

EVALUATION OF SUPPORTING COURSEWARE BY MEANS OF ONLINE AND OFFLINE QUESTIONNAIRES.

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ABSTRACT:

A template for worked out problems and tutorials on the internet, as presented in former CBLIS conferences, was recently extended with an evaluation system. At the end of a session the student is prompted to fill in a questionnaire. Evaluation data, together with variables from the template (answers to questions in the courseware, timely information) are gathered on a central location.

The system is used for evaluation of the courseware supporting a first year university physics course. Apart from the internet data, a paper and pencil questionnaire at the end of the course provides information about the students' study habits and preferences. In this way an answer is expected to the question, which supporting courseware will be appropriate for students with a certain profile of study habits.

The paper gives the results of the evaluation. Furthermore a discussion is given which data can be gathered online and what kind of data are collected preferably by means of an additional questionnaire.

KEYWORDS: Evaluation, Internet Site, Worked-out Problems, Study Habits, Study Preferences

INTRODUCTION

At the CBLIS conferences of 1995, 1997 and 1999 the development was described of a template for worked-out problems ([1], [2], [3]). This template is also suitable to present computer lessons in another mode, for instance expository lessons on a certain topic. Projects were conducted both at the higher secondary school level and in first year university courses, studying the support of the learning process by means of computer materials. While the first attempts were undertaken with stand-alone computers, in the last few years a template was devised to deliver worked examples by the internet or internet-like presentations [3]. At all occasions the effects were monitored by asking the students about the degree the system met their need for materials and how it supported their study habits. In one study an attempt was made to compare the learning effect of *computerized* worked-out problems with the effect of printed ones; it did not show a significant effect [4]. In another study it turned out that student from upper secondary education, in particular female students, appreciated much the extensive feedback and the active study mode provided by worked-out problems [5].

This paper concentrates on two possibilities to evaluate the use of internet materials by students. One mode of evaluation is the classical one, consisting of a questionnaire given to the students after having used the materials. The other one, recently

developed as an addition to the template, consists of an on-screen evaluation form, presented at the moment the students completes a lesson. The result of this evaluation is sent to a central place where the courseware developer or the teacher can inspect it. The combination is studied before by Gosper and Love [6] who found a better response rate and more information from the online questionnaire.

In a study by Martín i Batlle et al. [7] it was suggested that first year university students have certain, but distinct preferences for the way they study a physics topic. However, a correlation with the way they use internet materials could not be found. This study investigates the correlations between favorite study activities and the effectivity in the use of internet materials.

DESIGN OF THE COURSE AND ITS EVALUATION

The present study relates to a course on Engineering Mechanics, the first physics course students follow on their entrance into the university study of Applied Physics. The course develops in six weeks, in each week a lecture and two tutorials (each session 100 minutes) are scheduled. Use is made of a textbook on mechanics by Meriam and Kraige [8], also containing sample problems and ‘classical’ problems to practice solving mechanics problems. For one topic, *elasticity*, scheduled in the fourth and fifth week of the course, the students use a reader and problems belonging to it. Throughout the course an attempt is made to enhance the ability to apply mathematics to physics problems. Therefore worksheets are contained in the *study guide*, to practice mathematical techniques like vector algebra and differential and integral calculus.

The course is integrated with a website, where the students can find six worked-out problems, a worksheet on vectors and an expository lesson about *elasticity*. After doing a lesson, an evaluation form is supplied, with questions about the effectiveness of the lesson and the difficulty of the problem (fig 1). The logfile resulting from this evaluation also contains information about the students’ progress through the lesson: answers to questions, timely information, occasions where help pages are consulted.

In the seventh week the students make an exam and they also complete an end of term questionnaire, evaluating the way they studied on the course and their preference for various study activities. A selection from this questionnaire is shown in fig. 2. By coupling the paper-based evaluation to the exam the response rate is likely to be favourable.

RESEARCH QUESTIONS

In this course the students have the choice between two ways to study worked-out examples: sample problems from the textbook and worked-out problems with the computer. The last way has the advantage of more activity, more feedback and the option to consult help pages. The first way has the pragmatic advantage of having the material at hand, without the necessity to turn on the computer. One aim of this study is to investigate students’ choices on this point.

The worked-out problems are devised to have several purposes in the study process. Beyond learning to apply theoretical principles in problem situations there are goals as learning a strategic approach to solve physics problems and learning to apply mathematical techniques.

A second aim of the study is therefore to evaluate if computerized worked examples serve the attainment of these goals.

Another aim is to find out what preferences students have for several study activities: lectures, tutorials, studying textbook sample problems, studying computer materials, studying theory from the textbook or solving problems for themselves. The correlation of these preferences to other personal data should be established. Three of them can be obtained easily: the exam results, the student entrance level (for math and physics) and student gender. However, to study relationships like this the data from

Evaluation						
Name	<input style="width: 90%;" type="text"/>	Stud. nr.	<input style="width: 95%;" type="text"/>			
Did you learn from this problem about mechanics, i.e. how laws work and how they are applied?						
	nothing	0	0	0	0	much
Did you learn from this problem to approach problems 'strategically', i.e. to provide yourself more insight by drawing a clear picture?						
	nothing	0	0	0	0	much
Did you learn from this problem something (more) about applying math to physics problems?						
	nothing	0	0	0	0	much
Could you make this problem without consulting this elaboration?						
	0 yes	0 for the most part	0 perhaps with some help	0 probably not	0 no	
Do you have further remarks, to the teacher, about the lesson you just did?						
	<input style="width: 95%;" type="text"/>					

fig. 1 Online evaluation form for worked-out problems (translated)

several sources should be matched and hence the evaluation can not be done anonymously.

A final question to be answered is whether all evaluation activities are necessary to obtain effective information about courses supported with internet materials.

IMPLEMENTATION OF THE COURSE AND THE EVALUATION

The course on Engineering Mechanics was given to 52 first year students and some students from the year before. During the course two students dropped out and at the end two other students did not make the exam. The end-of-term evaluation was carried out for 50 students, including two 'repeating' students. For reason of uneven distribution (48 students male, 4 female) it was decided not to include the gender factor would in the analysis.

In total 41 logfiles were collected, nearly three for each student using internet. One logfile was excluded because it did not contain usable data. 11 logfiles were about the expository lesson on *elasticity*, the remaining part (29) were on the six worked-out problems.

56 % of the students passed the exam, a figure that is somewhat less than in preceding years.

In the exam some items test the knowledge of the last part of the course. The score on these 'late' items is recorded separately. Alternatively, by subtracting this score from the total score a corrected score can be obtained related.

The answer on the last item in the questionnaire (see fig. 2) was coded as follows:
 1 = textbook more favourable, with reason related to learning, 2= ibid, but pragmatic reason, 3= both problem modes equally effective, 4 = internet problems more effective.

Did you make the worksheet on Vector Calculus, to what extent?						
	0 not	0 scarcely	0 not entirely	0 complete		
Did you make the worksheet on Integration Constants?						
	0 not	0 scarcely	0 not entirely	0 complete		
Did you study many sample problems from the textbook?						
	0 not	0 some	0 several	0 many		
Did you learn much from doing sample problems from the textbook?						
	0 not	0 somewhat	0 rather much	0 much		
Assess please with a figure (1=least .. 6=most) which activity is most effective for your study ('most result per hour') and what you like (pleasant) most to do						
	lecture	tutorial	study sample problems	study internet problems	study theory from book	solve problems
effective	.....	.....	.....	.....	.....	.....
pleasant	.....	.....	.....	.....	.....	.....
Do you have access to internet now at home?				0 yes	0 no	
Can you easily get access to internet at the university?				0 yes	0 troublesome	0 no
Can you indicate what is more effective for you: sample problems from the textbook or worked-out problems by internet. And why?						

fig. 2 Selection from the 'end of term' evaluation form (translated)

EVALUATION RESULTS

The findings in the evaluation are given here with numbers, for easy reference in the discussion. Means refer to a 5-point scales, minimum is 1 and maximum is 5.

From the logfiles the following givens were gathered:

1. Only 30% of the students use internet materials, all of them do at least one worked-out problem.
2. 22% makes use of the expository lesson on *elasticity*.
3. 16% of the students uses the internet worksheet on vectors.
4. Learning theory from worked-out problems differs over problems, the mean ranges from 2.0 to 4.2 and the overall mean is 3.6.
5. Learning problem approach differs over problems from 3.3 to 4.7 , overall mean is 4.0
6. Learning to apply math differs over problems from 1.0 for a problem where no math was applied to 4.3 for a problem intending to show the application of mathematical techniques.
7. The difficulty ranges over problems from 1.5 to 4.0, overall mean 2.7.
8. Questions in the computer lessons were answered right in most cases ($p = .78$).
9. Some students make a habit of calling help pages, other students neglect this option, mean use of help is 1.5 times per lesson.

From the evaluation form the following result appear:

10. 55% did the worksheet on Vector Calculus, half of them only scarcely.
11. 45% did the worksheet on Integration Constants, half of them scarcely.
12. Nearly all students studied sample problems from the textbook 85% several or many times.
13. Students indicate that they learn well from the textbook sample problems, 91% rated 'much' or 'rather much'.
14. Studying internet problems is rated not very effective, the mean 'rank' on this question is 2.9 , about the same as for lectures and tutorials, studying sample problems and solving problems is rated more effective (both mean rank 4.4).
15. Studying internet problems is rated moderate pleasant (mean rank 3.4) , more pleasant is solving problems (4.1) and less pleasant is studying theory from the book (2.9).
16. 74% of the students have access to internet at home.
17. 64% of the student can get access easily at the university.
18. 19% favours internet problems over sample problems from the book, 14% feels no difference, 16% favours sample problems for reasons of better learning, 51% favours sample problem for the pragmatic reasons of 'having the book at hand'.

Some interesting correlations were found (* refers to significance at 1% level, others are at 5% level):

- a. Use of internet materials (1) is connected with rating internet problems as effective (14, $r = .38$), with access to internet at home (16, $r = .38$) and with favouring internet problems (18, $r = .45$), negatively with rating textbook theory study as effective (14, $r = -.32$)
- b. Favouring internet problems (18) is further connected with rating internet problems as effective (14, $r = .60^*$) , rating internet problems as pleasant (14, $r = .48$) and negatively with rating textbook theory study as effective (14, $r = -.30$).
- c. Use of internet materials in general does not have a significant correlation with entrance level or result on the exam. However, use of internet materials from the last part of the course (two problems and the expository lesson) is connected with entrance level ($r = .49^*$).
- d. Rating internet problems as effective (14) is negatively connected with rating solving problems as effective (14, $r = -.38$), however, this figure is biased (see below).
- e. Use of the study guide worksheet on Vector Calculus (10) is connected with the degree sample problems were studied (12, $r = .34$), with learning well from sample problems (13, $r = .31$), with rating studying sample problems as effective (14, $r = .31$) and negatively with rating studying theory from textbook as effective (14, $r = -.29$).
- f. The exam result itself is not connected with other process variables, but the score corrected for 'late' items is connected with use of the Integration Constants worksheet (3, $r = .31$) and with the degree textbook sample problems were studied (12, $r = .31$).
- g. In a secondary analysis a linear combination of scores indicating use of both worksheets, use of textbook sample problems and rating of effectiveness of sample problems (“10”+”11”+”12”+”14”) showed a connection with the exam result.

DISCUSSION

The use of internet materials is not as extensive as anticipated. It correlates with the availability of internet at home, but 74% of the students have already access at home, so better access will probably not result in much increase in internet use. It seems that the availability of other materials explains this failure to study from internet, the students like textbook sample problems and find them very instructive. Apart from that, 16% of the students indicate a reluctance of working with computers and/or internet, giving an additional reason why it is not used.

About 20% of the students like to study worked-out examples on the internet and find it a more effective way than studying textbook problems. Which profile do those students have? Two items in the evaluation show significant correlations, notably the rating for effectiveness of theory study from the textbook –which has three significant negative correlations with variables about internet use– and rating for effectiveness of solving problems yourself. The correlation coefficients are rather low, about .30, and the correlation between the two ranks is biased, because rating the one item with a higher rank automatically pushes down the rating of the other one. Therefore we can only conclude that a weak indication exists: students having preference for internet materials rate studying theory from the textbook less effective.

Possibly the appreciation for the thorough and complete explanation in worked-out problems on the internet would be better in groups with more female students, as was found once before in secondary education [5].

The quality of the internet materials is rated well by the students who made use of it. All problems contribute clearly to learn a strategic problem approach. For those problems where it could be expected, also a contribution to the ability to use math in solving physics problems is recorded. For a problem that was rated as ‘rather easy’ students do not learn very much but even then the score is beyond the neutral point of 3.0 and the other problems were rated as ‘very instructive’.

Only a problem belonging to the ‘late’ part of the course was not rated as instructive. This is an instance of a set of more findings, indicating that the study progress in the later part shows a shift in study pattern. The degree internet materials for this part are used is connected with entrance level, indicating that students leaving secondary education with higher results persist better when the course topic has changed somewhat. The correlations between use of the worksheet Vector Calculus and use of textbook sample problems, both important in the first part of the course, can also be considered as an indication for this shift. The correlation of the combined score on use of those non-internet materials with the result at the exam (g) sheds some light on the most effective study process for most of the students.

CONCLUSION

From the data obtained it can be concluded that internet materials are not as popular as conventional materials that serve the same function in the learning process. Even when all students could have access to internet at home, only a minority (about 25%) will have a preference for worked-out problems on the internet, if also textbook sample problems are available. For studying textbook sample problems a –weak– connection with learning results is shown, for studying internet problems this is not the case. However, internet problems are rated quite satisfactory by the students who made use of it; in particular the positive rating of 'learning a strategic approach to

solve problems' shows the usefulness of these materials. It can be advised to supply students with the option to use materials like this, serving the 25% who benefit from it. This percentage may be higher in groups with more female students and in situations where the textbook does not provide sample problems.

The response rate on the paper-based evaluation was satisfactory and the data were quite valuable. So the drawbacks formulated by Gosper and Love [6] were not encountered, probably due to the combination of the evaluation with the exam.

The data giving answers to our research questions came from the online and offline questionnaires separately, but not from the connection between them or from connections with personal data. Therefore it was, in retrospect, not necessary to obtain names and student numbers on every evaluation. Student entrance level, a factor explaining some variance in other variables, can also be measured by asking the students to fill in. In this way the evaluations get anonymous, which is methodologically more sound.

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