Constructive Alignment with Student in Centre and Front Experience from Case-projects and Intensive Summer Courses

Hans-Petter Halvorsen[1], Josef Timmerberg[2], Saba Mylvaganam[1]
[1]*Faculty of Technology, Natural Sciences and Maritime Sciences, Department of Electrical Engineering, Information Technology and Cybernetics, University of South-Eastern Norway;* [2]*Jade University of Applied Sciences, Wilhelmshaven, Germany;*

ABSTRACT: Constructive alignment (CA) as envisioned by Briggs, has been implemented in many forms with focus on learning objectives, activities and assessments (LO-A-A) using different types of curricula in many disciplines. The paradigm «Student in Centre and Front (SCF)" nurtures the development of the student in the discipline as well as a responsible member in the society. Our experience in engineering disciplines at bachelor level and master level covers different groups of students and from different academic institutions, due to the incoming students based on exchange agreements as well as intensive courses held during summer for students from different academic institutions. This paper addresses CA maintaining SCF, with some examples from courses held at Jade University of Applied Sciences in Germany (JH), Texas Tech University (TTU) and University of South-Eastern Norway (USN). Examples are mainly from case-projects involving group of students as part of selected courses in USA and international summer courses held in Germany and USA, with JH and TTU as partners. The courses with project-based learning (PBL) in different forms had focus on SCF and CA. With individual assessment in PBL in groups with many students, a positive group experience is also an outcome of this mixed SCF and CA approach. The three elements LO-A-A of CA along with SCF help to achieve curricular goals for the students as well as personal satisfaction in dealing with group activities and valuing human and societal issues. In this context, we discuss briefly the change from STEM (Science, Technology, Engineering and Mathematics) to STEAM (Science, Technology, Engineering, Art and Mathematics) to increase the number of female students in traditional STEM disciplines. Examples from different cases are provided with some pertinent conclusions for studies in STEAM.

1 BACKGROUND

1.1 Student in Centre and Front (SCF)

Recently, there has been an increasing focus on the paradigm "student in centre and front" (SCF) in the context of procedures related to university admissions of aspiring candidates as well as in the campus during the process of university education involving lectures, tutorials, lab works, group projects, various forms of examinations and final year projects with their mandatory reports. Disciplines associated with engineering education need to be tuned to the needs of the various professions, relevant and matched to the current developments with some anchoring in research and development in STEAM (an increasingly common acronym in use particularly in USA through IEEE, discussed in detail below) subjects. The students must be curious about facts and techniques, with focus on current developments, critical about anything they hear/see or read and creative in their own ways. The education must also cater to the needs of the existing and evolving labour markets. SCF is discussed in detail in [1].

In a recent workshop on "Voice & Communication" held in Campus Bergen of the Western Norway University of Applied Sciences meant for music pedagogues involved in teacher training, an interesting question arose as to the methods employed in improving the participation of all students in the course, [2]. As music involves mandatory participation of individuals at diverse stages in playing an instrument in an orchestra or singing in a choir, each person involved in the process needs some prior exposure and some training in using that particular instrument or singing the particular line in choir at the right note and at the right time. Such an orchestration is essential in all learning activities involving groups, such as in PBL (Project Based Learning). This process involved in "Voice & Communication", places the student in centre and front indeed. Interestingly, two analogues arose in the process of teaching the techniques involved in playing drums, "sandwich" mode and "fruit salad" mode! Sandwich mode

implies a careful insertion of other drums/instruments leading to a melody, whereas "fruit salad" was a coordinated but an intended blend of many drums/instruments, all leading to some melodies. In such active learning models based on "learning by doing", participation of every student in the group based on preparation and understanding is mandatory. In pedagogic courses intended for future music teachers, there was a good blend of the genders. This observation led us to small note on motivating female students via Art to take up studies in MNT, the theme of this conference.

1.2 STEM to STEAM and CA with SCF

There has been and there is still an ongoing discussion on the low percentage of females in **STEM** (**S**cience, **T**echnology, **E**ngineering and **M**athematics) related studies. Some initiatives of engineers in the USA and current discussions in the IEEE community support the idea of adding an A (for Arts) in STEM leading to STEAM (**S**cience, **T**echnology, **E**ngineering, **A**rt and **M**athematics), [3]. With the element of gamification in many subjects and associated elements of Art in many disciplines, this strategy may help to improve the number of female students, as confirmed by a study performed in 2016. According to the "STEM vs. STEAM: "The Gender Gap" report, parents of both male and female children equally report that their child's favourite STEAM subject in school is math (26 percent) or science (30 percent). It's when the school day ends that the differences emerge. Forty-one percent of the parents with boys surveyed said their children show the most interest in technology/computing activities outside of school, compared to 18 percent of parents with girls. Meanwhile, 45 percent of parents with girls report that their children show the most interest in art outside of school, compared to 10 percent of parents with boys.", [4]. Fig. 1 and Fig. 2 presents these results based on a survey of 500 parents of children between 6 and 14 years old. This survey was conducted with focus on STEAM to understand gender differences in children's playing and learning. To the best of our knowledge, results from such comprehensive studies addressing the promotion of intake of female students in STEAM disciplines in Norway or EU are not available, at least in the public domain.

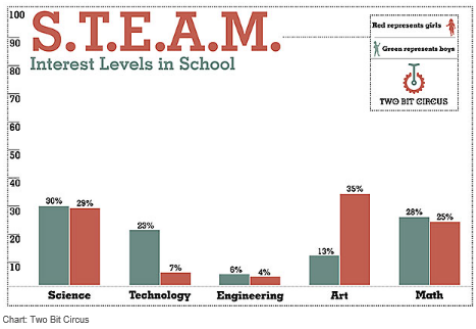

Fig. 1. Subject based interest levels in school, [4].

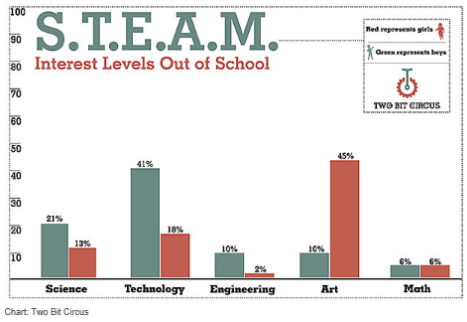

Fig. 2. Subject based interest levels out of school,[4].

The model used in music pedagogy is very well suited in **STEAM** related education in secondary schools as well as universities. In this context, the terminology "gamifications" is dominant in many academic circles, irrespective of disciplines. Curricula with STEAM can be useful in realizing CA with SCF. Programming in general is both Science and Art". In general, male students are better when it comes to learning core-programming techniques. Since "Art" is a key component in software engineering, like creating Graphical User Interfaces (GUI), web design, documentation and good code structure, etc. the female students become excellent software engineers as well.

1.3 Constructive Alignment (CA)

Once in the university, the student is involved in the learning process, where the next paradigm is very often set into play, viz. constructive alignment involving learning outcomes, activities and assessment, as promulgated by Biggs, although Taylor already proposed a similar line of approach in higher education in 1949. CA is mainly based on curricula assessing students' performance, [5]. Biggs defines CA as, "coherence between assessment, teaching strategies and intended learning outcomes in an educational programme".

The adjective in CA "Constructive" implies that students achieve knowledge through relevant learning activities constructively and the noun "Alignment" in CA refers to the alignment of teaching and learning activities, and assessment tasks for achieving the Intended Learning Outcomes (ILO). Alignment is best achieved by designing TLAs and the assessment tasks that activate the same verbs as

are stated in the ILOs. CA enables a logical structure for learning and acquiring knowledge and skills and is an effective method for teachers and students how well the goals of teaching and learning have been achieved.

One of the pioneers in educational theories emphasized more focus on the experience-based learning, overall person and less on rigidly planned lectures by the teacher with written exams involving external examiners, [6]. In the same context, Bloom's taxonomy with the verbs "Remember, Understand, Apply, Analyse, Evaluate and Create" are used to realize CA, [7]. In describing modules in different programmes, it is mandatory to use active verbs to emphasize the CA base in curricular planning. In practising CA, in the context of STEAM related topics, the practice can be explained through the keywords shown along with the "CA-triangle" shown in Fig. 3.

2 CASE PROJECTS IN THE CONTEXT OF CA

Fig. 4 shows the steps involved in PBL and illustrates how the elements of CA are explicitly and implicitly involved and intertwined in the teaching and learning process. Case-projects in diverse curricular with hands-on experience can be part and partial of the STEAM modules, which can be organised as PBL. Practitioners of PBL (i.e. both students and staff!) are of the opinion that the students following STEAM subjects using PBL perform better and score higher than the students following STEAM subjects in traditional courses, because of their somewhat superior learning outcomes, competencies associated with problem solving, self-assessment techniques, data gathering, behavioural science, etc. In addition, with good planning involving students and staff, some elements of "gamification" can also be incorporated in-group activities involving case-projects and practical HW/SW assignments. Isaacson in the 14th January 2019 issue of Time writes, "For the past 50 years, the rational exuberance of the American economy has been propelled by the combination of three innovations: the computer, the microchip and the Internet. The research and development that produced each came from a triangular alliance of government, academia and private business", [7], a similar view also promulgated in Mylvaganam et al., [8].

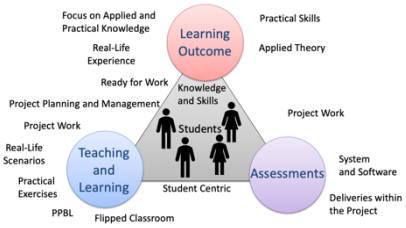

Fig. 3. CA in STEAM subjects with SCF with various topics at ILO-A-A "nodes".

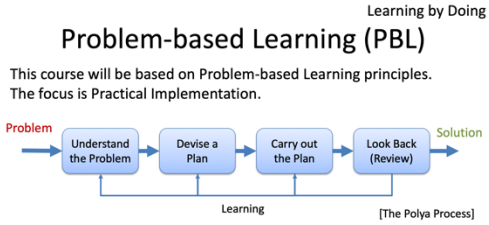

Fig. 4. PBL as a means of achieving CA with excellence in ILO.

3 EXPERIENCE

3.1 Summer courses arranged by Jade University of Applied Sciences and Texas Tech University

For about a decade, JUAS and TTU are continuing a yearly cooperation in running a common module with student and staff mobility from both USA and Germany. The organization of a stay abroad during the normal period of a semester at TTU and JUAS proved to be very difficult. Thus, the summer crystallized as a suitable period for both countries. The summer courses take place during the lecture-free period for the TTU and the JUAS usually in July for six weeks. Since 2010, American students have travelled to Wilhelmshaven in this period and participated together with German students in two to three modules. For the Americans, one module means three credit hours; for the Germans, one module is 5 ECTS-credits. The courses had some lectures and considerable project work addressing topics covered in the subjects taken up in the summer school. A typical schedule is shown in Fig. 5. The project involved realizing a small-scale smart house with the necessary sensors and the needed measurement and control for achieving certain amount of autonomy in temperature, humidity control and lighting with the necessary actuators.

The main strategy behind the German-American Summer Course was that a cultural understanding is an integral part of the course thus giving a flavour of art tallying with STEAM. Since 2010, engineering and culture are included in the summer courses. Typical courses offered are, in engineering/technology, Engineering Statistics, Electrical Circuits, Engineering Dynamics, General Electrical Engineering, Fluid Mechanics, Rubber-Technology, Basics of Wind Energy, along with following modules in cultural studies, German Culture and International Engineering Project. The programmes are organized so that the students always have the opportunity to participate in two courses. The culture module is mandatory for the American students. The cultural aspects of the course address among others the acquaintance of historical and political foundations of Germany. Also included in the cultural module are visits to various industries. The summer course frequently ends with an excursion to the capital city of Germany, Berlin lasting couple of days.

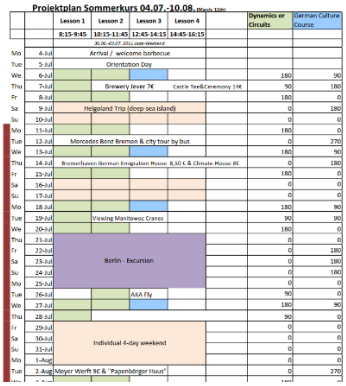

Fig. 5. An extract from the timetable from the summer school with subjects outlined in text.

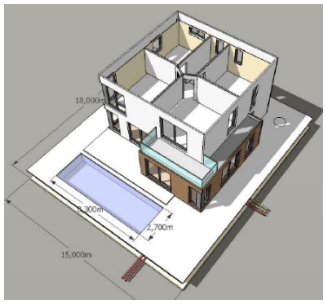

Fig. 6. Project SMART home – real model of a house; scale 1:10. Involving student groups to work together adopting the Polya process of Fig. 4. STEAM project in the true sense.

3.2 PBL models at USN

We take the example of two different modules in the master level course in the Department of Electrical Engineering, IT and Cybernetics in the Faculty of Technology, Natural Sciences and Maritime Sciences, viz. Systems & Control Laboratory and Hard/Soft Sensors in Process Measurements. In the module "Systems & Control" (10 ECTS), the students are expected to solve a concrete system integration problem using their knowledge acquired in different courses. These problems can be in close collaboration with the collaborating industrial partners, the municipality, the hospital etc.

In another module dealing with Hard/Soft Sensors in Process Measurements (ECTS), the students are expected to solve concrete sensors and actuators related problems in collaboration with the partners mentioned above. Usually, these problems involve using sensors with dedicated HW/SW and data fusion with AI-techniques, currently categorized under machine learning, with the help of different techniques based on fuzzy logic, neural networks, support vector machines etc. In addition to the traditionally well-known MATLAB toolboxes, students have started to use Python and Julia in their solutions. Fig. 7 illustrates the approach for different solutions in the work done by the students with the elements well known in PBL addressing the SCF and CA.

4 DISCUSSIONS

Under some conditions of teaching and assessment, some students make a strategic decision that a surface (superficial) approach would see them through his tasks. Teaching and assessment methods often encourage a surface (superficial) approach when they are not aligned to the aims of teaching the subject, [9]. This observation confirms that an approach with SCF and CA is essential, if expertise is to be attained during the final stages of a course or training. PBL with SCF and CA may offer a suitable path to achieve this goal, nicely illustrated in Fig. 8.

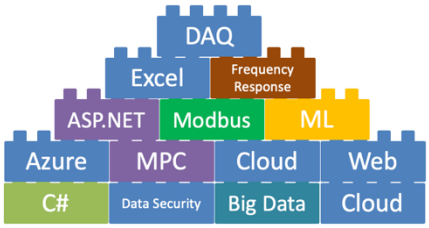

Fig. 7. Systems and control applications using some of the latest hardware and software. Familiar building blocks from HW/SW in EE, IT & Cybernetics

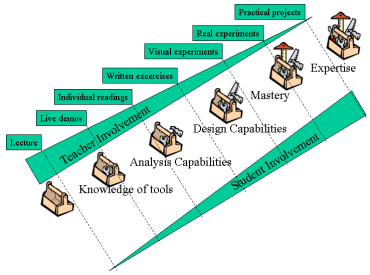

Fig. 8. PBL with SCF showing the process from knowledge base using CA to raise the students' expertise

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