

# The Active Learning Educational Organisation: A case study of innovation in Electrical Engineering Education.

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*Abstract-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.*

*Keywords-Learning organisation, Innovation, Active learning, Teaching projects, Triple loop learning, Influencing professionals, Learning cycle*

## 1. Introduction

We all know about learning by the students and learning by ourselves and other staff. Can there be learning on the level of the school or the department too? The department of Electrical Engineering of the University of Twente, Enschede, The Netherlands has introduced projects in the curriculum about ten years ago. During this process the department has changed, as well as its students and staff. Activities and learning took place on three levels: the students, the staff, and the department. Thus one could say that the whole organisation of students, staff, and department became an active learning educational organisation.

New teaching methods are being introduced for several reasons. The technology is changing and gives us computer-aided instruction, use of the www, course management systems for teaching and learning, etc. Also the societal context is changing and requires competence development by curricula, quality control, accreditation procedures, internationalisation of the curriculum, the courses, and the study plans, etc. And third, the pedagogy changes and introduces reflection, self-regulated learning, personal development plans, etc. Often such innovations fail to satisfy.

Usually someone who either is responsible or is enthusiastic for an improvement starts an innovation. This change agent (Havelock, 1973) can be yourself, a colleague, a student, an official, someone from the board of the department or even higher in the hierarchy, or an educational consultant. Change agents often meet with resistance. It is not sufficient to have a vision on learning, teaching, or the organisation of it. It is not sufficient that the students, the teachers, or the board like the change. It is not sufficient that the board wants a change. This is, among other reasons, because of the risk.

The precious time of students, colleagues, and officials is at stake. No one can really tell what problems will arise and who has to solve those at what costs. No accurate predictions are possible: often planning fails or there might even be unsolvable problems (Fullan, 1991). Everybody knows of examples of enthusiastic teachers who introduced some innovation and

fount out that this evoked unforeseen problems. In other cases of hierarchically introduced innovations the effects and returns were meagre.

Enforcement of a change is sometimes necessary, but often the results are not as wanted. An isolated innovation often is gone when the teacher or the official moves to another (place in the) university. For a lasting change the students and colleagues have to be committed, as well as the department with its head, board, and committees (we neglect higher levels that might be involved like the faculty, university, government, or professional organisations).

A gradual process of learning on three levels is necessary: the levels of the students, the staff, and the department. This process has to include a large amount of learning from experience. The three stakeholders or actors have to learn from their own and each other's experiences. They have to be active learning. How does this work? The problem faced in this paper is to make a model that describes such an educational organisation that is actively learning on three levels.

Such a model could serve as a goal towards which the change agent and his "allies" can work. It could serve as a checklist to see what was "forgotten" or what could be a next step in the change. It could give some hints about a change towards such an organisation. It should give some indications about the roles the change agent or others have to play, in the specific organisation at hand. In order to be of such use, the model has to meet some specifications.

The model should have a system approach of three levels. The model should show cycles of learning on these three levels. The learning should relate to experiences and involve activities on all levels. The model should give a coherent and comprehensive view on an active learning educational organisation in which an innovation will be accepted, implemented, and last.

Different educational organisations have different structures, but the educational functions that are fulfilled are the same: Therefore the model should be functional. The model should contain functions that can be described by examples from a case, but that can be filled with other examples. In this sense the model should be an "empty" template. Then functions could be fulfilled by the change agent in the beginning and by other actors later. Such a model can be constructed as follows.

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.

On the student level the learning from experience can be described by the learning cycle of Kolb (1984) that includes four aspects in experiential learning.

The model of Van Delden will be used on the staff level .

On the departmental level an analysis of responsibilities has been carried out and a generalisation of Kolb and Van Delden to this level has been made.

Similarities will be highlighted.

Relations among the three cycles will get attention.

The method by which this problem is approached:

Such a view can be found from an integration of what is known about active learning of students, promoting change of professionals, and organisational learning, and applying this to an educational organisation.

In projects the students learn from active experimentation that induces concrete experiences, followed by a phase of reflective observation to develop their view on what is learned. Then a phase of abstract conceptualisation follows, to formulate the concepts and rules necessary for generalisation. This generalisation can be tested by active experimentation, thus returning to an earlier phase. These phases form the cycle of Kolb (1984) for experiential learning. The four phases can also be interpreted as four learning styles, that all have to be served by the course.

For influencing professionals and their organisations a model of Van Delden's (1992) is available that includes four strategies that all have to be served by any change agent. These strategies include giving the staff motivating experiences; developing their vision; giving them means that help and stimulate them to exert the required efforts; and let them be active, produce contributions to the change (cf. Vos and Daudt, 2002). The phases are analogous to the four phases in Kolb's cycle.

The characteristics of an active learning organisation are as follows. It should be able to store new knowledge, that is, it should have one or more memories. It should have experiences from activities that are carried out. There should be a relation between actions, outcomes, following actions etc. And its learning should include again four aspects, analogous to the earlier ones. Then a real consistent triple loop learning can take place (cf. Senge, 1992). It must be stressed that for experiences to happen, unexpected events are important: bad assessment results, disputes, controversies, cognitive conflicts.

The questions to be answered thus are the following. How does active learning proceed on the three levels? What are the relations between the levels? How looks the dynamic state of an active learning educational organisation? These questions will be answered for the case of the Electrical Engineering department of our university, focusing on the introduction of projects in the curriculum.

The results of this research.

At the level of the organisation, the resolutions and decisions of the Board and the Dean of Education form the active part. Experiences are the effect of evaluations and questionnaires about the results of actions. The vision on the curriculum is formally the responsibility of the Curriculum (or Educational) Committee. The means for development, implementation and dissemination of the innovation are provided by the Director of Personnel of the department.

With these analogous four aspects on three levels of the organisation, the factors can be described that should be present in the successful introduction and maintenance of Projects in the Electrical Engineering department of the University of Twente. This case study fills the full 4x3 matrix of possible combinations (see Table 1). It can be an illuminating guide for those who want to introduce active learning or other innovations at their institutions.

Table 1. Four aspects and three levels of an Active Learning Educational Organisation: The case of the introduction of teaching projects.

Aspects	Department	Staff	Students
<b>Experiences</b>			
For motivation	Questionnaire alumni + employers	No application of theory, mastery insufficient.	Motivation: use, sense
From rating	Evaluation of t & l processes by the Educational Quality Committee.	Evaluation of product/ learning processes.	Assessment.
Involvement	Effect of reports.	EE Labs Committee.	Teams. Disputes.
<b>Vision</b>			
	Integration of curriculum Position, function of projects Red thread: design	Design education Contrib. to curriculum Prior knowledge stud.	Self responsibility Use knowledge Becoming an engineer
Stakeholders	Educational Committee	Project co-ordinator	Self-reflecting student
<b>Means</b>			
Facilitation	Project room. Equipment.	Staff & TA training. Educational Consultants.	General Labs Guide. Digital reflect. journals.
Incentives	Quality of alumni. Speed of graduation	Teaching assistants. Contacts with students.	Winning design contest. Self-directed learning.
<b>Action</b>			
	Dean of education, board: Resolutions, decisions	Contributions GLG	Design, realise, co-op.
Phases	Phased introduction	Formulating assignments	Plan, execute, present

Another question is the issue of the memory. Minutes of meetings can be considered as memories, but these are dead memories. Living memories are those of officials or educational consultants who remind people of decisions made in the past. Before reports are effective in regular procedures, these people have to see to the continuation of the cycle of progress, with actions, products, following actions, etc. on the organisational level.

It must be stressed that this matrix applies to the dynamic state of an active learning educational organisation, a goal to strive for. It does not describe how this state is reached. For instance, it does not describe where in the organisation people with much influence are situated, what facilitators are available, how the memory can function, etc. The change process itself depends strongly on the organisation, but a gradual development seems most fit for it. In the present case this development took about ten years.

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