

# AN ACTIVE LEARNING ORGANISATION: TEACHING PROJECTS IN ELECTRICAL ENGINEERING EDUCATION

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**SUMMARY :** *The introduction of active learning in engineering education is often started by enthusiastic teachers or change agents. They usually encounter resistance from stakeholders such as colleagues, department boards or students. For a successful introduction these stakeholders all have to learn what active learning involves for them. This means that active learning has to take place on three levels: the students, the staff, and the organisation. These three actors have each to learn from experience, and their learning processes have to be related. Learning on the lowest level is based on the cycle of Kolb for experiential learning. If learning is seen as a form of change, similar cycles can be distinguished for learning on the levels of the staff and the organisation. On the staff level a model of Van Delden's for influencing staff members is used. For organisational change some ideas about the learning organisation from Senge are adapted to educational organisations like departments. A comprehensive view on student learning, staff development, and organisational learning is presented. The model includes four aspects of learning on three levels of educational actors and the relations among them. This model can be an illuminating guide for the introduction and/or general acceptance of active learning at your institution as a lasting change.*

**KEY-WORDS :** *Learning organisation, Active learning, Teaching projects, Triple loop learning, Influencing professionals, Learning cycle*

## 1. INTRODUCTION

Active learning in engineering education is necessary, useful, motivating, gives sense to education. Enthusiastic teachers often start with the introduction of active learning in their own courses. Sometimes educational consultants from teaching centres or the like, are available to help them. As change agents (Havelock, 1973) they usually encounter resistance. It is not sufficient to have a vision on learning. It is not sufficient that the students like it, or the teacher. Not only students and colleagues have to be committed for successfully introducing active learning, but also the department with its head, board, and committees.

For all these actors there are risks at stake. An investment of attention, time, and/ or money is asked, while they do not yet know what active learning of the students will involve for themselves. No one can really tell them what problems will arise and how they can solve those at what cost. Therefore the stakeholders all have to learn by themselves, actively, what active learning involves. This means that active learning has to take place on three levels: the students, the staff, and the organisation.

These three actors have to learn from their own and each other's experiences. Learning from experience is described by the learning cycle of Kolb (1984) that includes four aspects in experiential learning. This cycle has been used often for describing and guiding the design of education of students, i.e. the lowest level. If learning is seen as a form of change, similar cycles can be distinguished for learning on the levels of the staff and the organisation.

For the description of the development of the staff and of the learning of the organisation, the cycle of Kolb has to be adapted. For staff development a model of Van

Delden's (1992) is adapted that includes four strategies to influence professionals and their organisations. For describing organisational change some of the ideas about the learning organisation from Senge (1992) are added and extended to describe changing educational organisations like departments.

A comprehensive view on student learning, staff development, and organisational learning is presented by relating the three cycles. The model includes four aspects of learning on three educational levels and the relations among them. With these four aspects and three levels the factors will be described that were involved in the successful introduction and maintenance of Teaching Projects in the Electrical Engineering department (EE) of the University of Twente since 1992.

This case study fills the full 4x3 matrix of possible combinations. It does not describe the dynamics of a change that is enforced by a crisis, but in stead the dynamic state of a learning organisation that is changing rather continuously and incrementally. It can be an illuminating guide to stimulate active learning at your institution.

In the following paragraphs the cycles of learning on the three levels will be presented, with examples based on the introduction of projects in EE. Then a comprehensive view on an active learning educational organisation will be presented, and finally a discussion and conclusion.

## 2. CYCLES OF LEARNING

The learning cycle of Kolb is a metacognitive strategy that involves four steps in learning based on experience that lead to successful and lasting processes of change. Many individuals have a preference for one or two of

these steps (learning styles). Alternatively, the cycle can be interpreted as four aspects of learning that have to be accounted for in teaching. The same alternative interpretations apply to the cycles on the two other levels. Also, as Kolb's cycle looks different in different educational settings, so do the cycles on the other levels.

### **2.1. The student level**

The four aspects of learning according to Kolb (1984) can be illustrated by playing the game of pool (l.c., p. 65). The pool player can focus on the position of the balls, make minor adjustments before hitting the ball because that "feels right", and rely on a global intuitive feel of the situation (active experimentation, AE, and concrete experience, CE). Another way is to watch others, or reflect on one's own shots (reflective observation, RO). A third method is to compile and organise into laws one's observations of the game (abstract conceptualisation, AC). And last, one could use theory about how the ball will travel, including basic physics, and even measure out angles (AC and AE). In more complex situations like projectwork these aspects look as follows.

CE is a learning style in which are important motivation by sensing the use and the sense of what one does, the formation of meaning, and maybe the feeling of freedom. But also feedback from assessment results and conceptual conflicts arising in disputes contribute to the feelings involved in CE. RO comprises the formation of ideas, the reflective observation that one is using knowledge supposed to be forgotten, becoming aware of the goal of becoming an engineer, and an orientation on self-responsibility. AC in practice comes to the formation of rules and procedures. It involves many sub-aspects, like defining concepts and the resulting definitions. Also a General Labs Guide to handle instruments, the procedures involved in the use of digital reflective journals, and the rules of a contest at the end of a project fall under AC. Finally AE includes the application of concepts and rules to concrete examples, practising design and realisation, co-operating in a team, the sequence of planning, executing, and presenting the team's work, and the evaluation of self-directed learning. The last activity leads to feelings that belong to CE.

These four aspects involve two dimensions: learning through actions and learning through sensing. The dimension of actions has extensional actions (doing, AE) at one end and intentional actions (reflecting, RO) at the other. The dimension of sensing extends from internal to external, i.e. from subjective feelings (CE) at one end to objective forms (AC) at the other. Although all aspects are involved in active learning, CE is at the heart of it. In ideal cases of active learning the students are committed to their activities. And these are meaningful to them. Otherwise they will not get an experience of success, or a feeling of learning or not learning, that are required for self-directed learning.

### **2.2. The staff level**

At the level of the staff, the four aspects come from the model of Van Delden (1992). This model consists of four strategies to influence professionals (cf. Vos and Daudt, 2002), along similar dimensions as above. They are presented in the order corresponding to the four aspects of learning.

The first aspect is personal oriented, focuses on people, and thus leads to experiences involving feelings. In practice it involves the existence or creation of teams like our EE Labs Committee, where staff members meet and discuss the learning results and processes and material facilities related to labs and projects. This aspect comprises mainly getting the staff members involved in projects. In the present case their motivation was among others that the staff was not content with the results of learning because the students were not able to apply what they had learned in theoretical courses to practical situations they met later during their study.

Another aspect corresponds to a rational strategy. It is focused on developing vision and stresses intellectual behaviour. In practice the staff becomes aware of the need for an ongoing red thread of design education through the curriculum, of the contribution of the project they supervise to the curriculum, and of the prior knowledge and experience of the students that they should be able to apply.

The third aspect is called conditional. It involves the means, methods, and procedures that have to do with formal, instrumental behaviour. It can comprise both conceptual and material instruments, but also personnel: educational consultants to facilitate the staff by training them and their teaching assistants. Incentives are another feature of this aspect. Although the staff usually is satisfied with getting some teaching assistants and seeing the progress in the performance of their students, the contacts with students are also important: to identify the good students and get them interested in the staff's research.

Finally, the operational aspect is mentioned that involves actions. Pragmatic behaviour is accentuated, in other words: involve staff members in getting results and/or products. Examples of this aspect are the assignments that the staff members design (and redesign!) for the projects, and the contributions they write for the General Labs Guide.

Relations between levels become visible now. The General Lab Guide and the assignments are major means for the students to know what they have to do, and how. Discussion on progress of the students and learning effects/ processes can be based on evaluations, organised by staff members themselves on an informal or on a formal basis, but formal evaluations can also be organised on the higher level of the department.

### **2.3. The department level**

What are the characteristics of an active learning, educational organisation? Of a department learning from experiences? The backbone of an organisation is its

formal structure: Its head, the dean, and the directors; The board; And the committees, all with their responsibilities. This structure should learn. In correspondence with the other levels, four aspects will be distinguished.

Experiences in the organisation take place when the Educational Quality Committee gets the evaluations of the teaching-learning processes and their results. Discussions then often lead to formal letters to the Director of Education in order to initiate actions. In the present case the start of the whole reform was originated by the results of a questionnaire among alumni and their employers which experience drew the Department Board into action.

The aspect of vision is represented in the Curriculum Committee, when the position, function, and integration of the projects in the curriculum are discussed. The introduction and implementation of threads through the curriculum like learning to do research or learning to design is a matter of the Curriculum Committee of the department too.

The conditional aspects on this level have the form of the costs and benefits. The director of personnel and facilities has to agree on the costs of facilitation, and of the large project room and its equipment. Benefits for the department come from the quality of the alumni and the speed with which they are educated. Also the rating of the department in educational quality assessments is important.

Finally the action aspect can be observed in the resolutions and decisions taken by the Department Board and the Director of Education. Also the creation of formal positions, the phased introduction of the projects, and the formal introduction of the EE Labs Committee, the Educational Quality Committee, and other ad hoc committees, are examples of actions on the organisation level.

So the structure of the organisation shows four aspects of learning in which experience is represented. However, for learning also a memory is required. On the organisational level the memory not only comprises the minutes of the committees. Also officials like the Director of Education and the departmental educational consultant remind committees and Board of decisions taken in the past.

The structure of the organisation can be called an active learning one now. Learning of the organisation as a whole is also strengthened by the relations between the levels. Some of these relations between the three level's learning have already been mentioned. They lead to a comprehensive view on the learning of the organisation.

### **3. A COMPREHENSIVE VIEW**

The relations between the different level have become more visible now. Results of evaluations by the Quality Committee concern the staff and lead to adaptations of educational processes. Not only are students involved as the information source in the evaluations, but also as

members of the Curriculum Committee and as assistant to the Quality Committee. The staff is committed to take part in the EE Labs Committee because there they can contribute with their experience and knowledge to the educational policy.

The three levels and the four learning aspects on each level represent a dynamic state of organisational learning. On all levels there are experiences from actions that are carried out. There are successions of actions, outcomes, following actions etc. On all levels the four aspects can be distinguished. And on all levels these can also be interpreted as a cycle to be completed again and again.

On the student level, after they got the motivation to start, the students will orient themselves on goals and tasks, study information that is needed, make and execute plans, have new good and bad experiences, reflect on those, formulate rules, try these out at a next opportunity, etc.

The staff members want the students to apply what they learned in lectures. The staff thinks about design, the organisation of projects and the assessment of the students in projects, writes assignments, gets experiences (feedback) from evaluations of the work of themselves and the students, reflects on these, and takes measures to improve whatever is necessary.

The organisation started with the evaluation of the alumni, its product, which produced an organisational experience. Then the Educational Committee got involved, the necessary personnel and costs were estimated, the change was started formally, and the results became evaluated in the Educational Quality Committee, finally leading to a strengthening of the department on all levels.

During all these processes the students got better, the staff became more experienced, the committees became more aware of their responsibilities and developed from ad hoc created teams of staff members into formal committees, and the relations between the three levels became strengthened. A consistent triple loop learning took place (cf. Senge, 1992) and is still going on. The department got number one in the ratings of the educational quality of electrical engineering education in the Netherlands the last three years.

### **4. DISCUSSION AND CONCLUSION**

The foregoing shows a picture of the dynamic state of an active learning educational organisation with its three levels of stakeholders. The organisation described is a sample organisation (case study) but its structure fulfils the functions that can serve as a goal to be reached in other cases. However, this goal lies on an abstract level. The aspects in the description are sets of functions that have to be fulfilled within the educational organisation at hand, according to the factual possibilities of the organisation.

The picture does not show the dynamics of the change to an active learning organisation. The dynamics

and processes of factual change depend even more on the actual characteristics of the organisation, like where in the organisation people with much influence are situated, what the motivations for change are on the levels of the organisation and the staff, what facilitators are available, how the memory can function, etc. The one thing that can be said is this. Since changes are needed on all three levels and relations between the levels have to be build, and all learning from experience takes time, the formation of an active learning organisation takes a very long time, in the order of 10 years or more.

When officials, staff members, or even students are not satisfied with the educational system they work in, and want more active learning, they can start to improve what they want to change, in their direct environment. However, if they want a lasting change that is accepted and implemented in the organisation, this paper might give them some view on the things that are important too to work on.

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