Consensus-Based Course Design and Implementation of Constructive Alignment Theory in a Power System Analysis Course

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This article presents implementation of the constructive alignment theory (CAT) in a power system analysis course through a consensus-based course design process. The consensus-based design process involves both the instructor and graduate-level students and it aims to develop the CAT framework in a holistic manner with the goal of including different perceptions. The considerations required to implement this approach are described in detail. To examine the effect of this approach, three different course evaluations were conducted by querying the students during different stages of the course. These evaluations show that most of the students find a benefit for their learning in the implementation of CAT within the new course design. These observations are supported by a comparison of the students' performance in the new course and the previous one. Finally, the revised two-factor study process questionnaire (R-SPQ-2F) is utilized to identify the students' learning approach toward the course. The aim is to correlate the students' approach with their final grade to assess if students adopting a deep learning approach are rewarded with higher marks and vice versa, i.e. to check if the CAT implementation was successful. Meanwhile, some of the R-SPQ-2F limitations, which affect the quality of the results, are identified and discussed. Additionally, to facilitate the practical usage of R-SPQ-2F, an algorithm was developed by the authors to rank the students' approach toward the course. The results of the new ranking algorithm demonstrate positive correlation with the students' final grade, which is an indication of the effective CAT implementation.

Keywords: Constructive-alignment theory, two-factor study process questionnaire, power system analysis

I. Introduction

This article argues for student involvement through the consensus-oriented decision making (CODM) model (Hartnett 2011) during the course design process and implementation. It presents a consensus-based implementation of constructive alignment theory (CAT) in a power system analysis course. This forms a new methodology for course design that uses the form of consensus with different stakeholders in the learning process.

A. Consensus-based course design

Through history, there have been several models for consensus-based decision making, most notably the Quaker model (Leadership 1999). The term consensus must not be misinterpreted as “unanimity”; it is used here to refer to a “general agreement” (Schutt 2010).

In non-engineering fields such as medicine and public health, consensus-based educational frameworks have been developed to address the needs stipulated by professional associations. Through the consensus process, working groups have been created to determine the competency set which educators can use to develop intended learning outcomes (ILOs) for courses in the study programs available for professionals working in this field (Subbarao, *et al.* 2008). For the engineering discipline, such sorts of competence have been developed and continue to be revised in the USA, Europe and Latin America (Lucena, *et al.* 2008), (Lohmann, Rollins and Hoey 2011), (Jamieson and Lohmann 2010). Defining this kind of competence sets are crucial for developing curriculum frameworks such as those developed in Australia and Asia (ACACA 2011), which assemble groups of stakeholders that deliver specifications or standards describing a competence set for pre-college studies. This approach can move the traditional education system to have a more systematic way of defining curriculum. For higher education, the key element to achieve this is the use of forms of consensus, a process which include different stakeholders in the curriculum design, as seen in Subbarao, *et al* (2008).

Students are the most relevant stakeholders in the educational system. For the engineering discipline, and particularly electric power engineering, it is not clear if student involvement exists in the consensus process that determines and redefines the core competence sets which students should achieve (Lohmann, Rollins and Hoey 2011). This is puzzling because students are the ones who will be affected the most by the decisions taken in the design of their education, and therefore their views should be considered in a more integrated manner. There is a good evidence supporting why it is relevant to increase the level of students' involvement in designing engineering courses. In Edström, *et al.* (2003), student representatives carried out surveys on learning experiences in Swedish universities; the findings of this work show that the participation of students can be useful for identifying the shortcomings in course designs.

Therefore, to account for the students' perception of the course efficiently, a method that combines the implementation of CAT and a consensus-based course design is utilized, in which the consensus-based design provides the opportunity to grasp the students' perception of the course through their involvement in the design process. Note that the background of the parties involved in the course design is pivotal. This issue is further discussed as the academic background of the students who have participated in this work is highlighted below.

B. *Constructive Alignment Theory (CAT)*

Constructive Alignment Theory is comprises a set of principles that can be used to devise teaching and learning activities (T&Ls) to achieve the intended learning outcomes (ILOs). This is accomplished by carefully aligning T&Ls and learning assessments to support the students to fulfil the ILOs. For a comprehensive exposure of the CAT the reader is referred to Biggs and Tang (2007), while an example of the implementation of the CAT in a course project and research activities in a power system analysis course is offered in Vanfretti and Milano (2012).

The underlying assumption of the CAT is that the teacher's fundamental task is to get students to engage in learning activities that are likely to result in achieving the desired outcomes in a reasonably effective manner. The major role goes to the students, since they use the activities to construct their knowledge and achieve desired outcomes. The minor role goes to the teacher, who designs a learning environment that encourages the students to perform the T&Ls that aid them to construct their knowledge.

Hence, it's very important that the set of T&Ls are devised in a manner that not only engages the students, but also sets them in the appropriate context that encourages them to carry out these activities spontaneously. The main notion here is that the learner's spontaneous (*self*) activities are just as crucial as those activities that are pre-defined by the instructor (Kirby & Pedwell 1991). Hence, the students' perception plays a key role in specification of the T&Ls. Wood (1995) states this assumption in his unexceptional list of what a teacher should do: "view students' conceptions from their perspectives". This is why a consensus-based method is chosen for the CAT implementation.

The aim is then to support both "deep learners" and those adopting the "surface approach", and to reward the deep learners with higher marks, while encouraging the surface-approach students to shift toward deeper learning strategies. In fact, studies by Slavin (1990) and Lai & Biggs (1994) have shown that deep-learners may not only find the instructional system with "low-level" understanding goals futile, but also they may perform badly under such a system. Even in a system with high-cognitive level goals, there may be the chance that the teaching and learning activities backfire if the objectives are not clearly aligned with respect to the required understanding level (Ramsden, Beswick & Bowden 1986). Hence it is of high importance to monitor the students' learning approach. This issue is further discussed in Section III. C.

C. Structure of the paper

The remainder of the paper is organized as follows: in section II the course serving as the research platform is described, and the design steps of consensus-based implementation of the CAT are discussed in detail. Section III scrutinizes the effect of the CAT implementation through analysis of the students' feedback, final grades, and learning approaches. Necessary discussions regarding the various aspects of the CAT implementation and the pros and cons of the tools utilized in this action research are provided in section IV. Finally, the paper is concluded in section V with a discussion on other potential courses that might be suitable for such a design approach.

II. Consensus-Based Implementation of the Constructive Alignment Theory

The course serving as a research platform in this study is a Power Systems Analysis course, offered by the Electric Power Systems Division of a Swedish University. This is a 7.5 credit M.Sc. level course that provides an introduction to electrical power networks and methods for their analysis. The methodologies studied in this course are well established and fairly general, so they can be applied to systems ranging from distribution networks to large-scale interconnected power systems, and are very similar to those presented in Saadat (2010) which is the textbook for this course.

The course is a compulsory foundational cornerstone for studies in different M.Sc. programs, including the M.Sc. program in Electric Power Engineering, and the Smart Electrical Networks and Systems M.Sc. joint program which is managed together with eight European universities in the European Innovation Technology (EIT) and the InnoEnergy Knowledge and Innovation Community (KIC). In addition, the course is also elective in other M.Sc. programs at the School of Electrical Engineering. Students enrolled in the course are not limited to those from the M.Sc. programs discussed above; in fact, the course is also offered to the power and energy professionals within industry collaborations and PhD students including those from other universities.

Therefore, the course has to cater to students arriving with different cultural and academic backgrounds, a broad age spectrum, diverse professional orientations, and possible (miss)pre-conceptions about the course. Therefore, it is not an easy task to design a course that offers the right learning environment to serve such a broad student base.

This course has a predecessor course serving relatively the same M.Sc. programs with similar content. The department of the authors' university decided that this course should be changed. Instead of latching on to the traditional structure, the course and its learning environment were completely re-designed into a new format that adapted the constructive alignment theory. To facilitate the CAT implementation, a consensus-based decision making process was during the design process.

The consensus-based course design consists of the adoption of a consensus decision-making model, formation of a design group and elaboration of a design through a systematic process. These aspects are discussed next.

1) Consensus model – The consensus-oriented decision-making (CODM) model (Hartnett 2011) was adapted to develop a new course design. The CODM model was chosen because of its collaborative nature. In Hartnett (2011), a seven step process is defined; the process gives the opportunity to involve all the stakeholders in the decision group (design group in this case) in an active manner. The result is a shared proposal in which the group members' concerns are considered as much as possible. This model accommodates for the case when the actual decision is made by the person in charge (the faculty in this case); however, it is necessary for the authority figure to respect and follow the design process and the resulting shared curriculum to guarantee the engagement of the design group. This is important as the design group was also involved in the development and implementation of the final T&Ls.

2) Design group – The design group (or decision group) was initially intended to consist a broad spectrum of stakeholders, such as representatives from industry and university administrators, but these all declined the invitation to participate. With this

limitation, the design group was then restricted to students and faculty, and its focus was set up to gather a broad amount of students' views regarding the course. Faculty was represented by the course examiner, which took the role of a facilitator. The group included two former M.Sc. students that have taken the previous course, one of which was a student attaining average marks and the second was the top student of the Electric Power Systems M.Sc. program. This allowed for considering the issues that different types of students might raise.

The design group also included two PhD students, one that graduated from the Electric Power M.Sc. program and had been a student of the ancestor course himself, and had also served as a teaching assistant for it, and another PhD student that came from another institution. The first student offered knowledge from previous experience in the course delivery and raised concerns coming from his different roles in the previous course, while the second student offered an outsider's perspective with sufficient knowledge on practices to deliver the same course in different universities.

Furthermore, the design group was involved in the implementation of the course, each with different roles, as explained below.

3) Design process (decision making process) - The design process was carried out using the guidelines of the CODM model. According to this model, the participants of the "design group" contribute to a shared proposal that involves different opinions; this gave the involved students a sense of ownership, which was important to attain because it was envisioned that the members of the design group would also take part in the implementation of the design. The design was carried out in five different sessions of about two hours each (10 hrs.) during June and July 2011, and the course was delivered from late August to early October, 2011. The steps in the CODM model were not repeated in each session; instead the meetings followed the method step by step until the design was completed.

Step 1: Framing the Problem –During the first meeting the facilitator gave the students an explanation of the CAT and the reasons to adopt a consensus-based approach to the course design. To frame the problem more specifically, the facilitator expressed the different pre-requisites and post-requisites that the design needed to take into account. Next, the facilitator proposed different T&Ls and assessment options.

Furthermore, a design rule was created by the design group using cause-and-effect analysis (Brophy 1979) relating the T&Ls and assessments to the ILOs. The adopted rule was that the T&Ls should bear a significant value to the students, that the assessment was aligned with the T&Ls, and that both the T&Ls and assessment actually supported the ILOs – in essence, the design rule made sure that the consensus process would inherently implement the CAT as shown in Fig.1.

Figure 1

Step 2: Open Discussion – After Step 1 was completed, an open discussion took place to determine which T&Ls the course should consider using the spoken version of the Round-Robin brainstorming technique (Soller, et al. 1998). Each participant was asked what teaching activities should be considered and to give an argument explaining how these activities supports the ILOs. At the end, the T&Ls which were selected by the design group were put together as a preliminary set of T&Ls. A similar process was separately taken to determine the assessment methodology; this methodology had to address serious issues raised by the students regarding the assessment method used in the predecessor course.

Step 3: Identifying Underlying Concerns – In this case, it was necessary to identify the constraints and problems that would affect effectiveness of different T&Ls to support the ILOs; some of the identified problems were as below:

(1) Time constraints to accommodate different T&Ls.

(2) Possible occurrence of plagiarism and the effective use of computer programs.

(3) Human resources to carry out the course implementation.
(4) Fairness of the assessment methods.

The most significant constraint was time. The course is compressed into 6 effective weeks; it was questioned if the number of the desired T&Ls could be actually implemented efficiently with this time constraint. The second problem was addressing the occurrence of plagiarism, as this is an issue that has been detected in previous occasions. Third, the resources available to carry out the T&Ls was a major practical issue as the course expected more than 60 students and only two teaching assistants were available to support the course (the same two PhD students participating in the course design). Finally, issues related to the fairness of the assessment method were raised; the design group needed to focus in making sure that the assessment method was aligned with the ILOs and T&Ls.

Steps 4 & 5: Developing Proposals and Choosing a Direction – The group was encouraged to bring forward proposals to mitigate the underlying concerns identified in Step 3. Hence, each of the T&Ls was studied individually, and as a whole. A holistic assessment was made to streamline the course design, and the decision rule in Step 1 was used to change or eliminate T&Ls or assessment activities. As a result, several T&Ls were taken out of the course design and assessment methods. After this process was completed, the final course design presented in Section II. C was achieved.

Step 6: Developing a Preferred Solution – This step looks on how the final course design could be further improved. To this aim, the design group became concerned with more practical issues that it would face when acting as the implementation group. For example, one of the modifications made on the T&Ls and assessment activity was "Weekly Tests and Weekly Test In-Class Solution" (see Section II. C.); to cater to the third constraint, the group decided to use peer-assessment for marking of these tests.

Step 7: Closing – The designed course was put into scrutiny once more. The decision rule developed in Step 1 was used to evaluate each of the T&Ls and the course assessment to ensure that there was consensus to move forward with the implementation. This is important as it is required for each person to assume personal responsibility for their assigned tasks in the course implementation.

A summary of the T&Ls and assessment that constituted the final CAT implementation is provided below. Figure 2 illustrates how these T&Ls and the course assessment aid the students in achieving the ILOs.

Figure 2

(1) Lectures: a total of 24 lectures that cover all the topics of the course.

(2) Daily in-class exercises: exercises were carried in the classroom by each student using a multiple-choice answer sheet. After each student arrives at an answer he can consult with others; if the answer was changed it was registered along with the first answer. Daily in-class exercises were not graded and aimed to prepare the students for their weekly tests, and to motivate them to go through the lecture materials before attending the class. In order to develop a meta-cognitive understanding level that makes the students able to apply the content to their own teaching methodology, "mini-discussions" were triggered in between of each daily exercise. The students with different answers tried to reach the consensus through these mini discussions, in which they explained their own reasoning to their classmates.

(3) Weekly Exercises: Each week there was a set of exercises for the students to practice the methods and study the concepts covered during the lectures of that week. The exercises were designed to encourage the students' self-activities in the course. The assignments were not handed in nor marked; however, they

presented similar questions as in the weekly tests; this served to motivate students' spontaneous activities.

(4) Weekly Tests and Weekly Test In-Class Solution: There were a total of 6 weekly tests that accounted for 50% of the final grade. In fact, only 5 out of 6 tests with the highest grade were counted. Each test consisted of 2 to 4 questions similar to those in the weekly exercises.

(5) Grading of the weekly tests: After the test was finished, the answer sheets were distributed among all students to check another student's test using a key provided by the teaching assistants. Afterwards, the teaching assistants double checked the grades assigned to the students.

(6) Weekly Test In-Class Solution: After the tests were graded, the teaching assistants stayed with interested students only to solve each of the problems in the weekly test using the blackboard.

(7) Final Exam: The final examination accounted for 50% of the final grade. The final exam was a single-part examination with problems similar to those solved in the weekly exercises and weekly tests.

Overall Assessment – A grade letter was awarded to the students according to the Table I. Those students that obtained a grade of FX were allowed to take an oral examination. If they passed the examination they were assigned an E.

Table 1

III. Analysis of the Effect of the Implementation of CAT through the Consensus-Based methodology

A. Students' feedback

During the course development stage several feedback channels were proposed to gather the students' perception of the changes, specifically in comparison with the previous course; there were three descriptive course evaluations. For each evaluation the following number of students replied:

- Evaluation 1: 66, from which 10 were enrolled in the old course.
- Evaluation 2: 62, from which 10 were enrolled in the old course.
- Evaluation 3: 62, from which 9 were enrolled in the old course.

Registered students that were also enrolled in the predecessor course were asked the following questions:

- Fig. 3: Is the new course structure preferable to the previous course structure?
- Fig. 4: Is the new course grading more preferable than the previous course grading?
- Fig. 5: Overall, are you more satisfied or less satisfied with the new course compared to the previous course?

Fig. 3 to 5 show an interesting phenomenon. Initially there was resistance from the students towards the new course design; however, this perception changed through time. The change in perception (shown in Fig. 3) shows that the course T&Ls are aligned to support the ILOs in a more efficient manner than in the previous course. The ratings given by the students reach the highest satisfaction level after the final evaluation, an evidence which supports this claim. Moreover, it can be observed that the assessment method of the new course is well aligned with the T&Ls and support the ILOs, as shown in Fig. 4. The students give a higher rating to the course assessment structure as the course progresses, reaching a high satisfaction level by the final evaluation. This is a good indicator that the course design has properly addressed the shortcomings of the previous course.

While it is beneficial to consider the opinion of the students who were repeating the course, further scrutiny should be made on the response of the entire student cohort. Thus, one possibility is to observe the time progression of the students' rating of the course as a whole. As shown in Fig. 6, the students' rating of the course improved through time; ratings at 3 (Acceptable) declined as the evaluations progressed, while ratings at 1 (Excellent) increased significantly for the final evaluation. Moreover, during the evaluations a few students evaluated the course as 4 (Bad) and 5 (Poor), with a maximum of 6.4% at 4 (Bad) in the final evaluation.

Figure 6

It was important to change the course assessment to align it to the course objectives. To this aim, the T&Ls had an important role to support the students' own learning. For example, when asking the students: "Did the 'weekly exercises' help you in your learning and preparation of weekly tests?", it was found that the actual rating increased over time, from 73% to 81%; ultimately 82% of the students strongly agreed. The weekly tests, however, did not show the exact same behaviour; from 53% to 55%, and to 50% answered as "strongly agree". This is due to the fact that the two last tests were rather more difficult and the answers of the students on the final course evaluation might be biased. This is supported by the fact that students' evaluative ratings correlate positively with the expected grade (Greenwald and Gillmore 1997, Holmes 1972).

B. Final grades

Fig. 7 shows the grade distribution for the new course delivered in 2011, and the previous versions of the course given in 2010, and 2009 and also the average results for the years 2007-2010.

Figure 7

Fig. 7 shows an even distribution between grades A, B and C for the new course, which is favourable as the grades are not clustered in B, C and F like in previous versions. Previously, the grade distribution was 9% A, 18% B, 31% C and 5% D and E, with more than 31% F. With the new course, a more even distribution was achieved. One possible interpretation is that the grading distribution does reflect the actual satisfaction of the course ILOs.

However, it was expected that the final course grade distribution would include a higher distribution of grades around the higher marks (A, B and C). It is speculated that this was not the case because of a major drawback in the course design; preliminary analysis shows that the final exam was not designed properly to generate the expected outcome. It is conjectured that students adopting a surface approach were still able to attain high marks; this conjecture must be investigated in further studies.

C. Identifying the students' approach toward the course

This section investigates a technique to properly classify the students' approach depth. The aim is to investigate the correlation between the students' approach depth and their final grades, i.e. if the students with deeper learning approach depth have actually managed to achieve higher grades as well. The reason to monitor such a parameter is to see if the CAT implementation was successful. In the context of the CAT, because the course assessments are well aligned with the course ILOs, the students who adopt the deep learning approach will actually manage to achieve higher grades as well.

During the final evaluation, the R-SPQ-2F was included (J. Biggs 2011). R-SPQ-2F is a recognized tool that allows determining if the students have adopted a surface or deep learning approach. The questionnaire can be downloaded from the link provided in J. Biggs (2011).

The questionnaire provides a basic ranking methodology. The students give each question on the list a score from 1 to 5. There are two types of questions, those which are related to the deep approach (Type 1), and those which are related to the surface approach (Type 2). There is no explicit indication about each question's type, as they are ordered randomly. For each student, the scores of the questions in a same type are summed. The result is that the student with the highest total score from the summation of Type 1 questions is most probably the student with the deepest approach, while the one with the highest score on Type 2 questions is probably the student with the most surface approach.

After scrutinizing the results, it was revealed that a large number of students had similar scores for both question types as shown in Fig. 8:

Figure 8

To eliminate the effect of this phenomenon in the final students' "approach depth" ranking, a new ranking algorithm was developed by the authors. Each student was assigned two ranks using the score they obtained from the questionnaire, one for the deep approach (DA) and one for surface approach (SA). Then these ranks were used as weighting factors, and the students have been assigned a final rank (equation 1). Students with higher scores were ranked higher. This ranking interpretation is that the student with the highest rank most probably has the deepest learning approach.

$$New\ Rank = (Score \times Rank)_{DA} - (Score \times Rank)_{SA} \tag{1}$$

Figure 9 shows the results of applying this ranking algorithm.

Figure 9

As it can be seen from Fig. 9, each student was classified only into one category with this new ranking algorithm. Hence, it was possible to correlate the students' learning approach depth with their corresponding final grade

To this aim, the students were divided into 4 groups (each group consists of 25% of the students) corresponding to their approach depth: the 25% with the lowest approach depth (first quarter), the second 25% with the lowest approach depth (second quarter), the second 25% with the deepest approach (third quarter), and the 25% of the student with the deepest approach (fourth quarter). The result of this correlation is shown in Fig. 10.

Figure 10

The vertical axis shows the percentage of the grades in each quarter. Fig. 10 shows a clear correlation between the student’s approach depth and their final grades. For example, students in the fourth quarter are represented with the highest percentage of the grade “A”, with almost 34% of the population obtained this grade. Note also that the second quarter and the thirds quarter have high percentages of the grade “C”, while there is no “F” in the fourth quarter. This correlation is promising evidence that the CAT implementation was carried out satisfactory.

IV. Discussion

A. Limits on application

While the results of the presented methodology are encouraging, it may not be an appropriate method for other courses considering how diverse engineering courses are. There may be some courses which are not a good fit for the participatory course-design. An example could be basic engineering courses, such as physics or mathematics, where the course contents require a more strict direction from the teacher in both the course design and implementation. The consensus-based approach, even though is not noxious, is actually irrelevant for those types of courses. However, in M.Sc. level courses, imposing a compulsory learning method would not be as efficient as involving them in the course design, because master students in engineering have already adopted a particular learning approach.

B. Extracting relevant feedback

The feedback channels and the newly proposed ranking algorithm offer a systematic mechanism to filter out the feedbacks that need to be addressed for improving the course in future deliveries. In fact, it is of paramount importance to incessantly change the course T&Ls to align it with the course objectives. Hence, it is necessary to gather students' feedback, identify the most relevant ones and properly address them.

Thus, the results from the new ranking algorithm allow selecting students from each category to conduct further interviews. The interviews allow identifying the most important feedbacks that need to be considered for making modifications to the course. The authors are currently developing such a method and evaluating its effects on the course modifications.

C. Design and administration of feedback channels

It is difficult to design feedback questions in a way that the students cannot determine the questions motive, specifically for R-SPQ-2F. Perhaps, some students feel the positive or negative value that each question bears and try to somehow change their answer to manipulate the outcome, i.e. to sound as a student adopting the deep learning approach. A possible remedy is to make the evaluation completely confidential, as it gives the students no incentive to be dishonest; however, this limits the amount of available data, as the feedbacks cannot be correlated with the learning approach depths.

V. Conclusion

This article proposes a methodology for the consensus-based course design, where all the stakeholders in the learning process can be taken into account; more importantly, the students have the opportunity to shape the design of a course to meet high learning standards. Although in this study the consensus process was carried out with a small set of stakeholders (mainly students), it can adapt to include other stakeholders which are interested to participate, such as representatives from industry, university authorities and study program coordinators.

The results shown in this paper are good indicators that the implementation of the CAT in a power engineering course is a good vehicle to enhance student's learning. Analysis of course evaluations and structured interviews is being carried out to determine the necessary actions to improve the course. However, the remaining question is how the consensus-based course design needs to be modified so that students operating under the surface approach are encouraged to adopt the deep approach.

Note that there are no concrete conclusions on the usage of a consensus-based method in other courses. While the result of the consensus based method to design this course are encouraging, the authors do not insist that it should be attempted for every engineering course, although there may be courses that can benefit from this paradigm. Specifically, it may not be adequate for some core engineering courses such as Mathematics or Physics. While there is no documented research on a consensus-based design for such courses, the authors speculate that the nature of these courses makes them to be inadequate for collaborative design methodologies.

On the other hand, from the traditional point of view, it may be argued that students at the M.Sc. level should have developed their own learning methods and that this type of course designs is forcing a learning methodology upon the students. However, this view disregards the different learning approaches (deep and surface) that the students adopt as their own pseudo-learning strategies, i.e. if they really learn or just aim to obtain good marks with minimum effort. The ultimate objective of this research is to facilitate a learning environment where students adopting the surface approach could actually move toward a deeper learning approach.

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References

ACACA. *Principles for the design of certification and assessment arrangements under national content and achievement standards.* ACACA, 2011.

J. Biggs, and C. Tang. *Teaching for Quality Learning at University.* Berkshire, England: Open University Press, 2007.

J. Biggs. "The revised two-factor study process questionnaire: R-SPQ-2F." *British Journal of Educational Psychology*, 2011. Download link: http://onlinelibrary.wiley.com/doi/10.1348/000709901158433/pdf

J. E. Brophy. "Teacher behavior and its effects." *Journal of Educational Psychology* 71, no. 6, 1979: 733-750.

K. Edström, J. Törnevik, M. Engström, and A. Wiklund. "Student involvement in principled change: Understanding the student experience." *11th Improving Student Learning, OCSLD.* Oxford, UK, 2003.

A. Greenwald, and G. M. Gillmore. "Grading leniency is a removable contaminant of student ratings." *American Psychologist* 52, no. 11, 1997: 1209-1217.

T. Hartnett. *Consensus-Oriented Decision-Making: The CODM Model for Facilitationg Groups to Widespread Agreement.* Gabriola Island, BC: New Society Publishers, 2011.

D. S. Holmes. "Effects of grades and disconfirmed grade expectancies on students' evaluations of their instructor." *Journal of Educational Psychology* 63, no. 2, 1972: 130-133.

L. H. Jamieson, and J. R. Lohmann. “Creating a Culture for Scholarly and Systematic Innovation in Engineering Education.” *American Society for Engineering Education*, Washington, D.C. 2010.

Quaker Foundation of Leadership. “A Comparison of Quaker-based Consensus and Robert's Rules of Order.” Richmond, Indiana: Earlham College, 1999.

J. R. Lohmann, H. A. Rollins, and J. J. Hoey. "Defining, developing and assessing global competence in engineers." *European Journal of Engineering Education* 2011, no. 31, 2011: 119-131.

J. Lucena, G. Downey, B. Jesiek, and S. Elber. "Competencies Beyond Countries: The Re-Organization of Engineering Education in the United States, Europe and Latin America." *Journal of Engineering Education* 97, no. 4, 2008: 433-447.

H. Saadat, *Power System Analysis.* PSA Publishing, 2010.

R. Schutt. “Consensus Is Not Unanimity: Making Decisions Cooperatively.”, *The Vernal Education Project*, 2010.

A. Soller, B. Goodman, F. Linton, and R. Gaimari. “Promoting Effective Peer Interaction in an Intelligent Collaborative Learning System.” Vol. 1452, in *Intelligent Tutoring Systems. Lecture Notes in Computer Science.*, by Barry Goettl, Henry Halff, Carol Redfield and Valerie Shute, Springer Berlin / Heidelberg, 1998: 186-195.

I. Subbarao, *et al*. "A Consensus-based Educational Framework and Competency Set for the Discipline of Disaster Medicine and Public Health Preparedness." *Disaster Medicine and Public Health Preparedness*, no. 2, 2008: 57-68.

F. B. Tan, and M. G. Hunter. "The Repertory Grid Technique: A Method for the Study of Cognition in Information Systems." *MIS Quarterly* (Management Information Systems Research Center, University of Minnesota) 26, no. 1, 2002: 39-57.

L. Vanfretti, and F. Milano. "Facilitating Constructive Alignment in Power Systems Engineering Education Using Free and Open-Source Software." *IEEE Transactions on Education*, no. 55, 2012: 309-318.

J. Kirby, and D. Pedwell. “Students' approaches to summarization”, *Educational Psychology*, 1991; 297-307.

T. Wood. “From alternative epistemologies to practice in education: Rethinking what it means to teach and learn”, in L. Steffe, and J. Gale. (eds.), *Constructivism in Education*. Hillsdale, N J: Erlbaum, 1995.

R. E. Slavin. “Mastery learning re-reconsidered”, *Review of Educational Research*, 1990: 300-302.

P. Lai, and J. B. Biggs. “Who benefits from mastery learning?” *Contemporary Educational Psychology,* no. 19, 994: 13-23.

P. Ramsden, D. Beswick, and J. Bowden. “Effects of learning skills interventions on first year university students' learning”, *Human Learning*, no. 5, 1986: 151-164.