Using Cases in an Undergraduate Course of Didactics of Informatics

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Authentic cases have been used in education both as case studies and as references to support students find solutions to similar problems. As cases are not deprived of complexity like the usual examples used for educational reasons, they can help learners to deal with complex ill-structured problems as those encountered in the workplaces and thus prepare them for the work world. In this paper, we present how cases can be used in a Didactics of informatics undergraduate course in order to support students in designing student-centered lessons of Informatics, using constructivist educational approaches and tools. Five cases were used in the framework of the course activities and each one described an one-hour lesson of Informatics conducted in the secondary education. The course outline and an empirical study that aimed to examine the efficiency of the particular approach in succeeding the course's learning objectives are presented in the paper. The results of the study are also discussed.

Keywords

Case based learning, Case based reasoning, Case study, Didactics of informatics, Instructional design

1. Introduction

The case method was introduced in higher education in the Harvard Law School during the second half of the 19th century. When Harvard Business School was established in 1908, the method was transferred to the new faculty, first in the course of Commercial Law and then spread to the entire curriculum [1]. In the way the method was implemented in business education, the students studied material describing a problematic business situation, analyzed the facts and seeked a solution, usually through discussion conducted into the classroom [2]. In the second half of the 20th century, the method became popular worldwide not only in business education but to other disciplines such as Medicine, Science [3], Engineering [4] and Teacher education [5]. In these disciplines the case method was no longer necessarily combined with the discussion method, but could be found in combination with lecture or group work [3]. Despite these differences, the cases were used as problem solving activities helping students to develop both analytical and decision making skills by dealing with complex real-world situations.

A different application of cases in education has appeared in the last decades in parallel with the development of Case-Based Reasoning (CBR). Studies in CBR examine how a model

can be developed for creating intelligent systems and explaining human cognition [6,7]. CBR suggests that solutions to new problems are generated by retrieving relevant experiences from memory and adapting them to fit new situations [7]. From this point of view, cases record previous experiences and are being used in education as references when trying to solve a new problem. This type of case, apart from the description of the problem, includes the description of the chosen solution and the outcome [6].

No matter in which of the aforementioned way are cases used in instruction, they can bridge the gap between theory and practice, encourage active learning and foster problem solving skills [4]. According to previous research, cases can be used successfully for professional education as they can prepare the learners to deal with complex ill-structured problems as those encountered in the workplaces [8].

Taking into account these characteristics, we decided to use cases in a course of Didactics of Informatics and study the effects of this approach. The course is offered in the last year of undergraduate studies of the faculty of Informatics and it aims to prepare the students who might choose to become Informatics teachers for the work world. The general purpose of the course is to enable the students to design student-centred lessons using constructivist educational approaches and tools. Designing a lesson is an ill-structured problem as there is not a unique correct solution and many parameters have to be taken into account in order to design a lesson successfully. The cases described authentic one-hour Informatics' lessons conducted in the secondary education and were used in the framework of activities elaborated by the students both as case studies and as references for supporting the solution of other problems.

The purpose of the study was to explore whether cases can support students to accomplish the course's main learning objective, that is the design of lesson plans, as well as to detect influences of the use of cases in the tasks elaborated by the students in order to foster the accomplishment of this objective, namely lesson reporting and lesson plan evaluation.

Particularly, the main research question was:

- Do cases help students design better lesson plans?

and the additional research questions included:

- How do cases influence lessons' reporting?
- Do cases help students to evaluate better given lesson plans and propose possible improvements?

Furthermore, the study intended to detect the opinions of students about the usefulness of cases in the tasks assigned during the course.

2. Course description

As the main purpose of the course is to enable students design student-centred lessons, it was organised itself in a student-centred way. That means that the usual lectures were accompanied by a series of homework assignments and a laboratory session in order to attain the students' active involvement. The course's lectures dealt with learning theories, instructional design, didactical approaches for the instruction of programming, concept maps as instruction tools [9], and, finally, evaluation and feedback. During the three-hour lab session, the educational software Microworlds Pro was presented and the students had the opportunity to use it in order to create educational applications. The homework assignments consisted of a) activities that aimed to help the students go deeper on the course's topics and b) projects that required the synthesis of the concepts discussed in the course in order to create authentic products. The activities were related to the topics discussed in the lectures. Each activity was presented to the students during the corresponding lecture. The assignment and the supporting educational material, consisting of the presentations used in

the lectures and relative papers, were available on the course's web site. The students worked individually for two weeks, and submitted their answers by email. The activities were evaluated and feedback was provided, both in an individual and in whole-class level. The individual feedback was available through the course's web site in the form of short comments, while the whole-class feedback, consisting of common errors and the proposed correct answers, appeared on the site and was presented and thoroughly discussed during the subsequent lecture. The 160 students enrolled in the course were divided into four groups, each one having a different focus. The groups focused on different course topics: a) the instructional use of the Educational Software Microworlds Pro, b) evaluation and feedback, c) the use of communication tools and d) the use of cases. The students of the latter group participated in an empirical study that aimed to examine the efficiency of cases in succeeding the course's learning objectives. The lectures and the lab session were common for all four groups, while differences appeared to the homework assignments. Further down in this paper we will describe the assignments and the way of work of the students that participated to the empirical study.

2. The empirical study

2.1 Method

The participants

In the study, that was conducted during the winter semester of the academic year 2006-2007, forty of the students that had enrolled in the course of Didactics of informatics participated. The students were further divided into two groups of twenty students each: one being the experimental group and the other the control group. They had no previous experience in lesson planning or teaching. Moreover, they were not familiar with the use of cases for educational reasons.

Materials and procedure

During the course, the students of both groups attended the course's lectures, participated in the offered lab session and elaborated equal in number homework assignments: four activities and two projects. The two out of the four activities and both projects were common for the two groups. The other two activities were diversified as the experimental group worked with cases on similar tasks with the control group.

More specifically, the first activity (see Table 1) that was common for both groups, concerned the learning theories and asked the students to comment on given alternative teaching approaches and then propose an approach on their own on a different subject matter.

The second activity's subject was "Instructional design" and the assignments were different for the two groups, as the students of the experimental group worked with cases. All the cases used in this activity and in general in the framework of the course, described authentic one-hour lessons of Informatics conducted in the secondary education. Each case was divided into five parts[6] as follows: a) the problem, that is what subject we want to teach and to which audience, b) the solution, which included the lesson plan and a description of its implementation in class c) the steps that the teacher made to prepare and conduct the instruction, d) the explanation of the teacher choices and e) the outcomes of the instruction concerning both the participation and interest of the students and the learning outcomes. In this activity the students of the experimental group were given three cases and were asked to study them and answer a series of questions for each one of them. In other words, the cases were used in the form of case studies. Especially, the first case described the

Table 1 The activities.

Assignment	Subject	Experimental group	Control group
Activity 1	Learning theories	-read three alternative teaching approaches for the instruction of the loop structure in programming -identify advantages and disadvantages for each approach -predict outcomes -select the most appropriate approach and justify the selection -propose a teaching approach for the instruction of secondary storage devices	
Activity 2	Instructional design	-study a case describing a lesson of the conditional structure using MicroWorlds Pro -identify teaching methods -comment on the used teaching methods -study a case of the instruction of bubblesort using the role playing method -comment on the role of the teacher during the role playing and the proposed scenario -describe the use of role-playing in another Informatics' topic -study a case describing the instruction of loop structure using the lecture teaching method -comment on the reduced participation of students -propose alternative teaching methods for the same subject	-evaluate the wording of four given learning objectives -propose new wording when necessary -write down 5-6 questions for the instruction of input/output devices using the teaching method of questioning and answering -propose an Informatics topic that could be taught using the brainstorming method -define learning objectives and teaching methods for the instruction on loop structure and secondary storage devices
Activity 3	Didactical approaches in programming	-read a case describing a programming concept instruction (procedures) using the didactical approach "Explorations" -identify correspondence of the questions in the worksheet described in the case with the approach's basic steps -read a case describing the instruction of the same concept using the didactical approach "Black box" -identify correspondence of the questions in the worksheet described in the case with the approach's basic steps -evaluate a given lesson plan implementing the approach "Black box" for the instruction of conditional structure in programming	-read a paper describing the use of the didactical approach "Explorations" and "Black box" for the instruction of the programming concept procedure. The paper contained detailed description and worksheets. - evaluate a given lesson plan implementing the approach "Black box" for the instruction of conditional structure in programming
Activity 4	Assessment-Feedback	-create an assessment question on the conditional structure, -predict possible errors and -provide corresponding feedback	

implementation of an activity on the conditional structure in programming using a Logo-like environment [10] and the students were asked to identify the particular learning objectives and the teaching methods and practices used. The second case described a role playing activity for the instruction of the bubblesort algorithm [11] and was followed by questions on the proposed scenario and the particular role of the teacher during the activity. Furthermore, students were asked to describe the use of role playing in another Informatics' learning content. The third case described the instruction of the loop structure using the lecture teaching method supported by a multimedia presentation illustrating the execution of an algorithm. This case was selected as a common misconception of the course's students was that the use of presentations in class constitutes always a student-centred teaching approach and they tend to propose analogous approaches. The students were asked to comment on the reduced student participation during the course and to propose alternative teaching approaches. The activity elaborated by the students of the control group concerned the same topics (learning objectives, teaching methods) but the questions did not refer to specific lessons. They as well had to define learning goals and propose teaching approaches for given learning contents.

The third activity concerned different didactical approaches in programming. The students of the experimental group read two cases, formatted like the cases of the second activity, that described the instruction of the same programming concept (procedures) using two different didactical approaches Explorations[12] and Black box[13]. Then they had to identify the basic steps of each approach on the corresponding worksheets that were provided within the cases. The students of the control group read the scientific paper that described the same lessons. Then both groups were asked to evaluate a given lesson plan based on the approach of the Black Box. In this activity, the cases were used both as case studies as the students had to answer questions concerning the described lessons, and as references as the described experiences were used to solve similar problems: evaluate the implementation of the same approach on another context.

The fourth activity was common for the two groups and was not of particular interest for the empirical study, but was elaborated in order to foster with completeness the course's objectives.

The two projects (see Table 2) were common for the experimental and control group. In the first project, the students had to visit a school in pairs consisting of one student from each group and attend one hour of instruction of Informatics in the secondary education. Then, they had to prepare a report describing the authentic lesson they had attended, explaining the teacher's choices and commenting them. Thus, they were prepared to design their own lessons, which was the requirement of the second project and the basic goal of the course. A slight diversification for the two groups concerned the form of the required report. The students of the experimental group were asked to provide a report structured as the cases used in the activities, while the students of the control group had not restrictions about the report's form.

The second and main project of the course concerned the basic goal of the course: lesson design. All students had to plan a lesson on their own and describe the way they would implement it in class. They could choose the subject they wanted to teach from the whole curriculum of Informatics in the secondary education as well as the teaching method, educational approach or tool from a list of four alternatives: Role playing, Explorations, Black box or Concept maps. All four alternative solutions were thoroughly discussed during the course's lectures and corresponding educational material was available through course's web site. An implementation of the three former ones was also described in the cases provided in the second and third activity to the experimental group. The project went under a peer assessment process that was divided in three phases. In the first phase (Phase A), each student submitted his/her lesson plan and description of the intended implementation. In the second phase (Phase B), the submitted solutions went through a blind review by a

peer who had to return analytical feedback. In the third phase (Phase C), the students had to read the review, revise their initial solutions and evaluate the evaluation and feedback they had received.

For the calculation of the course's grade the performance of the students in all the homework assignments was taken into account. Each activity valued 10% in the total grade, 20% valued the first project and 40% the second one.

After the completion of the course, the students of the experimental group were asked to fulfil a questionnaire that asked them to recall the subjects of the cases studied in the framework of the activities and comment on their usefulness for the elaboration of the projects.

Table 2 The projects.

Assignment	Subject	Experimental group	Control group
Project 1	Lesson reporting	-attend an one-hour Informatics lesson in the secondary education -interview the teacher -create a report structured as the cases provided in the activities	-attend an one-hour Informatics lesson in the secondary education -interview the teacher -create a free form report
Project 2	Phase A Lesson plan development	-choose an Informatics topic and an didactical approach, tool or method -design a lesson plan	
	Phase B Lesson plan evaluation	-evaluate a peer's lesson plan and -provide feedback	
	Phase C Lesson plan revision	-revise the initial lesson plan, -evaluate the evaluation and feedback received -comment on the feedback justifying which propositions were taken into account and which were ignored in the revision process	

Data collection and analysis

The students' answers of the two groups in the first activity were used as a pre-test to identify their prior knowledge before the insertion of diversification in the offered treatment.

In order to identify whether cases can support students design better lesson plans, which is the basic research question, the lesson plans designed by the students of the experimental and the control group in the framework of the second project were rated by two expert teachers using a 4-point scale:1=very poor, 2=poor, 3=good, 4=very good. The evaluators rated independently the submitted lesson plans focussing on the application of the selected teaching method, educational approach or tool. Disagreements were solved through discussion.

Furthermore, the empirical study seeked effects of cases in the courses activities that foster the lesson planning such as lesson reporting and evaluating. As far as the lesson reporting is concerned, the analysis was restricted to identify whether students who had previously worked with cases were able to explain better other teacher's choices. The focus on this feature was decided because the usefulness of cases depends highly on the explanations they contain [6], thus it is very important for the quality of lesson reporting which is in fact a case writing activity. Moreover, the evaluations of lesson plans in phase B of the second project were analysed in order to identify if the students of the experimental group could identify better problems concerning the application of given teaching methods, educational approaches or tools. For both evaluations the same 4-point scale and rating process was used.

Finally, the analysis of students' answers in the post experience questionnaires aimed to identify their perception about the usefulness of cases in the elaboration of the course's projects.

2.2 Results

The students' answers in the first activity, which was used as a pre-test to identify the prior knowledge of students of the two groups before the insertion of diversification in the offered treatment, revealed that their level was similar. More specifically, the majority of the students were able to comment sufficiently on given teaching approaches underlining the need for student-centred lessons, but, when asked to propose an approach on their own, they tended to describe teacher-centred lessons, using the lecture as the basic teaching method.

As far as the reporting skills were concerned, students of both groups tended to omit the explanation part in their lesson reports, although it was required explicitly in the first project assignment. However, only 18% (3 out of 17 students) of the experimental group did not explain the teacher choices in their reports, when the same proportion in the control group was double: 37% (6 out of 16 students). Furthermore, 9 out 17 students of the experimental group explained explicitly the teacher's choices in their reports when only 5 out of 16 students of the control group provided detailed explanations.

Differences between the experimental and control group were observed in their lesson designing skills (see Table 3). More specifically, the results from the rating process revealed that the students of the experimental group produced better lesson plans when implementing the didactical approaches that appeared in the cases (average 3,1 versus the 2,5 average of the control group). Analysing further the results in regard of the implemented approach, the differences concerned the plans implementing Black Box and Explorations while the plans implementing the Role Playing approach were similar between the two groups. This may be explained by the fact that the didactical approaches Black Box and Explorations have a predefined sequence of steps which the students had to implement while the use of Role Playing method was much more demanding in terms of design as the students had first to define the steps themselves and then describe how this would be implemented in the classroom.

Important differences were not observed between the two groups in the quality of the evaluations of the lesson plans implementing approaches that appeared in the cases (see Table 3). The average of the experimental group evaluations rating in the three approaches presented in the cases was 3,5 while the control group's was 3,4.

Table 3 Number of students' projects in each Quality Rating

		Experimental group					Control group				
		Rating				Total number of projects	Rating				Total number of projects
		1	2	3	4		1	2	3	4	
Role Playing	Design	0	1	2	1	4	0	0	1	1	2
	Evaluation	1	0	1	2	4	0	0	1	1	2
Black box	Design	0	1	2	1	4	2	1	1	1	5
	Evaluation	0	0	2	2	4	0	2	0	3	5
Explorations	Design	0	0	4	1	5	1	1	1	1	4
	Evaluation	0	0	0	5	5	0	0	2	2	4
Concept maps	Design	1	1	0	3	5	0	0	3	1	4
	Evaluation	1	2	0	1	4	1	0	1	1	3

The answers of the 13 experimental group students that fulfilled the questionnaire were used to detect their opinions about the cases' usefulness (see Table 4). According to these answers, the cases were very helpful in the lesson reporting assignment (Project 1) as 10 out 13 students answered that they consulted the provided cases before writing their report. Furthermore, 11 out of 13 answered that they used the cases as references when designing their own lesson plans. However, the cases did not influence them greatly in the selection of the teaching approach they would implement, as only 5 out 13 students answered that the cases were taken into account in order to make this decision. This was reflected to the proportions of students of the two groups that selected approaches presented in the cases which were similar (72% versus 68% of the experimental and control group respectively). Finally, only 6 out of 13 students recognize the usefulness of the cases in the evaluation of lesson plans process.

Table 4 Number of students that recognised the cases' usefulness in the elaboration of the courses projects

Task	Number of students
Lesson reporting (Project 1)	10/13
Subject selection (Project 2)	5/13
Lesson plan design (Project 2 Phase A)	11/13
Lesson plan evaluation (Project 2 Phase B)	6/13

3. Conclusions

The study presented in this paper aimed to detect whether the use of cases describing authentic lessons in a Didactics of informatics course can help the students achieve higher results in designing student-centered lessons of Informatics. Indeed, clues supporting this hypothesis were found, though only for a part of the didactical approaches which were covered by the cases. The results of this preliminary empirical study will be used to design further research in the future in order to identify the characteristics of the topics that cases can support and examine the way cases could be used in the framework of activities in order to support a larger variety of topics.

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