Constructive alignment in Computer Engineering and Informatics departments at Dalarna University: An empirical investigation

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Abstract

Background: Constructive alignment (CA) is a pedagogical approach that emphasizes the alignment between the intended learning outcomes (ILOs), teaching and learning activities (TLAs) and assessment tasks (ATs) as well as creation of a teaching/learning environment where students will be able to actively create their knowledge.

Objectives: This paper aims at investigating the extent of constructively-aligned courses in Computer Engineering and Informatics department at Dalarna University, Sweden. This study is based on empirical observations of teacher’s perceptions of implementation of CA in their courses.

Methods: Ten teachers (5 from each department) were asked to fill a paper-based questionnaire, which included a number of questions related to issues of implementing CA in courses.

Results: Responses to the items of the questionnaire were mixed. Teachers clearly state the ILOs in their courses and try to align the TLAs and ATs to the ILOs. Computer Engineering teachers do not explicitly communicate the ILOs to the students as compared to Informatics teachers. In addition, Computer Engineering teachers stated that their students are less active in learning activities as compared to Informatics teachers. When asked about their subjective ratings of teaching methods all teachers stated that their current teaching is teacher-centered but they try to shift the focus of activity from them to the students.

Conclusions: From teachers’ perspectives, the courses are partially constructively-aligned. Their courses are “aligned”, i.e. ILOs, TLAs and ATs are aligned to each other but they are not “constructive” since, according to them, there was a low student engagement in learning activities, especially in Computer Engineering department.

Keywords: constructive alignment, active learning, learning outcomes, student-centered education

Introduction

One of the main goals of higher education is to prepare students for life and work in the 21st century by providing students with adequate competencies (skills and knowledge). In the current higher education settings, there is a large variability among students in terms of motivation, previous knowledge, culture, etc. This variability introduces a number of challenges to university teachers. Therefore, there is a need for an educational approach that accounts for the said student variability where students are expected to acquire competencies and use them in their academic work. Outcomes-based education (OBE) is an approach in which the design of teaching and learning processes are driven by the learning outcomes that students should possess by the end of the courses and programmes [1]. As a result, quality assurance higher education agencies evaluate the results of courses and programmes in their respective countries based on the OBE framework. For instance, the Swedish National Agency for Higher Education assesses the extent the students achieve learning outcomes in relation to the intended learning outcomes (ILOs) stated in the course and programme plans.
Additionally, the Bologna Declaration emphasizes the importance of organizing higher education in terms of ILOs. In the Leuven/Louvain-la-Neuve Communiqué of 28-29 April 2009 [3], the ministers have set a number of priorities including developing student-centered learning outcomes and teaching missions where they stated:

“We reassert the importance of the teaching mission of higher education institutions and the necessity for ongoing curricular reform geared toward the development of learning outcomes. Student-centered learning requires empowering individual learners, new approaches to teaching and learning, effective support and guidance structures and a curriculum focused more clearly on the learner in all three cycles. Curricular reform will thus be an ongoing process leading to high quality, flexible and more individually tailored education paths. Academics, in close cooperation with student and employer representatives, will continue to develop learning outcomes and international reference points for a growing number of subject areas. We ask the higher education institutions to pay particular attention to improving the teaching quality of their study programmes at all levels. This should be a priority in the further implementation of the European Standards and Guidelines for quality assurance.”

Constructive alignment (CA) is an outcome-based approach to teaching where various aspects of teaching like ILOs, teaching and learning activities (TLAs) and assessment tasks (ATs) are aligned to each other [4]. In constructively-aligned courses the ILOs are defined before teaching takes place and the TLAs and ATs are designed and aligned to achieve the ILOs and to what extent they have been achieved, respectively. According to John Biggs [4], CA has two parts. The “constructive” part refers to the learning process where knowledge is constructed through the activities of the learner. The “alignment” part refers to the process of aligning TLAs and ATs to the ILOs. Implementation of CA in courses has been previously tested and has shown to increase deep learning approaches among students [5]. Additionally, implementation of CA would lead to greater coherence in learning as well as more effective and transparent evaluation. According to Biggs [4], teachers that intend to adopt CA in their courses should clearly state the ILOs, explicitly communicate the ILOs to the students, match ATs and TLAs to the ILOs, and create a learning environment where students actively construct their own knowledge.

The objective of this paper is to investigate the extent of constructively-aligned courses in Computer Engineering and Informatics departments at Dalarna University, Sweden. The results are based on responses of the teachers of the two departments to a custom-designed questionnaire. The empirical study, even though it has a small sample size, is expected to represent an overview of practical implementation of CA in the courses provided by the two departments.

Methods

Data collection

Ten university teachers were asked to fill a paper-based questionnaire and their responses were summarized in the subsequent analysis. There were 5 teachers in each department (Computer Engineering and Informatics). The questionnaire consisted of total of 8 questions (Q) where 6 were multiple-choice and 2 were free writing. Table 1 summarizes the text for the
questions and their respective rating scales. The complete questionnaire can be found at Appendix A.

Data analysis

The responses to questions based on Likert rating scale were visually inspected after analyzing and interpreting their bar graphs. The responses to free-writing questions were summarized in a qualitative manner. No statistical analyses were performed on the data since the sample size was low.

<table>
<thead>
<tr>
<th>Text</th>
<th>Rating scale</th>
</tr>
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<tbody>
<tr>
<td>Q1 To what extent do you clearly state intended learning outcomes in your courses?</td>
<td>Likert</td>
</tr>
<tr>
<td>Q2 To what extent do you explicitly communicate the intended learning outcomes to the students?</td>
<td>Likert</td>
</tr>
<tr>
<td>Q3 To what extent you align teaching and learning activities to the intended learning outcomes of the courses?</td>
<td>Likert</td>
</tr>
<tr>
<td>Q4 What kind of teaching and learning activities do you use the most? Please specify their ratio.</td>
<td>Free writing</td>
</tr>
<tr>
<td>Q5 To what extent the students are engaged in learning activities?</td>
<td>Likert</td>
</tr>
<tr>
<td>Q6 To what extent you match the assessment tasks to the intended learning outcomes?</td>
<td>Likert</td>
</tr>
<tr>
<td>Q7 Do you think your teaching is teacher-centered or student-centered?</td>
<td>Free writing</td>
</tr>
<tr>
<td>Q8 Please specify the form of teaching in your courses?</td>
<td>Three-category</td>
</tr>
</tbody>
</table>

Table 1. The questions of the questionnaire and their rating scales. Likert rated questions had the following items: “Very little extent”, “Little extent”, “Some extent”, “Great extent”, “Very great extent”. The three-category rated question had the following items: “Distance”, “On-campus”, “Both”.

Results

When analyzing the responses to Q1 (To what extent do you clearly state intended learning outcomes in your courses?) most of the teachers from the two departments responded as “Great extent”, except 1 Informatics teacher who responded as “Some extent”. Fig. 1 shows the responses to Q1 of the teachers for the two departments.
The teachers responded differently to Q2 (To what extent do you explicitly communicate the intended learning outcomes to the students?). The responses of the Computer Engineering teachers were scattered from “Little extent” to “Great extent” (Fig. 2). Two teachers at this department responded as “Little extent”, 2 as “Some extent” and 1 as “Great extent”. In contrast to Computer Engineering teachers, all of the Informatics teachers responded as “Great extent”, except 1 who responded “Some extent”.

The responses to Q3 (To what extent you align teaching and learning activities to the intended learning outcomes of the courses?) per each department and item of the scale are shown in Fig. 3. All of the Computer Engineering teachers responded that they align TLAs to the ILOs of their courses at great extent. Similar responses were obtained from the Informatics teachers, except one teacher who responded as “Some extent” to this question.
The responses to Q4 (What kind of teaching and learning activities do you use the most? Please specify their ratio.) are qualitatively summarized as follows. The responses obtained from Computer Engineering teachers were: “Lectures (online + recorded), labs, supervisory sessions (flipped classroom)”, Labs usually 4 times during a course, lectures 10-15 times, project work and examination seminars 3 occasions”, “Lectures (40%), labs/projects (50%), seminars (10%)”, “Lectures and labs”, “Lectures (25%), labs (25%), seminars (25%), and projects (25%)”. Similar responses were obtained from Informatics teachers including “Flipped classroom, seminars, labs”, “Lectures (50%), labs (25%), seminars (25%)”, “Labs (60%), lectures (40%)”, “Labs and lectures”, and “Mostly lectures, seminars and some labs. Many courses include projects”.

When responding to Q5 (To what extent the students are engaged in learning activities?) the responses were mixed. Half of the Computer Engineering teachers that is 3 teachers responded that student engagement in learning activities is small, i.e. “Little extent”. In contrast, the Informatics teachers tended to rate the student engagement in their courses towards the higher end of the scale. The majority (50%) of the Informatics teachers responded as “Great extent” to this question.

![Fig. 4. Responses to Q5 per department and item of the scale. Abbreviation: CE, Computer Engineering; IN, Informatics.](image)

Both the teachers at the two departments responded as “Great extent” to Q6 (To what extent you match the assessment tasks to the intended learning outcomes?), (Fig. 5).
Responses to Q7 (Do you think your teaching is teacher-centered or student-centered?) are qualitatively summarized as follows. The Computer Engineering teachers responded as following: “For the moment not full student-centered but I am working on that”, “Teacher-centered but there are labs where students do things on their own”, “Teacher-centered”, “Student-centered”, and “I try to be student-centered”. The Informatics teachers responded as following: “Trying to be student-centered but probably end up somewhere (intending) in between”, “Mostly teacher-centered but certain courses tend to be more student-centered (flipped classroom)”, “Moving from teacher-centered to student-centered using flipped classroom”, “Teacher-centered tending towards student-centered”, and “I try to be student-centered”.

When responding to Q8 (Please specify the form of teaching in your courses?), eight teachers (4 on each department) stated that they teach both on-campus and distance, 1 Computer Engineering teacher stated that he/she teaches only on distance and 1 Informatics teacher stated that he/she teaches only on-campus.

**Discussion and conclusions**

This paper presented results obtained from a questionnaire designed to measure the extent of constructively-aligned courses in Computer Engineering and Informatics departments at Dalarna University, Sweden. The results were based on teachers’ perceptions of the extent of CA implemented in their own courses. The questionnaire was designed based on recommendations of Biggs [4] for adopting CA in courses and programmes in university teaching. Recommendations were directed towards aligning the TLAs and ATs to the ILOs as well as create a teaching/learning environment where students will be able to create their knowledge through their active behavior. In addition, the questionnaire included items like forms of studies (distance/on-campus) and teacher’s perception on his/her teaching (student-vs. teacher-centered).

Results indicated that the teachers at both departments clearly state the ILOs in their courses and try to align the TLAs to the ILOs. In addition, they stated that when they select ATs they take into account the ILOs specified in the course plans. Nevertheless, there were some
differences in responses of the teachers of the two departments. Teachers of the Computer Engineering department stated a lower extent of explicit communication of the ILOs to the students as compared to the teachers of Informatics. Another interesting observation was that the Computer Engineering teachers stated that their students are less active in learning activities as compared to Informatics teachers who rated the student engagement with great extent. This observation is in line with current qualitative observations of the staff members at the Computer Engineering department. Current discussions on this topic are directed towards challenges and difficulties of creating a teaching/learning environment where students are active, i.e. come prepared in the classroom sessions. It is worth mentioning that, currently, Bachelor education at Computer Engineering is done 100% on distance and another interesting research question to be investigated in the future would be to assess whether distance education itself impacts the student engagement. This inactivity of the students may be correlated to the attrition of students in our Bachelor programme of Digital Forensics and IT-Security. Generally, retention of students in online programs is a challenge and several studies have shown that attrition rates for online programmes are much higher than for on-campus programmes [6]. This problem is complex and challenging to be investigated and is out of the scope of this paper.

As far as teachers’ perceptions of their own teaching is concerned, responses to Q7 (do you think your teaching is teacher-centered or student-centered?), majority of the teachers at both departments clearly stated that currently their teaching is teacher-centered but have intentions to make it more student-centered. It would be interesting to investigate factors that are hindering this development from teacher- to student-centered teaching; to indicate whether those factors are individual (teacher-specific) or institutional or combinations of these. Biggs [7] suggests that despite individual teacher efforts there is a need for appropriate institutional support for successful implementation of any major teaching reform, in this case CA. From the responses on Q4 (What kind of teaching and learning activities do you use the most? Please specify their ratio.) can be concluded that majority of the teachers from both departments mostly use lectures, labs and seminars as main TLAs. Some of the teachers refer to flipped classroom approach to teaching as an alternative to conventional TLAs and to transform their teaching from teacher-centered to student-centered.

A limitation of the present study is that the results are based on teachers’ perceptions of their own teaching. There may be different factors for contributing to inappropriate results. One such factor may be related to teacher’s subjective interpretation of CA; every teacher may differently interpret ILOs, TLAs, and ATs and how they should be related to each other. Another factor that could influence the results of this study would be the teacher’s intentional attitude towards higher rating of the items of the questionnaire in order to not look bad in front of colleagues. Another limitation of the study is related to the small sample size indicating that drawing reliable conclusions from the obtained results is not feasible. However, these results can be used for representing an overview of the extent of constructively-aligned courses at Computer Engineering and Informatics departments. In order to tackle these issues it would be interesting to have a larger study where a panel of experts in constructively-aligned teaching would investigate the extent of CA in the courses. In order to reduce the observer effects it would be important to have blinded observations so that the teachers would not know whether they are being observed. Additionally, it would be interesting to compare the levels of student satisfaction, teacher perceptions and course
outcomes in pre- and post-CA-aligned courses and have longitudinal observations of many courses within a same or more departments.

Quality assurance agencies and Bologna Declaration stress the importance of having an OBE where courses and programmes are constructively-aligned. The Swedish Higher Education Agency evaluation model consists of five stages and one of them aims at investigating learning outcomes and programme syllabus in higher education institutions in Sweden [2]. More specifically, the focus is on evaluation of results and learning outcomes. In the next generation of evaluations, the Swedish Higher Education Agency will focus on outcomes, among other factors [2]. A special focus will be given on coordinating first- and second-cycle evaluations to the third-cycle evaluation (PhD). Therefore, it is very important to emphasize the need for OBE in university education by embedding CA in a supportive culture at both departmental and institutional levels as well as closely connect research and education at all educational cycles.

In conclusion, the courses in Computer Engineering and Informatics departments are partially constructively-aligned; they are “aligned” but not “constructive”. From the responses to the questionnaire can be concluded that the teachers try to align TLAs and ATs to ILOs but there is a problem with low student engagement in learning activities, especially in Computer Engineering courses.

References:

Appendix A: Questionnaire – Constructive alignment in university teaching

This questionnaire is used as part of an individual assignment in “Teaching and Learning in Higher Education” course. The assignment aims at investigating the extent of constructively aligned courses in Computer Engineering and Informatics departments. What is a constructively aligned course? A course in which intended learning outcomes, teaching and learning activities and assessment tasks are directly aligned to each other, with the aim of enabling students to construct the knowledge through their own learning activities.

Question 1: To what extent do you clearly state intended learning outcomes in your courses?
- Very great extent
- Great extent
- Some extent
- Little extent
- Very little extent

Question 2: To what extent do you explicitly communicate the intended learning outcomes to the students?
- Very great extent
- Great extent
- Some extent
- Little extent
- Very little extent

Question 3: To what extent you align teaching and learning activities to the intended learning outcomes of the courses?
- Very great extent
- Great extent
- Some extent
- Little extent
- Very little extent

Question 4: What kind of teaching and learning activities do you use the most? Please specify their ratio.

Question 5: To what extent the students are engaged in learning activities?
- Very great extent
- Great extent
- Some extent
- Little extent
- Very little extent

Question 6: To what extent you match the assessment tasks to the intended learning outcomes?
- Very great extent
- Great extent
• Some extent
• Little extent
• Very little extent

Question 7: Do you think your teaching is teacher-centered or student-centered?

Question 8: Please specify the form of teaching in your courses?
• Distance
• On-campus
• Both

Thank you for your time!
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