Conceptual Test as a Tool for Validation of Course Performance

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INTRODUCTION

This research aimed at analysing the use of conceptual test as a tool for evaluating and validating the effectiveness of various learning tasks. The use of learning assignments instead of conventional exam requires more teaching personnel to be effectively used in teaching. The results of this study give the responsible teacher of the course valuable tools for negotiating the adequate personnel resources for ensuring the quality learning at the course.

The research was set up within two corresponding courses of polymer technology with students from four different degree programmes. Two groups of students have been chosen for analysis: one group completed the course with a conventional exam and the other group had weekly assignments and oral group discussion in the end of the course. All the students had freedom to select whether they would attend the lectures or complete the course studying independently.

The research was conducted during the years 2010-2012 in the courses "Basics of Polymer Technology" (3 ECTS) and “Basics of Polymer Technology and Materials” (4 ECTS). These courses are compulsory for students in four different degree programmes and are annually taken by ca. 200. The majority of the students annually is 2nd year students aiming at the degree of Bachelor of Science (Technology).

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In order to be able to analyse the factual and conceptual learning of the students, a two-part questionnaire was designed. The questionnaire was to be filled in at the very beginning and in the end of the course. The first part contained questions of both substance knowledge and the second part was open ended question to study students' motivation in the studied filed. The results of the first parts of the study have been reported by authors [1, 2, 3].

1 RESEARCH OBJECTIVES

The aim of this study was to investigate whether the use of conceptual test would serve as a tool for evaluating and validating the effectiveness of various learning tasks to the results in course performance.

One way of enhancing active learning process may be e.g. that students are given small learning tasks to activate them to study independently also between lectures. This type of teaching approach requires also the teacher to participate in the learning process more actively compared with traditional lecture course. This is because teacher's role is to guide and mentor the learning process also while students are completing the learning tasks: the teacher is expected to be prepared to asses and give feed back to the student during the whole course. This type of work load differs a lot form the conventional way of giving the lectures and preparing and assessing the exam.

In a case of large, compulsory course it is not necessary fruitful to make all the students to follow same learning form. Offering different ways to complete any course would certainly improve the course results but is also a question of teacher resources. In order to better motivate the need for additional ways to complete the course and especially to motivate the use of resource sensitive teaching methods, this study was completed.

2 THEORETICAL FRAMEWORK

2.1 Action research

Action research is a research method used widely on social and educational research. It has been found suitable for case studies where it may be frequently used. . Action research was selected as a research method for this survey as the outcome of the research was especially intended to benefit teacher's goal to develop the course and teaching within it. This type of research where aim is to develop a course by making a change to course arrangement or teaching practice and hence analyse their effect is nicely conducted as an action research [4].

Action research is based on a development cycle where the intention is to plan a solution to a research theme to an identified situation or problem, then to act with specified and planned actions. During the identified situation e.g. a course the researcher makes observations and at the final phase, researcher makes analysis and reflects the observations with respect the original objectives [4].

However, as action research may be used to investigating a very small scale theme e.g. around a small course or teaching praxis, it is sometimes criticized for the imitations of the usability of its findings [4]. These may be answered by careful analysis of the literature when designing the first phase of the research and analyzing

the results of it. Another characteristic action research it considered to have is its usability as a tool for spreading out good practices in teaching to colleagues. [4]

2.2 Concept tests

According to contextual learning theory, learning occurs only when students (learners) process new information or knowledge in such a way that it makes sense to them in their own frames of reference (their own inner worlds of memory, experience, and response). This approach to learning and teaching assumes that the mind naturally seeks meaning in context, that is, in relation to the person's current environment, and that it does so by searching for relationships that make sense and appear useful. [5]

In the case of large lecture course the learning environment cannot be designed to be very experimental. The activities have to happen in our case in students' heads. This is why we want to know about students' conceptual understanding already in the beginning of the course in order to be able to make attempts in order to motivate students to be awake and seek meaning of the subject area in their own reality as students at their degree programmes. The teaching is planned based on constructivic learning theory where learning is said to take place only when learners connect information to their own frame of reference [6].

2.3 Active learning

Active learning can be defined various ways [7]. One way is to include only the activities that happen in lectures and class rooms in order to enhance engagement to learning process. In this research project we do not speak about collaborative learning, cooperative learning or problem based learning but we have selected a broader idea and decided to look at learning activities carried out between lectures in form of learning assignments. These assignments consist of pre-formulated substance knowledge questions and learning log to show deeper understanding.

3 METHODOLOGY

3.1 Questionnaire

To compare both the factual and conceptual learning of students from different study programmes, a two-part questionnaire was designed. The same questions were given to the students at the very beginning and in the end of the course. The questions of the concept study were formed by the lecturer and commented by the peer researchers.

The first part contained questions of both substance knowledge and attitudes. The main aim was to evaluate the development of students' understanding of basic facts of polymer technology. Part of the questions measured knowledge that can be obtained in high school of other basic courses at Aalto University. The test included also part that required deeper expertise knowledge that was taught at studied courses.

The second part was an essay titled "Me and polymers ten years from now". The aim of this question was to discover how the students' conceptual understanding of utilising polymers had developed during the course. The diversity in the backgrounds of the students was thought to lead to versatility in this area, too. [8, 9]

The population of informants was large, the count being 139 students. This amount was large enough to make the study reliable according to theory [4]. However, the count of informants did not allow a completely unstructured questionnaire.

The questionnaire was designed as a semi-structured: the questionnaire had a clear structure and focus, but the format was open-ended enabling the informants to answer with their own terms. [4] The questionnaire was piloted year 2009 at the course Basics of Polymer Technology. The questionnaire had a potential role in promoting learning outcomes in two ways. Firstly the questions were formulated to give students idea of the desired learning outcomes and secondly, by feeding them an idea that the studied materials could be useful for them also after completing this course already in the beginning of the course.

3.2 Sample

The courses Basics of Polymer Technology and Basics of Polymer Technology and Materials are compulsory in Bachelor's studies in two schools and four degree programmes at Aalto University [10]. For the study the group of Chemical Technology students were chosen from the first mentioned course and the latter course was taken as a whole. The Chemical Technology students were the largest group of students in general and also they form the majority of assignment takers group years 2010 and 2012. The sample is introduced in *Table 1*. The amount of students that participated in the tests varied form 43% to 59% which provided representative intake for the research.

Table 1. Sample information.

Student group	**Code**	**Number of answers**	**Answer percentage**
Chemical Technology – Assignment makers	A	21	43 %
Chemical Technology – Exam takers	B	75	51 %
Bioproduct Technology – Assignment makers	C	43	59 %
Assignment makers (A+C)		64	53 %

The sampling method used may be seen having features of a volunteer sampling method which is a non-probability sampling method [4]. Every student attending the course was offered a chance to participate. To motivate students to take part in the study, they were given 2 points to their final exam or to their week assignments. The students were to pass the course without these points and extra points could only influence the grade they obtained. The tests were carried out at the first and the last lecture of the course.

4 RESULTS AND DISCUSSION

For comparison the groups of assignment makers of both courses were combined (student groups A+C). Comparing group C with group A+B provides an idea of what happens when all the students at the course are using the same learning method.The maximum amount of points in the concept test was eight (8). The measuring point was the last lecture at the course. The exam was after this point which naturally affect the results of exam takers grpup. The assingmnet makers also had their final assesmet to come after the lectures.

As can be seen in *Fig. 1* all the students had significantly higher post-scores compared to their pre-scores which is positive from teacher's point of view. This study shows that level of knowlwdge in the begnning of the course was higher in the

group of the students that chose the assignments. This could indicate these students being highly motivated in learning. This factor naturally supports getting good results in the end-of-course test, too. But why woud the students of in Bioproduct Technology degree programme be more motivated than those studying in degree programme of Chemical Technology? Their degree programme has been renewed recently and the group (ca. 30 students) works closely together which has not been made possible for students of Chemical Technology (intake 95 students yearly).

The differences in students‘ pre-course knowledge originates from the choices they have made in high school regarding the number of courses in mathematics and physics and from their study program. In high school only one chemistry course is compulsory. It is also not compulsory to take the chemistry test when students apply into Aalto-university School of Chemical Technology [11].

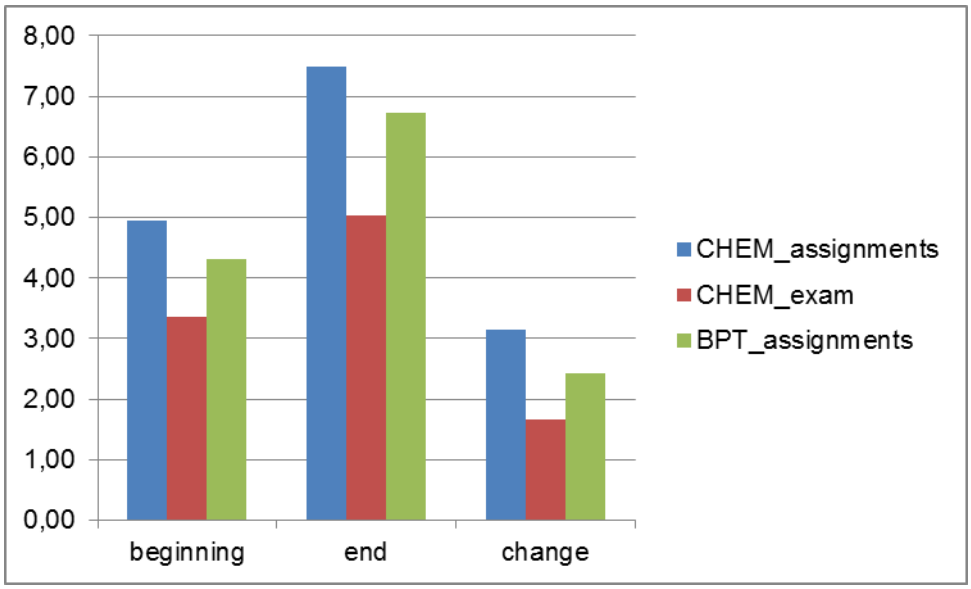

Fig. 1.Comparison of the concept test results.
CHEM Degree programme of Chemical Technology
BPT Degree programme of Bioproduct Technology

The difference in test results did not show significant change when test results in the beginning and end were compared. The assignment makers’ result was ca. 30 higher for all studied student groups. One could have expected that students that had lower level in the beginning would have easily come closer to the assignment makers group towards end of the course. The good motivation of students who chose the active learning strategy seemed to stay high during the whole course.

It is not compulsory to attend the lectures which menans that this study is not able to depict the meaningfulness of lecture activities on studied learning outcomes. About 70 % of Bioproduct Technology students attended lectures where as the amount of attendees at Basic course of Polymer Technology was ca. 30 %. However, there is no possibility to connect the students that took part to the study and those attending lectures.

At the course for Bioproduct Technology students the learning assignments played more active part of the whole teaching that at the larger course. Since all the

students made the assingments these were discussed at lectures that gave the teacher an effective possiblity to give feedback. The situation was different at the other course where going through each assignment would have required separate feedback sessions. However, this did not have an effect on students' learning results when compared to assign making Chemical Technology students. CHEM-students scores increased 66 % and BPT-students end-scores were 64 % higher than their scores in the pre-course test. This result shows how little teachers' activities at lectures actually can affect studetns' learning.

Surprisingly, the exam takers and assignment makers both were able to present approximately 67 % change in their performance measured by the conceptual test. A clear difference for the benefit of assisgnment takers was expected. One might question the construction of the learning tasks – are they currently the best to support the meaninful learning? The other interesting question is the length of the teaching period. The course is lectures and the learning tasks completed within seven weeks. Most probably there is too limited time for students to properly get aquanted with the subject or have reasonable time for their learning process. Third and also very imrtant theme would be to analyze further the teacher's role as a tutor for students' learning process: how could it be renewd to better support learning within both groups? On the other hand it might interesting to test, what kind of effect peer support would have in a sense that learning tasks would be completed in small groups.

From the point of view of course development acitve learning rises questions about teaching recourses. How many assignment can one teacher handle? It is not enough just read the papers but students expect feedback. Personal feedback is highly appreciated. If there is teaching assistants availeble the workload can be chared but the it has been seen that even all the teachers have same cirteria they tend to assess in their own way. This challenge has been solved by circulateing students so that everyone gets feedback forn each of the teachers.

Computer based assesment or using student colleagues in reading the papers have been considered but not tried yet. Rubyrik-style assesment with ready made phrases would cetrainly make teachers' work little esier. It has also potential in making assesment independent of assessors person and e.g. moods and cricumstances. Also making assignments in small groups would make teachers' workload smaller but then there are questions about guiding the groups' work and assessing groups. Peer-rewiev is also an alternative in handeling teachers' asssessment workload in case of large (>20) students groups. This culture is just developing in our univeristy.

The results encourage the development of teaching and guiding of learning into more active direction in sense of making students to process studied knowledge continuously. This kind of research based evidence is a powerfull tool in convincing engineering teachers to commit in developing more active learniong and assessment at their courses.

It would be extremely interesting to be albe to thet these groups after one year again to see how the learning srtategies affect their long term memorising and ability to use the concepts learned.

5 SUMMARY AND ACKNOWLEDGMENTS

It may be concluded from the results that students' skills in conceptual learning are improved during the course. However, this research did not make difference with students doing additional learning tasks with students participating only conventional lectures. However, the researchers consider it is useful to add resources for this kind of teaching method as it enhances students' commitment to the learning process. The students appreciate the possibility to follow learning strategies that suit them best. In addition, previous studies have shown that the use of conceptual tests may also reveal other motivational factors which have their role in ensuring meaningful learning.

These results may be utilized in the development of education at Aalto University School of Chemical Technology as they support teacher's decision making in the choice of teaching method.

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