

## **Assessment tasks in the course ‘Energy Systems and Climate Change Mitigation’: ensuring constructive alignment**

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### **Introduction**

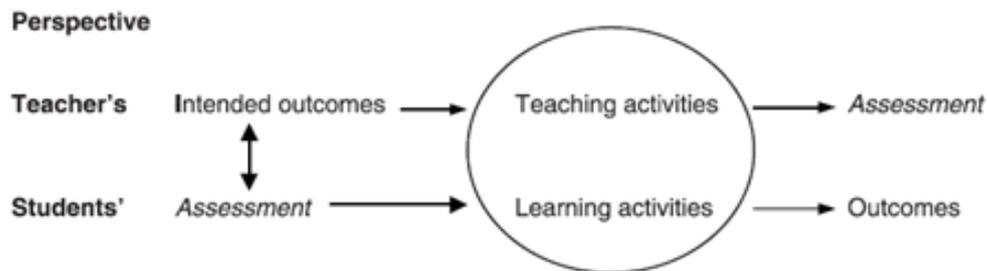
In this project, where I focus on exams and assessment tasks in the course ‘Energy systems and climate change mitigation’ I wish to, based on the theories on constructive alignment, particularly the learning outcome-assessment task dimension (ILO-AT), explore how student case work as a teaching and learning activity (TLA) can be integrated in the final assessment/exam to further increase course alignment.

Constructive Alignment (CA) is an outcome based didactic theory developed by John Biggs. The fundamental assumption is that deep learning is supported by focusing on what students do rather than on what students are, or what teachers do (Biggs & Tang 2007, Mørcke & Rump 2013). CA builds on constructivism (hence the first part of the name) as formalized by Jean Piaget (Dolin 2013) suggesting that learners construct new knowledge out of their present experience through an interaction between that experience and the experience of the surrounding world, e.g. a teacher.

‘Alignment’ refers to the process of stimulating deep learning by ensuring that the learner experiences coherence between what the learner is expected to become capable of (Intended Learning Outcomes, ILOs), the learning environment (Teaching and Learning Activities, TLAs) and the assessment of the learners learning (Assessment Tasks, ATs).

With respect to assessments Biggs & Tang (2007) argue that while teachers often consider the ILOs as the guiding element in a teaching-learning event students might consider differently. To the student passing

the exam is the element that guides learning activities (Fig. 11.1). This so-called (negative) backwash effect leads to surface learning.



**Fig. 11.1.** Teacher's and student's conflicting view on assessments. Adopted from Biggs & Tang (2007), fig. 9.2, page 169.

Backwash can be used positively. If the final summative assessment is aligned with the learning outcomes then teaching activities and learning activities focus on the same goal, the ILOs. When students prepare for the assessment they automatically train for the learning outcomes (Biggs & Tang 2007, Frankland 2007).

## Material and methods

This report is based on own experience teaching the course in 2014 and 15, and on oral feedback from the students. Written evaluations on Absalon were few and did not provide specific input to the question treated here. It hasn't been possible to carry out the suggested changes of exam forms within the timeframe of the Teaching and Learning in Higher Education programme.

## Course

The course 'Energy Systems and Climate Change Mitigation' is a 7.5 ECTS restricted elective course in the MSc programme in Climate Change at University of Copenhagen. The course covers one block (8 weeks) in the spring semester. Apart from climate change students the course is open to students from other programmes at UCHP and from external students. The course was executed first time in 2014 (academic year 13/14) with 30 students.

In 2015 40 students attended. The final assessment and grading of students is based on four hours written test at the end of the course. The test takes place at the university (corresponds to exam type IV in table 11.2). The test is a mix of calculation exercises, discussion items and multiple choice questions. Multiple choice questions are used to test basic facts like energy conversion efficiency, energy units and forms, and scale relations (ILO 2). Discussion items focus on evaluation of strategies and interrelations between energy and climate systems (ILO 1 and 4). Calculation exercises target ILO 1, 2, 4 and to limited extent 3.

### **Course alignment**

Course alignment The level of course alignment is presented in table 11.1 below. By comparing the lecture plan, learning outcomes in the course description and the options provided by the exam form I find misalignment between some assessment tasks and learning outcomes. As can be seen from table 11.1 misalignment particularly occurs for the elements emphasizing the highest level of understanding (level 4 and 5 in the SOLO taxonomy).

I evaluate the current exam form inadequate of supporting ILO 3, 5 and 6 because these requires more time that four hours for the students to identify relevant problems, find and analyse data, and reflect over strengths and weaknesses of potential solutions. Moreover ILO 6, work in interdisciplinary groups, is incompatible with the current exam form.

### **Student feedback and own experience**

A core element in the teacher's and course responsible's approach to teaching the course is to provide the students with hand-on experience in developing, designing and evaluating renewable energy systems at all scales (ILO 4-6, table 11.1). A chosen activity to support that outcome is group work on a self-elected case. From my perspective the case work is very valuable in supporting the learning outcomes and this is seconded by student feedback.

### **Suggested changes**

In the following I present my suggestions for changed exam forms to ensure further course alignment in support of deeper learning. However exam

**Table 11.1.** Evaluated levels of constructive alignment between intended learning outcomes (ILO), teaching and learning activities (TLA) and assessment tasks (TA). Central verbs in the ILOs are set in italics. The ‘SOLO’ column refers to levels of understanding following the SOLO taxonomy (Biggs & Tang 2007), table 5.1 page 80. Filled arrows indicate alignment, open arrows indicate misalignment.

TLA		ILO	SOLO		AT
Lectures, exercises and group work (Module 1: Introduction, module 3: non-renewable energy, module 4: renewable energy)	→	Understand and <i>describe</i> the interrelations between the climate systems and the energy systems	3	←	Final exam (individual written summative assessment)
Lectures, exercises, group work and excursion to power plant (Module 2: thermodynamics, module 4: renewable energy)	→	<i>Describe</i> the renewable energy technologies available to mitigate climate change	3	←	Final exam (individual written summative assessment)
Exercises and group work on self-elected case (Module 3: non-renewable energy, module 4: renewable energy, module 5: energy systems)	→	<i>Analyze</i> existing energy systems, at all scales, and their contributions to climate change and mitigation	4	↔	Final exam (individual written summative assessment)
Lectures and group work on self-elected case (Module 5: Energy systems)	→	<i>Evaluate</i> the appropriateness of alternative strategies for transformation of the energy systems for climate change mitigation	4	←	Final exam (individual written summative assessment)
Group work on self-elected case (Module 5: Energy systems)	→	Contribute constructively to the <i>design</i> of sustainable energy systems at all scales	5	↔	Final exam (individual written summative assessment)
Lectures, exercises and group work on self-elected case (Module 1: Introduction, module 2: thermodynamics, module 4: renewable energy, module 5: Energy systems)	→	Work in inter-disciplinary groups to <i>solve</i> problems related to energy systems and climate change mitigation	5	↔	Final exam (individual written summative assessment)

forms cannot be changed at will and all forms have their benefits and weaknesses, which are discussed.

## Regulatory framework

Exam forms are particularly regulated by ministerial order 670 of 19 June 2014 on exam and censorship at university studies [Bekendtgørelse om eksamen og censur ved universitetsuddannelser] (Uddannelses- og Forskningsministeriet 2014), and the joint curriculum for BSc and MSc programmes at the Faculty of Science (UCPH 2015). The ministerial order section 4 states that exams can be organized as individual or group tests but in any case an individual assessment must be performed followed by individual grading of the students.

The curriculum section 6.1 states that exams can be organized as one or more tests leading to either a weighted assessment and grading of the

individual tests or an overall assessment and grading of the test portfolio. Furthermore section 6.4.1 states that written tests can be organized as individual or group tests. However, group tests must allow for individual assessment and grading of the students requiring either a declaration of the individual contributions by each student to the written work or a subsequent oral examination.

The core constraint is that no matter how the final assessment and grading is organized it must provide the examiner and censor the means to assess and grade the students individually.

### **Exam forms**

It is important that the choice of exam form ensures reliability as well as validity (Biggs & Tang 2007, Andersen et al. 2013). Reliability meaning that the assessment and grading is unequivocal, transparent and not dependent on external factors like the student, examiner or censor them-selves, the place and surroundings but only on the performance. Validity requires that the exam tests the learners' learning with reference to the purpose of the learning (ILOs). An example of low validity is presented by Vennervald (2010) in her project on a course in human parasitology, where a multiple choice test was found inadequate to test "*the students' abilities to analyse problems in relation to human parasite infections in a broader context in relation to human health*".

Andersen et al. (2013) distinguish exam forms by product type and where the exam takes place. Exam forms commonly encountered in Denmark are illustrated in table 11.2 below. An exam form more commonly used abroad, course participation, is in a Danish context and regulatory framework considered a prerequisite for exam participation rather than an exam form in it-self (Andersen et al. 2013). Within each form the exam can be executed in numerous different ways.

Oral exams are often considered having relatively low reliability because they depend too much on e.g. chance, personality, and the student's eloquence and language proficiency (Andersen et al. 2013). On the other hand the oral exam allows the (good) examiner to test the student's conceptual understanding and not only her/his ability to reproduce facts. Higher reliability is associated with some forms of written exams, e.g. multiple choice tests, calculation exercises as assessment and grading relies on the product (result) rather than on the process of reaching the result. As such the subjectivity is removed from the assessment.

**Table 11.2.** Exam forms distinguished by product type and place. An off-site exam takes place where the student determines. An on-site exam takes place at the educational institution or a place the institution determines. Adopted from Andersen et al. (2013), figure 1, page 372.

Product type Place	Written	Written + oral	Oral
Off-site	I) Written product made off-site (thesis, project report, case report, portfolio)		
Off-site + on-site	II) Written test on-site following a written product made off-site (rare type)	III) Oral test on -site based on written product made off-site (thesis, project report, case report, portfolio)	
On-site	IV) Written test on-site (exercise set, multiple choice, essay)		V) Oral test on-site (with or without aid, with or without preparation)

## New form

A new exam form must emphasise alignment on the ILO-AT axis with focus on learning outcome 3, 5 and 6 without changing the well-established ILO-AT alignment for outcome 1, 2 and 4. A shared teaching activity targeting outcome 3, 5 and 6 (and 4) is the self-elected case work, and I find it obvious to include, in some form, the case work in the final assessment. The output of the case work is a poster and an oral plenum presentation of the poster. As organised currently neither the joint poster nor the plenum presentation meets the regulatory requirements for individual assessment (curriculum sections 6.4.1 and 6.4.2), and based on the positive feedback on the case work and own experience I would be hesitant to change the format.

Execution of oral exams is generally perceived as more resource demanding than written exams (Andersen et al. 2013). This may particularly be true to courses with many students. With the number and growth of students in the ‘Energy Systems and Climate Change Mitigation’ course oral exams is not considered feasible. Consequently an individual oral exam based on the case work (type III, table 11.2) is not considered.

My suggestion for a new exam form is a weighted two part exam. One part is an individual essay based on the case work weighing 40 % (type I, table 11.2) and the other part is a shorter, e.g. 2.5-3 hours, written exam comparable to the current (type IV, table 11.2) weighing 60 %.

## Reflections

My suggestion for a new exam form for the 'Energy and Climate Change Mitigation' course could achieve the goal of course constructive alignment and ensure a reliable and valid assessment of the students learning.

The essay part of the exam allows the students to analyse, characterise, compare, contrast, generalise and reflect on their own experience and learning. All verbs associated with the relational and extended abstract level of understanding in the SOLO taxonomy (Biggs & Tang 2007). To achieve this, the essay should not be a summary of the poster and case work but a personal reflection over the implications and perspectives of the case work findings. If planned and organised well the essay could target learning outcomes 3-6. A risk with the essay format suggested here, produced un-invigilated is plagiarism (Andersen et al. 2013). However, as it will be based on supervised case work, I believe the risk is small, but for that reason I suggest it to account for less than 50 % of the final grade.

To minimise the risk of plagiarism and other fraud it is important to set up a very clear framework of guidelines and expectation for the students (Andersen et al. 2013, Biggs & Tang 2007), and finally software exist to detect internet plagiarism.

The validity of the suggested format is high as it builds on a real life case. Reliability in the assessment and grading is challenging for the examiner and censor and requires not only that they are experienced in assessing written work, but also a comprehensive documentation of the assessment (Andersen et al. 2013).

The written on-site test could be used more specifically to target learning outcome 1-4 with calculation exercises and multiple choice tests. These test forms are considered highly reliable (Andersen et al. 2013). Validity of the test must be ensured in the formulation of test items as topical, timely, and targeted conceptual understanding.

Misalignment on the ILO-AT axis is experienced in other courses and treated in earlier projects in the Teaching and Learning in Higher Education programme. Vennervald (2010) suggested a change from an on-site multiple choice test to an on-site, heavily guided, short essay based on a scientific paper to e.g. ensure alignment, encourage deeper learning, assess higher levels of the SOLO taxonomy, and activate students. When Damsgaard (2013) found ILO-AT misalignment in a course in human nutrition she did not change exam form (on-site oral test partly based on written product) but revised exam questions to ensure alignment and to demand

answers on a higher taxonomic level. The outcome of the changes was positively received by students as well as other teachers on the course. Hougaard (2013) experienced ILO-AT misalignment because the exam, in practice, only aligned with parts of the learning outcomes. 75 % of the grading was attributed to a project report and the oral exam (25 %) should target the rest of the curriculum, but did not. Her solution was to shift weights between the written and oral part of the exam to equal weights. Furthermore she discusses the possibilities of introducing more formative assessment or feed-back, and hence ILO-AT alignment in a course through student reflection papers for each module (6 modules in the course), but fears that an excessive workload be put on the teachers. Hansen (2013) experiences a similar form of misalignment, where practice doesn't follow the formal course description, and too much weight is put on a report and too little on the oral examination of the curriculum. His observations did not lead to changed exam forms but to changed behaviour for the teachers not only to increase alignment but also to prevent administrative problems caused by the disagreement between course description and student assessment practice. As demonstrated in the above cases ILO-AT misalignment is not rare, but several actions can be taken to improve it. Changed exam form is only one approach. Also shifted weighting between exam elements and changed practice has been applied to improve alignment.

## Summary

In summary this project finds ILO-AT misalignment in the course 'Energy Systems and Climate Change Mitigation' and discusses options and limitations to improve alignment to support deeper learning at higher taxonomic levels. The report discusses the validity and reliability of different oral and written exam forms, and the risk of plagiarism and fraud. Limitations imposed by regulation requiring individual assessment together with cost expectations narrow the field of applicable options to improve alignment. Finally the project suggests a new exam form for the course made up of two written parts: An individual un-invigilated essay based on supervised group work and a 'traditional' invigilated exam with calculation exercises and multiple purpose tests.

All contributions to this volume can be found at:

[http://www.ind.ku.dk/publikationer/up\\_projekter/2015-8/](http://www.ind.ku.dk/publikationer/up_projekter/2015-8/)

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