ASSESSMENT IN A LEARNING-CENTERED COURSE DESIGN FRAMEWORK

Hossein Nadali Najafabadi, Magnus Andersson, Matts Karlsson

Department of Management and Engineering, Linköping University, Sweden

ABSTRACT

It is important for course designers to establish assessments in accordance to intended learning outcomes and course activities in order to promote deep learning in higher education. In this context a learning-centered course design (LCCD) framework could be utilized to interconnect the assessments towards the high level learning objectives and learning activities. The primary objective of this paper is to highlight the effectiveness of using such a framework with the emphasis on assessment component for developing a new course, Fluid Mechanics, at Linköping University, Sweden. This study indicated an implementation of the LCCD framework, which facilitate establishment of CDIO Standards 8 and 11. This has been achieved by designing an assessment method that involves active learning activities in accordance to the intended learning outcomes. The inherent property of this approach, the integration between different components of teaching, is thus the key feature in achieving the highlighted standards and contributes in enhancing the student's knowledge, skills and attitude within the subject.

KEYWORDS

Student-centered learning, Constructive alignment, Active learning, Developmental assessment, CDIO standards: 8, 11.

INTRODUCTION

According to Black and Williams (1998), assessment includes all classroom activities that students carry out, such as observing the students within class discussions, analyze their classwork and/or homework, tests and etc. These analyses can be used for improving teaching and learning process according to the students' learning needs, i.e. student-centered learning. Snyder (1971) found that what influenced the students was the method of assessment and not the method of teaching. Moreover, Ramsden (1992) discussed that from the students' point of view it is the assessment that forms the curriculum and not the material indicated in the curriculum.

It is therefore important to strive for assessment activities that effectively work towards the intended learning outcomes (ILO) of the curriculum during the design process. This is also reflected in the description of the CDIO Standard 11, stating that the assessment of student learning should reflect on the extent in which individual students achieves specified learning outcomes. This standard highlights assessment of student learning in personal and interpersonal skills as well as in disciplinary knowledge, which in turn can call for

developmental assessments (DA) correlated to active learning activities (ALA). While according to Garfield (1993) active learning activities play an important role in disciplinary knowledge, they assist the students in developing other personal and interpersonal skills and attitudes such as teamwork and communication, see Loyer et al. (2011). Establishing teaching methods under the concept of ALA has been well documented, e.g. Meyers and Jones (1993), Shakarian (1995), Silberman (1996). High importance of ALA has been highlighted by CDIO under Standard 8, which calls for direct student engagement in thinking and problem solving activities, rather than listening passively to an instructor. Thus, the instructor will incorporate active learning methods in order to foster active learning.

The importance of integration between ILO, DA and ALA have been highlighted. In order to facilitate course designers for establishing such integrations, a learning-centered course design (LCCD) framework could be used Fink (2003), which interconnects the high level ILO to the DA and also ALA; which also can be viewed as constructive alignment Biggs (1999). This framework has been used to develop a new course, Fluid Mechanics (TMMV18), at the Division of Applied Thermodynamics and Fuid Mechanics. This course is an intermediate course in fluid mechanics, taught entirely in english and open for program students and international exchange students. The objective of the current study is to evaluate the DA method which has been employed when utilizing this framework for designing this course. The contribution of the used method in CDIO standards will be addressed in order to indicate how assessment methods in a LCCD framework can enhance implementation of CDIO programs in course design level.

In the subsequent sections first a brief review on the implementation of the LCCD framework for designing this Fluid Mechanics course is given. Then details of the developmental assessment will be covered. Afterwards, students' perception and CDIO related discussions will be given followed by concluding remarks.

LCCD FRAMEWORK FOR COURSE DESIGN

To productively establish learning processes that facilitate the students learning requires careful considerations in the course design stage, Diamond (1998). Figure 1 indicate the LCCD components, also used by Whetten D. (2007), Fig. 1.

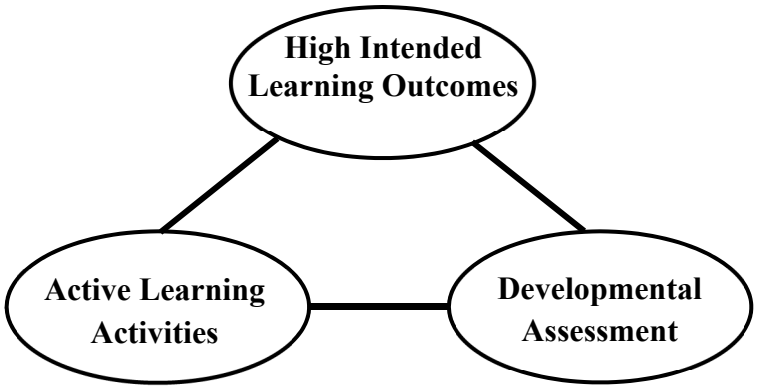

Figure 1: Components of learning-centered course design adapted from Fink (2003) and Whetten D. (2007).

The order in which these LCCD components are defined in this study reflects on the so called ‘’backwards design’’, Wiggins, G. (1998). This design outline has the following steps:

1) Explicit high intended learning outcomes have to de defined. In this regard, the taxonomy of learning objectives (verbs) suggested by Anderson and Krathwohl (2001) have been used for this course. This includes both comprehension (remembering, understanding and applying) and application (analyzing, evaluation and creation).

2) Valid developmental assessment of student learning, i.e. progressive examination and feedback throughout the course, needs to be identified based on ILO. This indeed has to reflect on questions such as how can I assess high level learning outcomes in the best and effective way. The consistent and effective implementation of such assessments has been shown to be the hardest element of LCCD, see Walvoord and Anderson (1998), Wiggins (1998). The DA for the course subjected to this study is designed such that it consists of two parts: i) performing a number of defined tasks during the course period and ii) written examination. Since DA is the core of the study, it will be addressed in detail in the consequent section.

3) Appropriate active learning activities must be created in order to promote engaged learning. The activities for this course include lectures, seminars, computer lab sessions and lesson session. Among these, the seminars will be addressed more elaborately in the following section as they are part of the DA. Figure 2 indicates the distribution of different activities including performing different tasks during the course. This Gantt Chart has been provided to the students to assist them in the planning throughout the course.

This design order highlights the choices of the students learning assessments that should follow the activities designed to enhance the learnings.

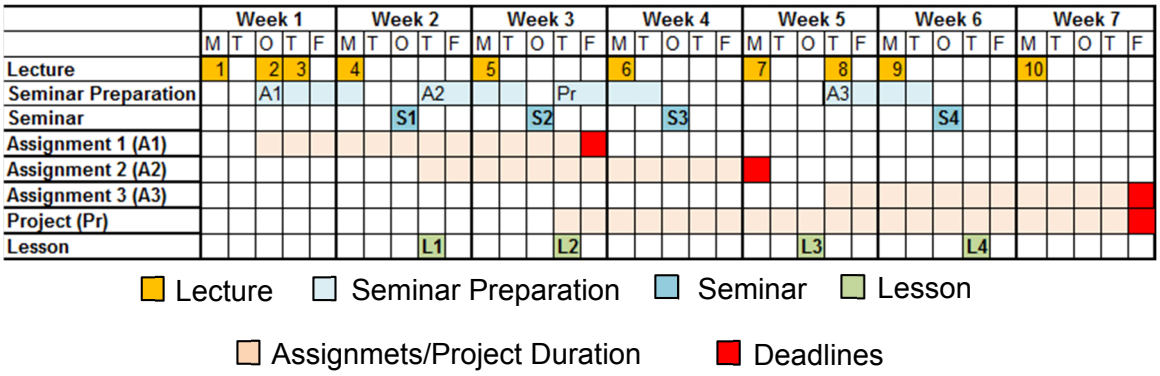

Figure 2: Distribution of different activities shown as Gantt Chart.

DEVELOPMENTAL ASSESSMENT

The developmental assessments for this course has two components, i.e. tasks (named assignments and project) distributed during the course and a final written examination. Table 1 indicates the contribution of these tasks as well as the written examination. It also shows the different activities designated to each task, which they have also impact in the assessment.

The assignments and project structure, which are considered also as part of the active learning activities, are described in the following content. A problem in line with the learning outcomes will be given to the students to be solved. The process in which the problems are solved is considered as jigsaw group project, Clarke (1994), and is divided into three phases (seminar preparation, seminar and final report) according to Tab. 1. It is worth mentioning that the project combines features from the assignments in a more advanced level and also demands slightly higher scientific level when it come to the final report.

Table 1 The contribution of different activities in the final assessment of the course.

Activity	Maximum Points			Total Points	Contribution in the Final Assessment
	SP[A]	S[B]	FR[C]		
Assignment 1	1.5	0.5	2	4	
Assignment 2	1.5	0.5	2	4	
Assignment 3	1.5	0.5	2	4	
Project	1.5	0.5	6	8	
Total points from all assignments				20	20*0.5
Written Exam	20			20	20*0.5
Final Assessment					20[D]

[A]Seminar Preparation, [B]Seminar, [C]Final Report

[D]Grading is: 0 – 9.99p → Fail, 10 – 11.99p → 3, 12 – 15.99p → 4, 16 - 20p → 5.

Seminar Preparation: In this stage students will be given few generic questions, relevant to the problem, and essential to be understood in order to solve the problem in hand. Note that these questions are important part of the problem, but they will not lead to a complete answer. Thus the students will need to utilize their knowledge from these questions to be able to solve the problem in hand.

The students are expected to work in groups of two; in total there are 20 students, to provide their answers as a written document and within a time interval. Since, the questions have not been discussed previously, complete and correct answers are not expected and grading assessed based the level of answer, group summative assessment GSA. Feedbacks will be provided for the students in order to allow them for further improvements both for their final report as well as next seminar preparations.

Seminar: In the seminar, students are initially re-formed into focus-groups (4 to 5), dividing partners from the seminar preparation group, to work on one specific question from the preparation assignment. Since the students have provided preliminary answers, the instructor will decide on the question to be assigned to each group. In this way it can be assured that in each group there is at least one student with good background about that particular question and thereby can guide and lead the others.

> ***Note:*** In the first seminar (corresponding to assignment 1), the entire class was considered as one group and the students were encouraged to participate in the discussion by formulation of questions from the instructor. However, after this seminar the abovementioned formulation has been used throughout the course. The motivation for this will be discussed in the next section.

Thereafter students will conduct discussion between themselves to formulate a final answer to the specific given question. The instructor participates in the group discussions for both

encouraging the students to contribute in formulating the answers and also to make sure that the right answer is developed. Active participation in the discussions will reflect on the students' assessment and contribute in the grading, and individual assessment. When the final answer has been achieved, the students will write them on the whiteboard. These seminars are organized in special classrooms where relatively long whiteboards are indicated around the class to give the possibility for each group to write their answers.

After this, from each group one or two representative students should also explain and present the final answer to the entire class, i.e. teaching others through panel discussion. The first objective here is to promote the learning by means of teaching, Springer et al. (1998). This oral activity is also utilized to encourage the student to participate further in the discussion and to improve their presentation skills. The presenter will change from one seminar to the other.

The seminar is considered as one of the ALA and further activities coupled to the assignments/project and seminars include lectures and computer labs. The lectures cover the foundation for performing the assignments and give an introduction to the problem. In the computer labs the students and instructor have the possibility to interact for solving the problem in hand problems.

Final Report: After the seminar, along with completion of the computer labs, the students are able to complete the given task and write a technical report including the answers to the questions together with some further investigations.

To facilitate the students in efficient writing and thus improving their writing communication skills, some guidelines regarding the structure of the report as well as a template have been provided.

The technical reports, written in the group formats as seminar preparation, will be assessed, graded (GSA) and direct reflections will be provided to the students. To engage the students further into critical thinking, each group is also asked to formulate a relevant question to the problem in hand. These questions will be collected and available in a web-based student platform called LISAM, which could be used as preparations for the final exam.

Group working and assessment can not only benefit the students by promoting learning through cooperative and active learning, promote skills etc., but also benefit the higher education institutions by reduced time and material resources required and reduced marking effort, Bacon (2005). However, it is of high importance to have procedures with fair, accurate and repeatable individual marks, e.g. see Thorley and Gregory (1994) and Burdett (2003). According to Lejk et el. (1999) integration of marks from group assessment is associated with some level of uncertainty, unease and reliability debate, in comparison to marks gained in individual assessments. Therefore, the DA for this course has also utilized the final examination to distinguish individual marks from group marks. The written examination covers content related to the lectures, assignments and teaching activities within the seminars, some relevant questions addressed within lesson sessions and also formulated questions by students.

STUDENTS PERCEPTION AND DISCUSSION

The developmental assessments approach for this course has been assessed using two anonymous surveys (A and B with similar questions) conducted during the course and an

interview with three students after the final examination. Survey A was conducted after the first seminar and survey B in the end of the course. Since this DA method has been implemented for the first time, survey A was conducted in order to get preliminary measures about student's perception and possible indicators of success or failure related to the seminar preparations and seminars method. Obviously such an early survey may not reflect on the true impact of the method in student's learning. Therefore, survey B was conducted in the end of the course to obtain a more thorough quantitative measures about the influence of the DA in achieving the ILO. The interviews were conducted to obtain more detail information from the students including reflections about the final examination. It should be noted that from the total number of students (18), the number of respondents for survey A and B are 16 and 17, respectively. It is of utmost importance to note that in order to verify the findings of the study, further evaluation of the method is essential.

Considering the seminar preparations, the results from both survey questions (Q1-Q9) show that this activity can facilitate students for better understanding of the contents discussed in the seminar. However, the interview results suggest that the students will benefit the most from the seminar preparation if enough time is designated for it, the questions are formulated clearly and appropriate literature is suggested. Figure 2 reveals relatively tight schedule from introducing the seminar preparation until the seminar, i.e. aligned with students' comments. Therefore, it is wise to allocate appropriate time interval to use the advantages of the approach. The students will also benefit from clear questions and instructions as they can devote their time to actual problem-solving rather than interpretation and surfing for literature.

> **Q1:** The seminar preparations were valuable and helpful in better understanding of the contents discussed in the seminar. Both surveys: 76.4% respond in strongly agree and agree.

As noted earlier, the first seminar considered the entire class as one group for the discussion. Even though, the instructor could involve the students into the discussions to some extent, it was not satisfactory enough. Therefore, instructor decided to investigate the cause for low interest from the students to participate in the discussions through survey A. Interestingly, the results indicated that despite of students' interest in participation in the discussion (Q2) the organization of the seminar seemed to not the reduce the motivation (Q3). Further investigations have revealed that creating informal cooperative groups, which can facilitate active learning is an effective and convenient approach for in-class group discussion according to Giddon and Kurfiss (1990), Johnson and Johnson (1994a). Indeed, this was aligned with students' comments that indicated conducting the discussions in smaller groups can be helpful as it will give them more comfort for expressing their thoughts. Therefore, the organization of the seminars has been changed to the procedure, re-grouping within the seminar, mentioned in developmental assessment section. The responses from survey B (Q3), showed that this adjustment was appreciated among the students. Thus, the results showed the importance of small group learning in promoting students achievements and interest towards course materials aligned with finding of the comprehensive study done by Springer et al. (1998). More detailed comments from the interviews show the students appreciation for oral presentation and constructive feedback from the instructor, learning by teaching, giving directions rather than direct answers, instructor engagement. The students have recommended to prevent very deep discussions, focus towards the group as a whole and prior clarification on the content of the discussion.

> **Q2:** I would like to participate in the discussions as it will assist me for deep learning. *Both surveys:* 81.25% respond in strongly agree and agree.

Q3: The seminar was organized appropriately and could increase my knowledge while assisting me to complete the assignment. *Survey A:* 50% respond in strongly agree and agree. *Survey B:* 76.5% respond in strongly agree and agree.

An important part of the assessment has been designated to the final report. It has been found that providing instructions and templates can assist the students for finalizing a better report (Q4, survey B). The interview results indicate the importance of constructive feedback on the reports.

Q4: The templates and report instructions were convenient and supportive in finalizing a better report. *Survey B:* 70% respond in strongly agree and agree.

The students' interest in formulating questions was found to be relatively low (Q5 survey B). A possible explanation for this can be the fact that this question is addressed before rather than after the exam, hence the students have not practiced their own critical thinking outcome yet and have not seen the real use of their work. In the interviews, the students commented that by creating your own questions for the written exam you are involved in recognition of important contents.

Q5: I think creating questions as part of the assignments/project are helpful. *Survey B:* 50% respond in strongly agree and agree.

One of the important findings was that the students recognize the connection and integration between different parts and their alignment with the course objectives (Q6-Q8, survey B), i.e. constructive alignment The results from the interviews complement that the assignments and projects are clearly connected to the lectures as well as the final exam. The students also appreciate the scientific level of the project and the fact that it demands their knowledge from the earlier assignments. This in turn has facilitated the students for continuous increase of their knowledge and promoting their skills.

Q6: There was a clear connection between different activities (Lectures, Seminars, Lessons, Labs etc) and they matched with the course objectives. *Survey B:* 94.2% respond in strongly agree and agree.

Q7: Overall different parts of the course can enhance my knowledge. *Survey B:* 100% respond in strongly agree and agree.

Q8: Overall different parts of the course can promote my skills. *Survey B:* 94.2% respond in strongly agree and agree.

The results further showed that students have a major concern regarding the course workload (Q9, survey B). Although, this may be interpreted as students' engagement in quality learning, it can also hinder students learning. A comment from the students' interviews was related to low motivation for the final exam due to high workload during the course. The comment, however, also suggest that exam preparation assisted students to obtain deeper knowledge. This suggest that the efficiency of the DA method should be improved in this regard.

Q9: I think the course workload is normal and evenly distributed. *Survey B:* 12.5% respond in agree.

The developed assessment method employed for this course in its current form has a major limitation. This is associated with the possible number of students for the seminar sessions. Thus to maintain desirable interaction between the students and the instructor as well as time management considerations, the number of students should be retained in the limit of 20 per seminar session. In addition, an important aspect of this DA is to provide quality feedbacks on seminar preparation, seminars and final reports, to allow students to improve their performances. This can be a time demanding task for the instructor and may call for adjustments to improve the efficiency of the method.

Developmental Assessment and CDIO

CDIO Standard 8 emphasizes on using teaching activities that engage students directly in the learning process. The DA method developed through this LCCD framework utilizes a number of active learning methods. Performing the assignments/projects follow the jigsaw group project as a whole. The seminar preparation demands small group work on questions. The seminar includes the group and panel discussion for deep learning. The final report includes creating questions, which encourages the students to think deeper about the course material.

The description of CDIO Standard 11 clarifies that the level in which the students achieve specified learning outcomes of their respective courses is the true measure of the assessment of student learning. It is therefore highlighted that an effective assessment uses combination of assessment methods, including written and oral tests, observations of student performance etc. Within the employed method students are assessed based on their pre-study outcomes, participation in discussion and oral presentation, written communication skills and final examination. This DA examines students both with respect to their disciplinary knowledge and personal and interpersonal skills.

CONCLUDING REMARKS

A learning-centred course design framework has been used to develop an engineering course, Fluid Mechanics, at Linköping University. The students' overall high grades and positive feedbacks, suggest an aligned integration between teaching activities and developmental assessment components of the LCCD to achieve high intended learning outcomes. However, implementation and evaluation of the method in the subsequent years is required for increasing the certainty of the outcomes.

In conclusion, the study highlights the importance of assessment in a LCCD framework in order to enhance the student's knowledge, skills and attitude within the subject. Successful implementation of the developed method enables is an effective approach to meet CDIO Standards 8 and 11.

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BIOGRAPHICAL INFORMATION

Hossein Nadali Najafabadi (Ph. D.) is currently a post-doctoral fellow at the division of Applied Thermodynamics and Fluid Mechanics, Linköping University, Linköping, Sweden. In addition to his research within the Turbomachinery field, he is involved in developing courses such as Gas Turbine Engines, Fluid Mechanics and Computational Fluid Dynamics.

Magnus Andersson is currently a Ph. D. student at the division of Applied Thermodynamics and Fluid Mechanics, Linköping University, Linköping, Sweden. In addition to his research within the field of biofluid dynamics, he is involved in developing courses such as Computational Fluid Dynamics and Heat Transfer.

Matts Karlsson is Professor and Chairman of the Division of Applied Thermodynamics and Fluid Mechanics, Dept. of Management and Engineering, Linköping University, Linköping, Sweden. His research focuses on computational biofluid dynamics, vehicle aerodynamics and industrial heat transfer. He is Chairman for School of Mechanical Engineering and Design.

Corresponding author

Dr. Hossein N. Nadali
Department of Management and Engineering
Division of Applied Thermodynamics and Fluid Mechanics
Linköping University
s-581 83 Linköping
hossein.nadali.najafabadi@liu.se