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A Postgraduate Course for Engineers Finds its Form

Astrid M. Sølvberg, Marit Rismark, Olav Bjarte Fosso
Norwegian University of Science and Technology (NTNU), Trondheim, Norway

In this article we explore how teaching may find its form, based on the assumption that the core elements of teaching are Teacher, Student and Content. In the following pages we analyze how a postgraduate course for engineers finds its form according to these three core elements of teaching.

As we are moving rapidly into a digital knowledge society, the role of ICT in education is becoming more and more important and may influence the development of educational practices of the 21st century. There is a wealth of ICT opportunities for educators to exploit when the ambition is to create exciting teaching and learning opportunities. Teaching may constantly need to find new forms according to prevailing pedagogical needs and technology developments. We argue that striving for quality in teaching in the 21st century is inseparably linked to systematic analyzes of teaching that brings forward conceptual knowledge of what is going on in the learning environments. Such conceptual knowledge is decisive for educators who constantly need to transform teaching practices to create learning opportunities in line with future needs. In this article we explore how teaching may find its form, based on the assumption that the core elements of teaching are Teacher, Student and Content. In the following we analyze how a postgraduate course for engineers finds its form according to these three core elements of teaching.

The postgraduate course came about to meet a comprehensive training need among employees within the power supply industry in Norway. The global energy situation demands smarter usage of energy which implies that energy production is not to be increased, but energy is to be used smarter. A number of countries have established Smartgrid centers that provide solutions to meet the need for smarter use of energy. These solutions need to be distributed to employees within the power companies. On this background, a course was arranged in 2012. The course was a postgraduate course for engineers within the power supply businesses at the Norwegian University of Science and Technology, NTNU. Arranging such courses naturally brings into attention several pedagogical and organizational challenges that need to find solutions. This involves addressing questions related to the course content, the teacher and the student.

Regarding the needs within the power supply industry in Norway, there was a content-wise need for a series of courses that together covered the employee's need for knowledge in areas of knowledge utilization of energy, infrastructure, transmission and distribution of electric energy systems. As such, the current course *content needed to be defined* according to this broader context. Such definition involves designing training content, scope and organization that can meet the training needs facing Norway within electricity supply. Furthermore, since the Smartgrids affect all areas within the electrical engineering, a *wide range of teachers* were involved in the introductory Smartgrid course. This gave rise to communication and collaboration challenges that needed to be addressed within the teacher group. Another challenge was to address questions evolving around the *students* who combined full time employment and university studies. The students that attended the course were employed at different power companies across Norway. At an overall level, the course was organized as a flexible continuing programme and thus enabled employees in the power industry to combine work and education. In the course, we introduced digital tools to meet challenges that evolved when the teacher group were

to organize a flexible study programme for this particular group of adult learners. The classic didactic triangle (Klafki, 1997), a schematic representation of three ahead mentioned basic elements in teaching; the teacher, the learning content, the student and the relationship between each of these elements, is used to explore how teaching found its form in the postgraduate course for engineers.

The complexity of teaching and the didactic triangle

Institutions of learning are always looking for effective teaching methods that place the student at the center of learning, both within individual and community learning. Along with the emerging technologies, the ranges of innovative and effective teaching methods seem endless and learning practices unimaginable a few years ago may very well be possible. Teachers are key players when integrating technology into educational practice. Several areas of knowledge must be taken into consideration. The Cognition and Technology Group at Vanderbilt (1996) maintains that the challenge of discussing the use of technology in education is based on the interrelationship between at least three key areas: technology, theories of human potential and human learning, and educational issues. As each area is constantly shifting, developing and interrelate with the other areas, changes in one area lead to changes in the intersecting areas. The interrelatedness of these areas may represent a conceptual framework when designing learning environments (Sølvberg & Rismark, 2009).

Departing from the overall framework of the three intersecting areas, teachers need to make considerations and decide priorities when they plan and lead learning activities. In planning processes, teacher reflections circle around both theoretical and practical elements of didactics. According to Wallin (Westbury, 2000) didactics provides teachers with ways of considering the essential what, how and why questions around their teaching and their teaching in their classrooms. Considerations will circle around issues such as who, what, when, with whom, where, how, with what, why and what for (Gundem, 2008).

Following the classical didactic triangle (Klafki, 1997), learning practices is perceived as involving the learner, the teacher and some subject matter content. This triangle can be traced back to Comeinius' work Didactica Magna (the major teaching doctrine) from 1657. The model shows that there are three key axes in the didactic situation: the axis between the teacher and the content (representation axis), the axis between teacher and student (communication axis), and the axis between learner and content (experience axis). When planning lectures, teachers may interpret and emphasize these axes differently. For example, if teachers emphasize the experience axis, they naturally put foreward student activity and students' opportunities to make first-hand experience with the content in question (Steffensen, 2003).

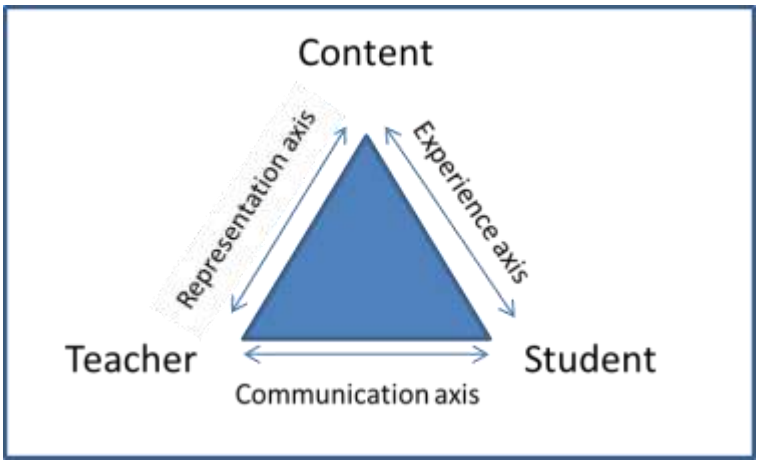

Figure 1: The didactic triangle

The triangle is used as a model or a tool for the design and for the analysis of teaching. Various underlying theories of teaching and learning may be applied to each of the elements in the triangle. Thus, scholars come to understand and to analyze educational settings differently. Künzli & Horton-Krüger (2000) explains that variations result from differing emphasis that stems from differing points of reference. For example, the representation axis joining teacher with content can be understood in two contrasting ways: a) as a doctrinal interpretation, which gives content priority over the teacher, or b) as a magisterial interpretation, which gives the teacher priority over content. With this, tensions may occur along all three axes in question.

The postgraduate course for engineers finds its form

A project group (two professors and a course organizer) was established at NTNU to plan for an initial postgraduate course to meet the comprehensive training need among employees within the power supply industry in Norway. The project group gathered 20 upfront scientists to be teachers in the course. The students who were enrolled in the course were adult learners, combining work and postgraduate studies. At the outset of the planning process there was a need to establish curriculum content and to decide upon teaching methods that could meet the pedagogical needs in the course. This planning process is described according to the three axes in the didactic triangle.

Representation axis

The representation axis joins teacher and content. The learning content is usually defined centrally and described in curriculum, syllabus and textbooks. Teachers are expected to plan and define aims and content based on the centrally defined content. There may be

tensions on this axis, often illustrated through the teachers' professional freedom at one hand and the state regulation of education on the other.

The broader context for defining content for the NTNU-course was the nation's need to meet power supply demands for the future. As such, it was quite a challenge for the teacher group in the course to decide which were to be the predominant teaching matters and which teaching approaches were needed to secure the appropriate teaching of the subject matters. Putting emphasize on defining the predominance of the teaching matter and the ability of the teacher to guarantee the appropriate teaching of subject matter, was the core plan activity in the start-up phase.

The process of deciding curriculum content was to decide the predominant teaching matters within knowledge areas such as knowledge utilization of energy, infrastructure, transmission and distribution of electric energy systems. These knowledge areas are rapidly developing and new technological solutions are constantly evolving. Due to this, the course curriculum needed to be defined according to the latest developments within the knowledge areas in question and suitable curriculum content was not to be found in published texts.

The topic Smartgrid is quite new and university courses within Smartgrid will to some extent have nation specific content due to different system issues and focus among countries. Due to several intersecting knowledge areas within Smartgirds, it is also an issue that a broad introductory course will cover many topics. At this point of time, content descriptions at an appropriate level may not be available within any of the knowledge areas. At the same time there is no overall philosophy of how the different knowledge areas fit together. It also became clear that a quite large number of upfront researchers were needed to cover all topics. The planning of the course proceeded according to the following procedure: A group of 5 persons with a broader perspective of the planning and operation of the power system defined the overall topics to be covered in the course and allocated an estimate of the number of lecture hours in each topic. The experts on the individual topics were then invited to participate in the planning and coordination of the content. The large number of speakers gave coordination challenges. Each topic should be covered properly and put into perspective and with limited overlap. All speakers where then called for a meeting and issues such as motivation, procedures and ambition level were discussed. After this a dropbox folder was created and all speakers could upload their suggested content and presentations as these developed. Some were late in uploading their material but since there were some examples uploaded these were used as templates.

Striving for quality in teaching involves to conceptualize tensions along the representation axis and to balance the teachers' professional freedom and the predominant

teaching content. Planning the postgraduate course illustrates that finding this balance may be a challenge with rapidly developing knowledge areas and lack of updated overall philosophies of intersecting knowledge areas. Another important issue in such postgraduate courses is about how to design course curriculum that enhances knowledge transfer from the university course back to the participants' companies. Content areas need to be designed accordingly, so that participants may download course content and use them within their companies. The purpose of such courses is not to create a money-machine for the future but to spread knowledge and encourage later specialization within the involved knowledge areas. To gain an overview so that students' own work can be put into perspective needs to be strived for.

Communication axis

If the teacher-student relationship is judged of great importance we have a communicative didactic (Künzli & Horton-Krüger, 2000). According to Englund (2007) this communicative perspective exceeds the traditional metaphors for teaching and learning by emphasizing teaching and learning as mutual communication. At the outset of the planning phase the ambition of the project group was to design a course where the teacher-student relationship was given priority. However, with all together 20 teachers involved in the planning process, there was great variety among the teachers when it came to emphasizing the communicative aspects of learning. Although all teachers agreed that the students had valuable experiences that could be topics for communication, the teacher group never went into discussions about how to encourage for such exchanges. At the outset of the course none of the teachers voiced the importance of emphasizing teaching and learning as mutual communication. As the course proceeded, teachers' presentations had the form of collective teaching. This implied that the teachers delivered lectures based on pre-structured manuscripts. There were few communication exchanges between teachers and students during such lectures. Thus the main source of knowledge in the classroom was the teacher. In this collective teaching there were few attempts to open up for alternative learning arrangements that may have encouraged student – teacher communication. However, during the course, students also worked with personal projects that dealt with accurate challenges at their respective workplaces. Towards the end of the course the students presented results from their project. This type of organization involved that the student's own activities were the departing point for elaborating the content issues at hand. With this organization the lecturers invited the students to come on stage and enhanced student-teacher communication.

Along the communication axis there may be possible tensions between student-oriented teaching and teacher-oriented teaching. The teachers in the course did not discuss such possible tensions and did not bring forward awareness of the importance of the teacher-student relationship in teaching. At the onset of the course the interaction between the teachers and the students were based on teachers' presentations. As such, the teaching in the course was mainly teacher-oriented. Towards the end of the course, when the students

were actively invited to share knowledge from the personal projects, the teaching had the character of being student-oriented. With this, the teaching practice transferred from teacher oriented towards student oriented teaching during the course span.

Striving for quality in teaching in higher education involves to conceptualize tensions along the communication axis and to balance the two pedagogical stands of student-oriented versus teacher-oriented teaching according to differing pedagogical needs. A first step on the way towards quality teaching will be to bring forward awareness of the importance of the teacher student relationship in the course at hand and how to organize teaching accordingly.

Experience axis

The axis between content and student, the experience axis, illustrates the student's relation to aims and content. This axis illustrates possible tensions between the material aspects of education, defined by the learning content and the formal aspects of education, defined by work methods and the individual student's experiences, interests and competence. Along this axis, theories of learning and experience are predominant when it comes to designing learning environments. A main concern is to make considerations regarding the student learning process. The project group aspired to join student and learning content in different ways. For example the student project reflected an ambition to join students' workplace experiences and learning content. The student project was organized so that the student learning process had the character of a research process.

Since suitable curriculum content was not published, tensions along the experience axis regarding joining student and learning content, was obvious at the outset of the planning process of the postgraduate course. In the start-up phase of the planning process the teacher group was introduced to several examples of how to use ICT in teaching to meet the curriculum challenges. Since none of the lecturers made active choices about using the technology tools, the project group decided to screen record all lectures. These recordings were uploaded on the learning management platform (LMS) and used for exam preparation. The following was produced and published:

Firstly, a video with an overall presentation of Smart-grid challenges and needed solutions for smarter use of energy was produced and made available to the students ahead of the course. This was meant as an overall introduction of the content areas of the upcoming course.

Secondly, a video with information about the purpose and content of the course, along with practical information was produced and posted on the LMS. This was a screen-recorded lecture. We used a non-commercial Java-based web application that creates

screencasts on Windows, Mac, and Linux operating systems (http://www.screencast-o-matic.com). This free screen recorder is easy to use, allows for the lecturers to add notes and the students to add comments. The program may be used to screen-record and allows the user to both draw and write on the screen as the recording proceeds. It is also possible to use a web-camera to record the lecturer actions simultaneously.

Thirdly, the course lecturers followed joint procedures as they produced regular power-points slides that represented the accurate topic content. These were posted on the LMS before each lecture. Since Power-point slides were regarded as too scarce curriculum documentation, the teacher group decided to screen-record lecturers in real time. The main purpose was to produce curriculum material and the screen-o-matic program was used for this purpose. For this we placed a web-camera so that the lecturer did not need to sit in front of the computer, but could move around a bit. After lectures, students could access videos showing a composite picture of the lecturer in the right corner of the screen and the power-point in the center. Also, students could easily go back and forth within a lecture and both watch and listen to selected parts. This technique offered various learning opportunities (Sølvberg, Rismark & Fosso, 2013). The students could watch the entire lecture or they could look into selected parts of a lecture.

Striving for quality in teaching involves to conceptualize tensions along the experience axis and to join student and curriculum content according to pedagogical priorities. In a course with limited written curriculum available, questions related to the conjunction of formal and material aspects of education naturally rise. In the postgraduate course tensions materialized regarding how to facilitate student learning after lectures with only copies of slides available. The teacher group was invited to discuss how to reduce these tensions by using ICT to facilitate student learning. All teachers were positive and motivated towards this initiative. However, since the teachers did not make moves to use ICT, the project group decided to screen record all lectures to join students and curriculum content.

Further developments

In our analysis of how the post-graduate course found its form, the presumption has been that at a basic level, core elements of teaching involve Teacher, Student and Content. Moving towards the 21st century, the basic elements of teaching, as envisioned in the didactic triangle, may assume new forms. In the knowledge based- and networked society, knowledge naturally changes rapidly and curriculum content of any educational system is likely to be continually changing. Also, the student role may alter when students are expected to create learning trajectories based on massive amounts of information and knowledge. The teacher is to take the role as a facilitator of learning according to pedagogical considerations about content issues and the student groups at hand.

The didactic triangle is one possible pedagogic tool for the design and analysis of teaching. If teacher groups are introduced to such tools in the planning process they may be enabled to conceptualize tensions in teaching and they may be enabled to decide upon priorities at the same time as they have a 'shared frame of reference' (Matusov, 2001; Rismark & Sølvberg, 2007; Sølvberg, Rismark, Strømme & Hokstad, 2007) in the pedagogical tool. To strive for shared frame of references may be essential when groups of people aspire to move forward and contribute towards the same educational goals.

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