Implementing Constructive Alignment Theory in a Power System Analysis Course using a Consensus Model

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Objectives

• To implement the constructive alignment theory (CAT) in a power system analysis course.
  - CAT is a theory from the educational research community for enhancing student learning.

• To adopt the consensus-oriented decision-making (CODM) model to design the course.

• To develop effective multiple feedback channels to gather the students’ perception.

• To select the relevant feedbacks and modify the course according to them.
Constructive Alignment – Basic Principles (Biggs and Tang)

• Basic principle:
  The *teacher’s fundamental task is to get students to* engage in learning activities that are likely to result in their achieving the desired outcomes in a reasonably effective manner.

• What the student does is more important in determining what is learned than what the teacher does.

• Constructive Alignment Theory:
  - Provides a set of principles
  - These principles can be used to devising Teaching and Learning Activities (T&Ls)
  - The activities can help in achieving the Intended Learning Outcomes (ILOs).
Using Principles of Constructive Alignment

- Using the principles from constructive alignment:
  - Start by carefully aligning T&LAs and Assessments
    - These activities should support the students to fulfill the ILOs.
  - The students role (MAJOR):
    - The students use the activities to construct their knowledge and achieve desired outcomes.
  - The teacher’s role (minor):
    - To design a learning environment that encourages the student to perform the T&Ls that aid the students to construct their knowledge.
The Power System Analysis Course

- Provides an introduction to electrical power networks and methods for their analysis.

- Students come with a very different background, and often lack any exposure to power systems at all:
  - Mandatory for M.Sc. Program in Electrical Power Engineering (TELPM), and M.Sc. Joint Program in Smart Electrical Networks and Systems (SENSE)
  - Elective in other M.Sc. Programs at the school of Electrical Engineering and some Erasmus Mundus M.Sc. programs
  - Also offered to power and energy professionals within industry collaborations and PhD students (including those from other universities)

- This variety in the students’ background makes it challenging to design well aligned and adequate T&L activities and proper assessment methods.
Variety of Background – Affects the proper implementation of CAT

- Affects student’s readiness to engage in the Teaching and Learning Activities
- Diagnostic test results show a very low average in the students preparation
- Fundamental knowledge is weak.

14. In which case will the light bulb be glowing?:

A) I, III, IV

B) I, IV

C) I, II

D) IV

E) II, IV

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<th>Ans</th>
<th>% of correct Ans</th>
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Average 61,5
Course Contents

The course is divided in five important topics:

• Modern Power Systems with an Introduction to Sustainable Energy Technologies and Smart Grids

• Fundamental Principles for Power System Analysis AC circuits

• Electrical Modeling of Generators, Transmission Apparatus and Networks

• Methods for Analysis and Design of Power Networks in Steady State and Unbalanced Operation

• Methods for Generation Dispatch and Sensitivity Analysis of Power Systems
Consensus Based Course Design Components

- **Design Group**
- **Consensus Model (CODM)**
- **Design Process**

- Links the design group to the consensus model.
- Five 2 hrs sessions (10 hrs)
- Allows to deliver a shared proposal:
  - Important if the design group will also be the implementation group – (needed commitment).
CODM – Design Process (Hartnett)

- Framing the Problem
- Open Discussion
- Identifying Underlying Concerns
- Developing a Preferred Solution
- Choosing a Direction
- Developing Proposals
- Closing

Hartnett (2008)
Design Rule for CAT Implementation

- Example of using the consensus based model
- Step 1 (Framing the problem): design rule used for one of the Teaching and Learning activities using Cause-and-Effect analysis.

Student Readiness for the T&L Activity

Student Preparation
- Lectures
- Daily Exercises
- Weekly Exercises

Staff Preparation
- Lecturer (Teaching Assistants, Division into Manageable Groups, Test Preparation, Test Delivery, Monitoring, Solution)

Assessment Method

Self-Reflection on Peer Assessment
- Identify (learn from) own mistakes
- Identify (learn from) others' mistakes

Peer Assessment
- Clear Grading Instructions
- Fair Assessment by peers
- Clarity own mistakes
- Learn from issues raised by others

In-Class Test Solution

T&L Activity (Written Test)

Choice and Mix of Types of Questions

Conceptual
- Numerical Computations

Well Designed Test
- Aligned with ILOs
- Aligned with Lectures, Daily Exercises, Weekly Exercises
- Proper Use of time

Staff Preparation for the T&L Activity

Staff Preparation

Effective Support of Course ILOs

Student Readiness for the T&L Activity

T&L Activity (Written Test)
Implementation of Constructive Alignment

1: Lectures (24)
2: Daily In-Class Exercises
3: Weekly Exercises (6)
4: Weekly Tests (5 out of 6)
5: Grading of the Weekly Tests
6: Weekly Test In-Class Solution
7: Final Exam

Course Objectives (Intended Learning Outcomes)

Teaching and Learning Activities

Assessment

[1], [2], [3], [4], [5], [6], [7]
Lectures are intended to develop conceptual understanding:

**CONE OF LEARNING**

- **After 2 Weeks we tend to remember**
  - 10% of what we **READ**
  - 20% of what we **HEAR**
  - 30% of what we **SEE**
  - 50% of what we **HEAR & SEE**
- **Nature of Involvement**
  - **Passive**
    - Reading
    - Verbal Receiving
    - Listening Words
    - Looking at Pictures
    - Visual Receiving
  - **Active**
    - Participating in a discussion
    - Receiving/Participating
    - Doing a Dramatic Presentation
    - Doing the Real Experience
- **Sources**
  - Edgar Dale
T&L Activities – Daily in-class Exercises

• Exercises were carried in the class room using a multiple-choice answer sheet.

• After each student arrives at an answer he can consult with others, if his answer was changed they should have been registered.

• Daily in-class exercises are not graded.

• The aim is to prepare the students for their weekly tests, and to motivate them to go through the lecture’s content before attending the class.

• There was a box asking the students if they have prepared before coming to the lecture.
T&L Activities – Weekly Exercises

• For the students to practice the methods and study the concepts covered during the lectures of that week.

• No points are awarded for these exercises.

• The exercises are aimed to prepare the students for the weekly tests.
T&L Activities – Weekly Tests

- There were a total of 6 weekly tests.

- They accounted for 50% of the final grade.

- For the final grade 5 out of 6 tests with the highest grade were counted.

- Each test consists of 2-4 questions similar to those in the weekly exercises.

- The students correct each other's answer sheets using a key provided by TAs.

- After the test, the TAs stay with interested students only to solve the problems of the weekly test.
T&L Activities – Final Exam

• The final examination accounts for 50% of the final grade.

• The final exam is a single-part examination with problems similar to those solved in the Weekly Exercises and Weekly Tests.
## Course Assessment

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<td>91 – 100</td>
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<td>84 – 90</td>
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<td>58 – 60</td>
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<td>00 – 60</td>
<td>F</td>
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</tbody>
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- ✔️ 50 points from the final exam
- ✔️ 50 points from weekly tests
Course Evaluations

• Three Course Evaluation
  - Two during the period
  - One after the final exam

• R-SPQ-2F Evaluation
  - Two different question types (surface and deep approach)
  - Students are graded using their answers
  - The results will reveal the students approach

• Final Interviews using the Repertory Grid Technique
  - A form of structured interview to find out a participant’s preference on a given topic and the way these preferences are ordered on a rating scale
Course Evaluations

- Is the new course structure (lectures, daily exercises, weekly exercises, and weekly tests) preferable to the previous course structure (lecture, assignments, and final examination)?
Course Evaluations

• Is the new course grading structure (50% weekly tests + 50% final examination) more preferable than the previous course grading structure (part a and part b)?
Course Evaluations

- Overall, are you more satisfied or less satisfied with the new course compared to the previous one?
Course Evaluations

- Overall rating of the course?
The Revised two-factor Study Process Questionnaire: R-SPQ-2F

- Allows to determine the students’ learning approach
- The process is exposed to some drawbacks!
R-SPQ-2F: The new ranking algorithm

\[(Grade \times Rank)_D^A - (Grade \times Rank)_S^A\]
Grade distribution and its correlation with students’ learning approach
Modification of the course, Academic Period 2012
T&L Activities

- 1: Lectures (20)
- 2: Reading Quiz, Conceptual Quiz
- 3: Weekly Home works (6)
- 4: Weekly Exercise sessions (3)
- 5: Weekly Tests (2 out of 3)
- 6: Final Exam
To implement peer instruction there is now very good technology.

- These are called clickers and are used for gathering students feedback in real-time.

For about 1-2 months we managed to convince the EES school to invest in two “kits” of clickers consisting of:

- 50 clickers for use one by each student, 1 response link

- Find out more @ http://www.ombea.com/sv/highereducation/products/

Clickers were given to each student and kept by them throughout the course.
Q2. If a symmetrical fault with impedance $Z_f$ occurs at bus $k$ in the system, and $Z_{kk}$ is the equivalent Thevenin impedance of bus $k$, which one is the fault current:

\[ A) \quad I_k(F) = \frac{v_k(0)}{z_f} \]

\[ B) \quad I_k(F) = \frac{i_k(0)Z_f}{z_{kk}} \]

Second try - Q2. If a symmetrical fault with impedance $Z_f$ occurs at bus $k$ in the system, and $Z_{kk}$ is the equivalent Thevenin impedance of bus $k$, which one is the fault current:

\[ A) \quad I_k(F) = \frac{v_k(0)}{z_f} \]

\[ B) \quad I_k(F) = \frac{i_k(0)Z_f}{z_{kk}} \]

\[ C) \quad I_k(F) = \frac{i_k(0)Z_{kk}}{z_f} \]

\[ D) \quad I_k(F) = \frac{v_k(0)}{z_{kk}+z_f} \]
Conclusion

- A wider variety of stakeholders can participate in CODM process.

- CAT is a good vehicle to enhance the students’ learning.

- R-SPQ-2F new ranking algorithm efficiently classifies the students’ learning approach depth.

- The challenge is how to modify the course so the surface approach students moves toward deep approach.
“The whole purpose of education is to turn mirrors into windows.”
Sydney J. Harris

Thank you for your attention!
Course Objectives  
(Intended Learning Outcomes)  
After completing the course, the students should be able to:

- Using first principles *derive* the basic concepts and methods used for power system analysis.
- To *construct* mathematical models for computing the steady state performance, and basic unbalanced performance of power systems.
- To *derive, describe* and *compare* different models of the most common equipment used in power network models.
- Using different methods, to *compute, analyze*, and *reflect* on the performance of a power system under steady state and unbalanced operation.
- To *describe* basic characteristics of renewable and variable energy sources and power electronic interfaces, as well as monitoring, analysis and control technologies used in Smart Grids.