Survey of Laboratory Exercises within the Applied Physics and Electrical Engineering (Y) program at Linköping University

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Abstract

A survey concerning the laboratory exercise activities within the Applied Physics and Electrical Engineering (Y) program at Linköping University is presented. The aim of the survey has been to view the laboratory exercises from a CDIO perspective. 64 laboratory exercises have been covered by the survey. The main conclusions are that "Verification and/or illustration of principles" and "Verification and Testing" are the activities most often found in the laboratory exercises, while activities like "Design" and "Formulation of goals and specifications" are less common.

1 Introduction

One of the activities within the CDIO Initiative for the Applied Physics and Electrical Engineering (Y) program at Linköping University during the beginning of 2001 was to carry out a survey in order to get an overview of the laboratory exercises within the program. Of particular interest was to try to view the different laboratory exercises from a CDIO (Conceive, Design, Implement and Operate) perspective.

The group carrying out the survey designed, in cooperation with members of the board for the program, a questionnaire. The questions will be further presented below. The questionnaires were then handed out to the teachers responsible for the considered courses. In most of the cases one form for each laboratory exercise was answered, but in a few cases one questionnaire for all laboratory exercises within a course was answered.

2 Basic facts

In the list below some background facts are given.

- 19 mandatory courses were covered.
- 2 out of 12 specializations were covered.
- 64 laboratory exercises were covered. 44 from mandatory courses, 13 from the Biomedical Engineering specialization and 7 from the Electronics specialization.

The standard format of a laboratory exercise is defined by the following properties.

- Mandatory part of a course.
- Carried out in groups of two students.
- Four hours in laboratory. Additional time for preparation and documentation.

The majority of the laboratory exercises covered by the survey has the standard format, but there are a few exceptions.

3 Questions

The questions were formulated in Swedish and the original version of the questionnaire is attached to this report. A translated version is given below.

Which aspects do You consider to be the most important in the laboratory exercise?

A.1 Generation of ideas.

A.2 Design.

A.3 Implementation.

A.4 Handling of equipment and/or software.

A.5 Verification and/or illustration of principles and relationships.

Which activities do You consider to be parts of the laboratory exercise, including preparation and presentation?

B.1 Choice of methods and/or tools.

B.2 Search for additional knowledge.

B.3 Formulation of goals and specifications.

B.4 Verification and testing.

B.5 Written documentation.

B.6 Oral presentation.

Which types of tools and equipment are used in the laboratory exercise.

C.1 PC/Work stations.

C.2 Measurement equipment.

C.3 Other electronic equipment.

C.4 Other mechanical equipment.

C.5 Software included in the Site license.

C.6 Software not included in the Site license.

The first question is meant to provide answers to the question *What?* the laboratory exercise is about, and the alternatives A.1 - A.4 are intended to correspond to C,D,I, and O respectively to some extent. Alternative A.5 is used for laboratory exercises that are difficult to put in the CDIO framework, like e.g. a laboratory exercise where the aim is to verify a principle from physics. The aim of the second question is to answer the question *How?* the laboratory exercise is carried out, i.e. which activities it contains, and finally the third question gives information about the tools used for carrying out the laboratory exercise.

The questionnaire was not designed with direct reference to the CDIO Syllabus, but the questions and the answer alternatives have close connections to the Syllabus. The answers A.2-A.3 clearly represent the the Design and Implement stages in CDIO, and they correspond to point 4.4 and point 4.5 respectively in the CDIO Syllabus. Alternative A.4 is related to the Operate stage, point 4.6 in the Syllabus, but the emphasis is more on how to operate existing tools than to design systems and products from an Operate perspective. Answer A.5 is more directed towards point 1 in the Syllabus (Technical knowledge and reasoning) and reflects the fact that some laboratory exercises are used to illustrate and verify principles from physics, signals and systems, etc. For the second question answers B.5 and B.6 are closely connected to point 3.2 (Communication) in the Syllabus. Alternative B.1 is related to point 4.4 (Design) in the Syllabus, while B.2 can be connected to both 4.4 and 2.2 (Experimentation and knowledge discovery). Answer B.3 corresponds strongly to point 4.3.1 (Setting system goals and requirements). Finally answer B.4 can be related to 4.5.5 (Test, verification, validation and certification), but also to point 1, according the arguments given above.

4 Results

The answer rate for each alternative is shown in the diagram below.

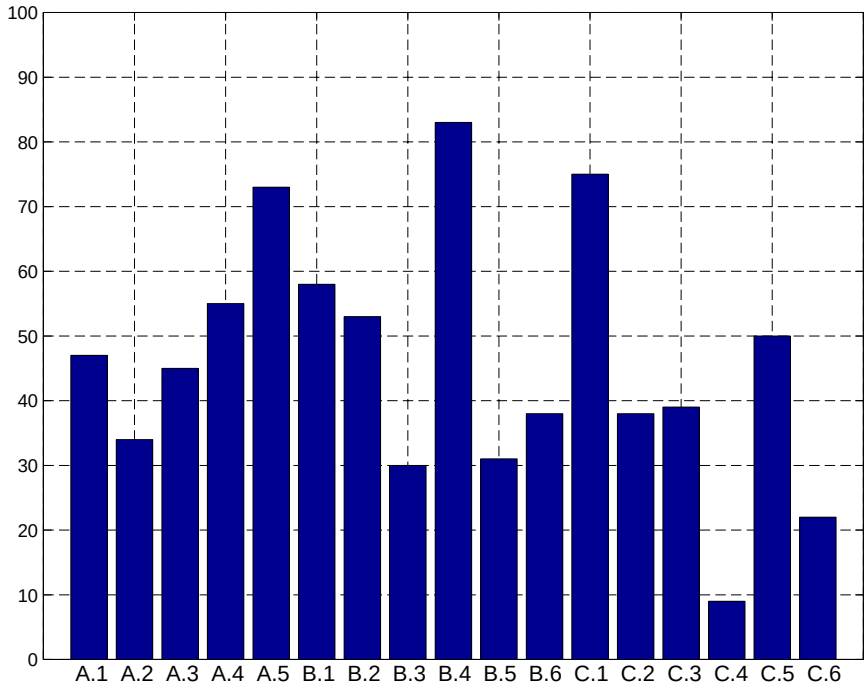

Figure 1: Answer rate in percent.

In the diagram some interesting observations can be made:

The alternatives with the highest number of answers in each group are A.5, B.4, and C.1 respectively, i.e.

- A.5: Verification and/or illustration of principles and relationships.
- B.4: Verification and testing
- C.1: PC/Work stations.

The alternatives with the lowest number of answers in each group are alternatives A.2, B.3, and C.4 respectively, i.e.

- A.2: Design.
- B.3: Formulation of goals and specifications.
- C.4: Other mechanical equipment.

Other comments:

- 47 % of the laboratory exercises are considered to contain alternative A.1, Generation of ideas.
- 31 % of the laboratory exercises contain written documentation.
- 38 % of the laboratory exercises contains oral presentation.
- The laboratory exercises containing Design (A.2) can mainly be found within the Electronics courses.
- In approximately half of the laboratory exercises only computer and software are used.

5 Needs for additional resources.

In addition to the questions presented above the form contained a question concerning the needs for additional resources that would improve the laboratory exercises. The list below presents all answers that that were given to this question.

- Better knowledge in Matlab.
- More time for "problems".
- Doubled personal resources.
- Doubled laboratories.
- Resources for supervision.
- More time for the students.
- A laboratory with UNIX computers.
- More fundamental theory concerning the interaction between light and tissue.
- Medical images.
- Test equipment.
- More medical data.
- More FPGA equipment.

It is noticeable that this question was answered in only 12 of the 64 questionnaires.

6 Laboratory resources

For the laboratory exercises in the mandatory courses the required laboratory resources in terms of student hours in the laboratories can be estimated. It is however much more difficult to estimate the overall usage of the laboratory resources. The reason is that the laboratory activities are spread over at least five different departments and that one specific laboratory at one department can be used by students from up to eight different engineering programs. To get a measure of how much the laboratory exercises connected to the Y-program require from the laboratory resources at each involved department would be a difficult and maybe not so meaningful task.

Only two of the answers, presented in Section 4, concerning the needs for additional deal with the need for additional laboratories. This can be an indication of that the laboratory space is sufficient in most cases.

7 Conclusions

A survey has been carried out for the Applied Physics and Electrical Engineering (Y) program. The aim has been to view the laboratory exercises within the program from a CDIO perspective. The survey has been carried out by letting the teachers responsible for the mandatory courses answer questionnaire with questions. Altogether 64 laboratory exercises have been covered. The main conclusions are that "Verification and/or illustration of principles" and "Verification and Testing" are the activities most often found in the laboratory exercises, while activities like "Design" and "Formulation of goals and specifications" are less common.

Laborationsenkät

Kursens namn och kurskod:

.....

Laborationens namn:

.....

Beskriv kortfattat syftet med laborationen:

.....

.....

Gruppstorlek vid ett laborationstillfälle: .....

Antal handledare vid ett laborationstillfälle: .....

Skulle några resurser behöva tillföras för att öka behållningen av laborationen:

.....

Vilket/vilka moment anser Du vara mest centrala i laborationen? Markera med kryss i tabellen nedan:

A.1	Idéskapande	
A.2	Design	
A.3	Implementering	
A.4	Handhavande av utrustning och/eller programvara	
A.5	Verifiering och/eller illustration av samband och principer	

Vilken/vilka verksamheter anser Du ingår i laborationen, inklusive förberedelser och redovisning?:

B.1	Val av metod och/eller verktyg	
B.2	Inhämtande av kompletterande kunskaper	
B.3	Formulering av mål och specifikationer	
B.4	Verifiering och testning	
B.5	Skriftlig redovisning och dokumentation	
B.6	Muntlig redovisning	

Vilken typ av hjälpmedel och utrustning används i laborationen:

C.1	PC/Arbetsstationer	
C.2	Mätinstrument	
C.3	Annan elektronisk utrustning	
C.4	Annan mekanisk utrustning	
C.5	Programvaror ingående i LiTH:s Sitelicenser.	
C.6	Programvaror utöver LiTH:s Sitelicenser.	