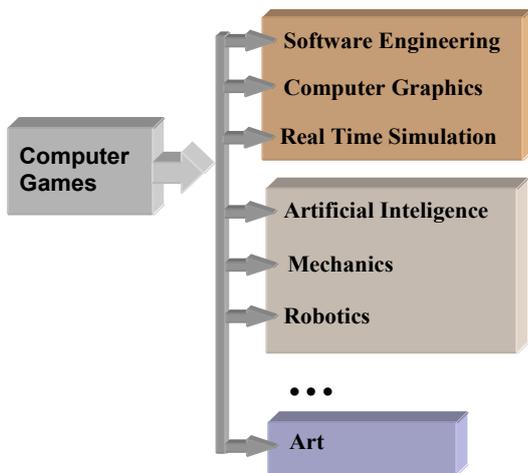


Fig 2 Theoretical base of Computer Games field

It is not obvious a priori how to compose the basic knowledge units enabling students to create games within a context of traditional teaching approach.

Additional point to be considered is rapidly evolving software technology for computer games. Namely, a variety of IDE's, game engines API's exist and is developing, to make easier game programming and hide complexity of underlying methodology like non Euclidean geometry in computer graphics or finite element method for solving partial differential equations in cloth modelling.

PBL is adaptive approach capable of following rapid dynamics of game development community and offering advantages over traditional learning model.

5.2 CG course implementation

The course is implemented as follows.

First, the core techniques from game design, computer graphics, real time programming, artificial intelligence and mathematical modelling of motion are identified and put into traditional teaching model.

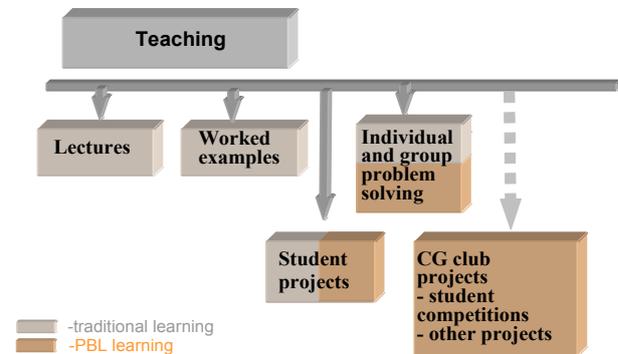


Fig 3 Combine teaching model for CG Course

Worked examples are composed in order to enable student after one semester to build simple 2D game using C++ IDE and OpenGL API. Doing homework, student confirmed acquiring knowledge. The next semester of course, focus on the 3D game concepts, introducing also 3D graphical modelling tools (Maya) and game engines (Unity 3D).

However, a teamwork and group problem solving are added to individual work as a choice to students. Also, a collaborative projects enabling several student to work on the same subject are introduced. In fact projects are individual, but share common goals, techniques, and enable exchange of knowledge and result. In parallel to the student classes, the student game development club is initiated with the aim to build the games and participate at student competition like Imagine Cup.

Instructors also took a part in these activities, but only as advisors, leaving students to build the teams, to define projects and find their way to solve imposed tasks.

6. BMU STUDENTS' PROJECTS EXAMPLES

After first semester the students shown very good results, some of them may be seen at [17]. Since the site is (still) in Serbian, a short description is given below.

A first game in the scope of the course was built before end of first semester as student project (fig 4).



fig 4 First game in the course

The game is very simple, Tetris-like and combines three elements – fire, water and paper. Fire burns the paper, water extinguishes fire, paper absorbs water.

The game is developed in Lua, inspired by student contacts with other gamers and teamwork in student club. The next project in the scope of Game AI, represents software environment for C++ implementation and testing of guidance and obstacle avoidance algorithms.

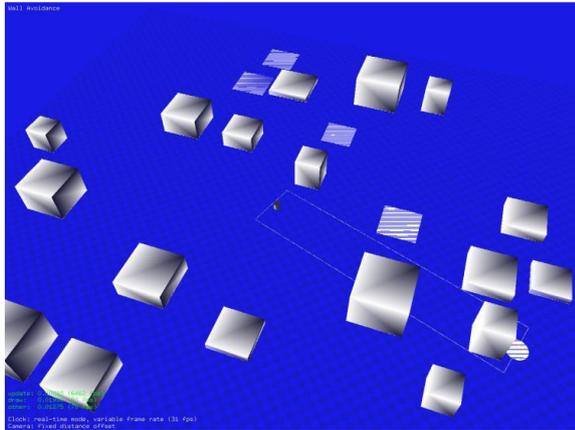


fig 5 Environment for implementing od intelligent agents

It is based on Opensteer library and OpenGL graphics .

A first 3D game was developed as a part of student activity in the game development club, to take part in competition Imagine Cup.



fig 6. 3D game Janitor for Win and Xbox

The robotised trash arrives from other galaxies and pollutes the schoolyard. The player is to clean the schoolyard finding right strategy to fight extraterrestres [14]. Developed in the XNA framework (language C#) for Win and Xbox platform.

The game is developed and submitted to competition before classes on 3D are finished. Also, XNA framework and C# were beyond the scope of the classes, so importance of problem based learning implemented in game development club is evident.

Other student examples are mainly from artificial intelligence field which has been shown attractive for students form other modules. Namely the students found virtual environment very practical for developing and

testing AI algorithms devoted for other (non game) applications..

7. CONCLUSION

Transfer of experiences, even positive experiences from one environment to another is never a simple and straightforward process. Local characteristics and small differences often pose a huge challenges.

Aalborg approach in PBL was found as a promising to increase efectiveness of the classsical approach in teaching software development for computer games.

The PBL approach in computer games software development course at BMU was found very useful in simulating conditions of real professional games world, facing the students with teamwork aspects, mutual competition and promoting creativity and action.

The positive feedback on the traditional learning line was also noted. Mutual collaboration helped students to make concept clear with less (or no) help of instructor. Also, often the students propose their own way to solve the problems and in the majority of cases it was easier to do way.

As it was pointed in [19]:

- Today’s learner will have 10 to 14 jobs ... by the age of 40!
- 1 out of 4 workers today is working for a company for whom they have been employed less than 1 year
- More than 1 out of 2 are working for a company for whom they have worked less than 5 years
- The top 10 jobs that will be in demand in 2012 didn’t exist in 2000.

So, the situation in engineering education is:

- We are currently preparing students for jobs that don’t yet exist
- ... using technologies that haven’t yet be invented,
- in order to solve problems we don’t even know are problems yet!

In this reality, problem based teaching approach, with its ability to teach many social, negotiation, group-work and society-awareness skills to future engineers, seems to be a reasonable and promissing answer to current educational challenges.

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