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R E P O R T

on

Experiences in Introducing Problem-based Learning at the University of Belgrade - Faculty of Civil Engineering (UBFCE) – Activity 6.3

Belgrade, June, 28th

Project-based Learning (PBL) was introduced within the course Design and Implementation of Geoinformation Systems. The course that included PBL was held in the summer semester 2018 (from February 2018 until June 2018). This course is mandatory and it is located in the second semester of the master programme, module Geoinformatics. The course has been selected for PBL because it is quite reasonable to assume that design and implementation of some typical GIS solution is actually the best way for students to acquire knowledge and skills that are listed in the course content. Therefore, it was estimated that this course is well-suited for the first introduction of PBL at the UBFCE.

ABOUT THE COURSE

The content of the course Design and Implementation of Geoinformation Systems is the following:

Lectures:

- Introduction. Information systems. Introduction to the design and implementation of information systems.
- UML models and diagrams. CASE and other tools for the development of information systems.
- System analysis and user requirements assessment.
- Modelling of functions and processes. Data modelling.

- System architecture. Database design.
- System implementation. Organization and management of the project. Introduction of the system into operation, user training and system maintenance.
- Design and implementation of geographical information system.
- Analysis of user requirements, evaluation of users, existing data, hardware and software.
- Spatial database design.
- Data acquisition and data conversion.
- Hardware and software selection.
- Data distribution.
- Specific aspects of development and implementation of geoinformation systems for real estate management.

Exercises:

- Development and implementation of a geographic information system for the selected area of application using various software tools (CASE tools, DBMS and GIS software): use-case analysis, modelling and implementation of database.

Learning outcomes:

- List, describe and explain all the major phases and activities during GIS design and implementation process.
- Use CASE and other software tools and to apply them for the design and implementation of GIS and for preparing project documentation (UML diagrams, data dictionaries, Gantt chart, etc.).
- Recognize the importance of user needs assessment and to apply it and use it as a starting point for the design and implementation of GIS.
- Perform system analysis, identify and analyse required functions of the system and translate them into user needs specifications.
- Perform modelling of functions and processes.
- Perform data modelling i.e. design suitable data model of the system.
- Analyse requirements, hypothesize, compare and propose solutions for the relevant issues during the design and implementation of GIS: evaluation and selection of suitable spatial data models and sources and software and hardware architecture. Formulate data, hardware and software specification.
- Assess user training needs and plan training activities.
- Plan and manage activities for implementation of GIS project and assess costs involved.

Prerequisites for a student to take this course is that student previously attended the course Geographic Information Systems (GIS) and have finished all the pre-exam prerequisites (passed two tests and finished one project work) for that course. The content of lectures for GIS course is the following:

- The principles and architecture of spatial databases.
- Database modelling and UML.
- Databases and standards for spatial data (ISO TC 211 and OGC).

- Spatial data infrastructures.
- Legal issues, ownership and use of spatial data.
- Metadata for spatial data.
- Internet and web-based solutions for publishing spatial database.
- Spatial decision support.
- Spatial data mining.
- Aspects of spatio-temporal data.
- National Spatial Data Infrastructure for real estate information management.
- Advanced GIS analyses for real estate management (spatial and non-spatial queries, geocoding and address matching, property transactions, polygon overlay, real estate appraisal, real estate taxation, real estate market analysis, marketing, etc.).
- GIS as a tool for managing real estate data, natural resources data and infrastructure data at the city level (objectives, legal and institutional framework, technology, resources).

Having in mind this, and the knowledge and skills which students acquired within courses Geoinformatics 1 and Geoinformatics 2 (bachelor study programme), it is expected that students are reasonably well prepared for the course Design and Implementation of Geoinformation Systems.

The effort that is required from a student to finish the course Design and Implementation of Geoinformation Systems is estimated to 5 ECTS.

PBL PART OF THE COURSE

For the moment, it is decided that a student should be reworded with 4 ECTS for the PBL part of the course, whereas for the lectures and tutorials related to UML models and diagrams and CASE and other tools for the development of information systems that are taught in a standard way of teaching, student gets 1 ECTS.

The total number of students that attended the course in this semester was 16. Students were divided in 4 equally sized independent groups for the PBL part of the course. Students with best grades are appointed as group leaders and they had the opportunity to select other members of the group.

PBL PROBLEM STATEMENT

Each group basically had to solve the same problem/task:

- Customer (public utility company) wants do develop and implement a system for the maintenance of horizontal and vertical traffic signals. Required outcome: report containing:
    - Detailed specifications for the software (terms of reference) and estimation of the budget, so that the software procurement could be prepared properly;
    - Detailed specifications for the spatial data (terms of reference) and estimation of the budget, so that the documents for tender for outsourcing data acquisition could be carried out;

- Timetable of activities on project implementation;
- Estimation of all costs on the project implementation.

At first glance, the task seems to be a straightforward process. However, there are many problems that have to be solved such as:

- how to draft specifications for appropriate software and hardware depending on user requirements and certain limitations (existing situation, available resources and budget, etc.);
- how to draft data specifications required for the system;
- how to estimate spatial data quantities;
- how to estimate duration of activities:
- how to estimate total costs, etc.

Of course, the starting point for solving this problem scenario is the analysis of user requirements. For this purpose, students were given an opportunity to specify the list of questions to be answered by the customer. They also had a chance for further clarifications and additional questions. In order to prevent plagiarism between groups care was taken that different answers were provided to groups. Care was also taken that these differences results in equal complexities of the problems given to different group. Some of these differences are: different customer, i.e. different city and project area, total different available budget and resources for project implementation and differences in existing software, hardware and data. Of course, all groups have to respect relevant legislation. Teachers provided help in this process by providing certain materials such as existing tendering documentation for software procurement and some relevant legislation documents. Customers' representatives also provided useful documentation regarding existing software, hardware, data and procedures used within their organisation.

PBL SESSIONS

PBL Part of the course is organised within the following PBL sessions:

- Tutorial 1 : Presentation of the study case. Clarification. Problem statement.
- Tutorial 2: Review. Work plan.
- Lecture: System analysis and user requirements assessment.
- Tutorial: Review. Task: System analysis and user needs assessment.
- Tutorial: Review. Task: Modelling of business processes and functions.
- Tutorial: Review. Task: Software specification development.
- Tutorial: Review. Task: Analysis of possible software solutions and estimation of costs.
- Tutorial: Review. Task: Data modelling and data specification development.
- Tutorial: Review. Task: Estimation of costs for data acquisition.
- Lecture: Project management for geoinformation system implementation.
- Tutorial: Review and update of the work plan.
- Tutorial: Review. Task: Timetable of activities on project implementation.
- Tutorial: Review. Task: Estimation of costs on project implementation.

- Tutorial: Final review.
- Seminar: Final presentation.

For each session, two or three hours (2-3 x 45 minutes) were assigned. Within these sessions and independent learning and work in between, students had the opportunity to solve given problem following 7-jump process: clarification, problem statement, brainstorming, clustering, identification of learning goals, self -study and post-discussion and application of the knowledge to the problem. As it can be seen from the list of sessions above, two lectures were held. However, before the PBL part of the course, lessons and tutorials on UML diagrams and using CASE software Visual Paradigm for making these diagrams were held for students.

PBL ASSESSMENT

We have decided to assess students' efforts and results on PBL part of the course in the following way:

- Group's product and performances (40%, final presentation); Each student/member of the group have major responsibility for one part of the problem – he presents results for that part during final presentation, so each group member receives grades/points depending on group's results, but also depending on his results also;
- Student's reflections (20%, survey form);
- Peer-assessment (30%, survey form);
- Self-assessment (10%, survey form);

No special testing of student's content knowledge was planned. Of course, this knowledge was assessed during final presentation, including student's answers to questions asked by teachers during and after presentation. After discussion with other project members, we have come to the conclusion that more formal assessment of student's content knowledge should be included in the next year. Therefore, the assessment will be the following:

- Group's product and performances (40%, final presentation); Each student/member of the group have major responsibility for one part of the problem – he presents results for that part during final presentation, so each group member receives grades/points depending on group's results, but also depending on his results also;
- Content knowledge (30%, test in written form);
- Student's reflections (10%, survey form);
- Peer-assessment (15%, survey form);
- Self-assessment (5%, survey form).

RESULTS AND FURTHER ACTIONS

First results and experiences are encouraging. It is clear that this approach is more interesting for students, because they participate actively on classes which is not the case with standard lectures. Also, they find it more motivating, because they believe that solving real-life problem ensures that

acquired knowledge is relevant for future professional. At least, this was a new experience for them and the first feedback is positive.

However, certain problems were also identified. Firstly, preparation for the PBL was time-consuming for teachers. It took some time to find suitable problem scenario. It was also difficult to prepare suitable documentation and to provide cooperation from the customer. Designing the problem so that complete course content, or at least major part of it, is covered by PBL was also a significant issue, especially having in mind that complexity of the PBL problem should be proportional to ECTS points assigned to PBL part of the course. We are still not sure that these requirements have been satisfied successfully/completely. To compensate for the considerable complexity of the problem scenario, teachers provided more help to the students than it had been initially planned. Students were also somewhat nervous and disoriented at the beginning, because this was a new experience for them. Problem was also that PBL sessions started with a few weeks of delay. The result of these problems is that final deadline for the presentation and the delivery of the results is extended.

Regardless of the problems encountered we believe that this was quite good experience, and we believe that PBL approach will be introduced in some other courses at UBFCE. The very next action will be introduction of PBL into a course GIS Programming. This is a 3 ECTS points course taught at the third semester of master academic studies, module Geoinformatics. Course with PBL implementation will start in October 2018. The approach will be similar to the one used for the course Design and Implementation of Geoinformation Systems. Of course, experiences gained during that first PBL implementation will help in avoiding some mistakes that were noticed.

It is obvious that standard way of teaching, that is, only through lectures are not interesting enough for many students. They have to be pushed/motivated somehow and PBL seems to be a good approach for that. Currently at FCEUB, knowledge gained through lectures is to some extent shallow, i.e. some students' gain knowledge that is not active enough. Students forget much of it after passing exam, and problem-solving skills are lacking. There are also too much testing at the faculty, especially in the first three years of the study programme (bachelor studies). This is a significant burden for students. They need a lot of time to memorize lots of theory (mostly facts) and to prepare and participate in testing process. This is also time-consuming for teachers. The result is that there is lot of efforts with poor effects and introducing PBL to greater extent could improve that. Other benefits, such as lifelong learning, working in team, discussing different proposals/opinions and reaching some sort of consensus are something that should be promoted by introducing PBL more.

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