

DESIGN-BUILD EXPERIENCE-BASED PROGRAM IN BIOMEDICAL ENGINEERING AS A PRACTICAL EXAMPLE OF SCIENCE FOR PROFESSIONS

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Abstract

The University of Borås, Sweden, has endeavoured to build a reputation as a university that trains professionals who will contribute to the broader society, hence its motto "Science for Professions". In keeping with this ambition the school of engineering has carried out a series of Design-Building Experiences (DBE) aimed to promote the development of specific engineering skills and attributes. In addition to subject specific attributes DBE aims at developing personal and interpersonal competences such as effective team work and communication. These generic competences have been selected from the CDIO syllabus. A total of three DBE activities have been implemented in a one-year master program in Biomedical Engineering. The learning outcomes that resulted from the implementation of the teaching-learning activity has been evaluated from the point of view of the students, through a questionnaire. The answers from the students suggest that the activity has reached the intended goal, especially facilitating the development the students' own personal and professional engineering skills and attributes. The results of this survey also indicate that students were concerned about peer assessment of the activity and its contribution to the final grade of the course. In general the implementation of the DBE was a success and provides us with new knowledge about implementing student centered learning methods in international master programs.

Keywords: Student Centred Learning, CDIO, Problem-based Learning.

1 SCIENCE FOR PROFESIONS AND CDIO

An immediate consequence of the motto "Science for Professions" at the University of Borås is the intended goal of producing professional university graduates. With that in mind, the School of Engineering aims to produce engineers customized for a professional working life. In order to achieve this the School makes use of teaching and learning initiative called Conceive-Design-Implement & Operate (CDIO). On the one hand, the CDIO syllabus has summarized a set of knowledge, skills, and attitudes that are desired in any engineering graduate [1]. On the other hand the Design-Building Experience (DBE) is a Teaching-Learning Activity not only aimed to support the learning of engineering knowledge but at the same time to enhance the development of personal and interpersonal skills and abilities in the students [2].

The CDIO framework is most often aimed at educational programs with 3-4 years of tuition. When applying a similar approach to a shorter educational program such as a one-year master program, several adjustments must be made. In our case we applied CDIO principles to a one-year master program in Biomedical Engineering. We did this by weaving into the course several DBE activities. This resulted in a master program that was characterised by DBE.

2 THE IMPLEMENTED DESIGN-BUILD EXPERIENCE

During 2009-2010 the Master program in Biomedical Engineering that is offered at the school of engineering was reformed to include DBE exercises with the aim to stimulate the development of specific engineering skills and attributes as well as personal and interpersonal competences.

2.1 Intended Goal of the DBE

The DBE was intended to be a Teaching-Learning Activity (TLA) where the students could develop their own personal and professional engineering skills and attributes. These skills and attributes include those listed in the CDIO syllabus: 2.1 engineering reasoning and problem solving, 2.2 experimentation and knowledge discovery, 2.3 system thinking and 2.4 personal skills and attitudes. N.B the numbering used is according the CDIO Syllabus.

To be more specific the DBE enabled the students to put in practice and improve the following competences:

- 2.1.1 Problem Identification and Formulation
- 2.2.2 Survey of Print and Electronic Literature
- 2.3.1 Thinking Holistically
- 2.3.3 Prioritization and Focus
- 2.4.7 Time and Resource Management

The DBE should also create a learning arena where the students can promote and develop their interpersonal skills in Teamwork & Communication. The content of the DBE was specifically intended to enable the student to learn about

- 3.1.2 Team Operation
 - 3.2.3 Written Communication
 - 3.2.6 Oral Presentation and Interpersonal Communication
- As well as support to practice 3.3.1 English

Moreover the goal of the DBE was twofold. In addition to promoting the personal and interpersonal skills of the students, the DBE reinforced the learning of the Core and advanced engineering knowledge in the rest of the program.

2.2 Contents of the DBE

The three-implemented DBE activities were aligned with the contents of the courses running during the same teaching period. During the first period the courses given in the program are Medicine for Engineering and Biomedical Instrumentation and the first DBE was focused on the analog design of a physiological measurand. The second DBE was focused on the implementation of a heart rate detector and tool for heart rate analysis; this DBE was implemented together with the courses Physiological Measurements and Digital Signal Processing. The last DBE was aimed to perform feature extraction to implement a classifier on physiological measurements; it was run during period 3 in parallel with the course Biomedical Signal Processing & Pattern Classification.

All three DBE activities were implemented by groups of 6 students. The tasks were planned and distributed among the group members of the project. For each DBE activity two students acted as project managers, one for the initial phase and another for the final phase. The teaching staff of the program acted as coaches for the student groups

3 ACTIVITY ASSESSMENT

To evaluate if the implemented TLA produced the intended learning outcome on the students, we asked the students to assess their own improvement in terms of knowledge and certain engineering, personal and interpersonal skills. The survey was anonymous and made use of a Learning Management Platform, PingPong. The survey contained 12 multiple-choice questions and 2 questions with an opportunity for free text writing. The students answered after the completion of two DBE activities, which were performed during the autumn and winter teaching periods in 2009.

3.1 Survey Questions

The questions and statements were given to the students to assess on their own learning and skills development facilitated by their participation on the DBE activities. 12 questions and statements were handed to the student to be graded with from 1 to 5 different levels of conformity. Between "Not at all"

to “Much more than expected, with “As I expected” in the middle. The questions are enlisted in the following table:

Nr	Questions
1	If you have experienced an improvement in your skills for problem identification, grade it.
2	If you have experienced an improvement in your skills for problem solving, grade it.
3	Have your own skills for literature research improve during the DBE?, grade it.
4	If you feel that your own skills for whole system envision have improved, grade it
5	If the activities performed during DBE have contributed to improve your skills for task prioritizing, grade it.
6	If you feel that your own awareness about the importance of time and resource management for project work has increased, please indicate in which grade
7	Indicated in which grade your awareness about team operation and dynamics have increased.
8	Do you feel that your written skills have improved during the DBE?
9	Do you feel that your skills for interpersonal communication have improved by doing the DBE?
10	If you feel that your skills for oral presentation have improved by doing the DBE, grade it.
11	Have the DBE helped you to practice English language?
12	Have the engineering tasks of the DBE supported your learning of part of the contents of the courses of the master program?

Three additional 2 questions were posted to find to what extent the students value the complete DBE activity. The type of answers to these questions was free text.

Nr	Statement
13	How do you value the DBE as a learning experience?
14	Do you think that DBE is a good tool to promote and facilitate learning of specific personal and interpersonal skills, or you would rather have specific traditional lectures?

3.2 Survey Answers

The questions were answered by approximated 50% of the total of the students following the course. Most of the questions were answered by 14 or 15 students with the exception of Q12 that was answered by 13 students.

Question nr	Answer Distribution (%)				
	1	2	3	4	5
1	0	6.7	53.3	40	0
2	0	20	40	33.3	6.7
3	0	35.7	35.7	21.4	7.1
4	6.7	33.3	33.3	20	6.7
5	0	46.7	13.3	33.3	6.7
6	6.7	20	20	46.7	6.7
7	0	28.6	35.7	21.4	14.3
8	7.1	35.7	50	0	7.1
9	7.1	35.7	35.7	14.3	7.1
10	21.4	28.6	14.3	35.7	0
11	30.8	30.8	15.4	15.4	7.7
12	0	14.3	57.1	14.3	14.3

The student participation when answering the text free question was smaller, 12 students for Q13 and 10 for Q14.

The students answered very positively to question the Q13, with comments like the following:

“It is absolutely a great experience”, “ It is indeed a useful activity for improving technical skills and subject knowledge, “It is very useful for those who want to continue their education in a higher level and also for those who want to be prepared for industry”.

All the answers to Q14 were also positive, in the terms of “DBE is indeed a good source of improvement of interpersonal skills...” “Yes, it is” or “I would definitely prefer this kind of activity where

I can experience a real life work". But some of them contained also some other feedback information, not directly addressing the specific question. "But I would also appreciate some individual tasks or projects which evaluate each and every person's skills and knowledge" or " ...But it could be better if there was a guarantee that everyone does his or her task and other members are not responsible for laziness of some students."

4 DISCUSSIONS

From the answers to Q1 to Q6 it is clear that the students felt very comfortable with their own progress regarding personal and professional engineering skills and attributes. Therefore the DBE was a useful activity promoting the students development in those areas.

Regarding their interpersonal skills on Teamwork & Communication, the answer to Q7 confirms the usefulness of the DBE for Teamwork, but the answers to Q8 to Q11, suggest that the DBE activity was not as efficient when promoting the communication skills of the students..

The answer to Q12 together with some comments in Q13 and Q14 confirm that the DBE activity re-enforces the technical knowledge taught in the lectures and helps to achieve the intended learning outcomes of the course.

From the feedback obtained from the free-text answers and from the teachers acting as coaches and interacting with the students, it is easy to identify that the students were troubled about the way the DBE was evaluated. They were, in particular, concerned about the influence of the DBE on the final grade of the courses. In some cases the students seem to be somewhat obsessed with the final evaluation and grade. Most of the students were from outside Europe and were sceptical towards the whole concept of student-centred learning and especially peer-assessment, an activity used as part of the assessment of the DBE activity. This response is something that Edström noted in his study on integrated assessment [3] .

5 CONCLUSIONS

The results of the survey indicate that generally the DBE activities achieved their purpose. From the answers it was obvious that the students appreciated such pedagogical activity and found them motivating and useful.

It can be concluded that the integration of the DBE activities in the program achieved the main learning outcomes but created certain discomfit among the students regarding the evaluation process for the whole course. The origin of such discomfit could be the result of many factors including the prior expectations that students have. Students used to traditional forms of teaching and learning clearly have some difficulty adjusting to DBE activities with their emphasis on cooperation, active learning and peer assessment.

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