Abstract:

Higher education is undergoing continuous changes and new learning tools and methods are implemented. Researchers in education do not always agree upon the effectiveness of some of the methods introduced into engineering education. The present thesis consists of two case studies on educational methods introduced at the Department of Energy Technology, at Royal Institute of Technology (KTH), Sweden. The qualitative research methodology has been used in case one and a combination of qualitative and quantitative methodology has been used in the second case. The sources of evidences consisted of: unstructured interviews, analysis of video recording, questionnaires, and analysis of a variety of documents. In the first case, an educational program in heat and power technology was analysed. The second case consists in an in-depth study of group dynamics in a Problem –Based Learning course. These studies showed that the learning approach adopted by students depends strongly on the way they view the particular learning tool or method. The first case study revealed the existence of two types of learners. Surface-learners follow the structure suggested by the designers of the multimedia program. This category of learners focuses only on the material available in the program. Deep-learners go beyond the information and the structure suggested in the program and combine different learning tools in their learning. These students do not follow the structure of the tutorials’ of the multimedia program. This study showed that students who had a strong view how to learn with a multimedia program or a learning method benefited less from the learning tools available. Students with weak views on how to learn from educational program or leaning tool benefit less from the presentation and engage in more surface learning. Self-motivated learners use the multimedia presentation in novel ways and crosscheck the information given with other material. The second study showed that students have unclear and weak views on how to learn with student-directed Problem-Based Learning model. Four types of learners were identified in Problem-Based Learning project: Leaders, Key Actors, Common Students and Social Loafers. Leaders and Key Actors are self-motivated individuals and participate most in the projects. Students who viewed themselves or were viewed as leaders were held responsible to take most of the decisions and students expected them to work more than the average student. Students who viewed themselves as common team members expected a lower workload than leaders’. Key Actors are self-motivated students who do not view themselves as separate from other group members but who participate more than others. Leaders learned more group and social processes, that they did not fully take part in, while common students learned more from the project management aspects that they did not take part in. The study also found that Problem-Based Learning groups can become very cohesive, and can develop distorted views on how to learn with Problem-Based Learning, and un-common group dynamics phenomena such as groupthink can occur in Problem-Based Learning setting.

Key words:

Qualitative study, Multimedia, Learning, Learning theory, problem-based learning, PBL, group dynamics, deep-learning, surface-learning, heat and power technology, engineering education.
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1 INTRODUCTION:

Higher education is undergoing continuous changes and new learning tools and methods are implemented. Researchers in education do not always agree upon the effectiveness of some of the methods introduced into engineering education. Therefore, further research is necessary in order to investigate potential problems, dysfunctions or improve the methods already in use.

This thesis presents the result of two studies on the implementation of two educational methods introduced at the Department of Energy Engineering (DEE), at the Royal Institute of Technology (KTH), Sweden. The first case study will focus on the multimedia educational program, CompEdu, developed by the Division of Heat and Power Technology (HPT) at KTH. The second case consists in the investigation of the Problem-Based Learning (PBL) course introduced in an international Masters’ program offered at DEE Department.

The qualitative research methodology has been used in case one and a combination of qualitative and quantitative methodology has been used in the second case. Two case study designs were developed for the purpose of the study. Several sources of evidence were used in order to ensure validity and reliability of the data. For the analysis section, a combination of relevant theories was used. This choice of combining theories is motivated by the different nature of the phenomena investigated, the specific unit of analysis and the types of data available.

1.1 Background:

During the late decades of last century, higher education has underwent different reforms in order to adjust to the demand for engineers with professional skills from government and industry (see for example (Abbes, 2001)). In order to respond to this large demand, universities had to introduce learning methods for mass education including different forms of e-learning solutions. Other methods were borrowed from other disciplines such as Problem-Based Learning (PBL). As a result of excitement for potential applications of new learning methods and technologies, some innovations were implemented despite divergence of researchers’ opinion with regard to their effectiveness (see (Allessi and Trolip, 2001), (Conlee, 2000), (Laurilard, 2002a) and (Laurilard, 2002b)).

Research in computerized education is relatively new if compared to other established disciplines (Allessi and Trolip, 2001). The earliest educational programs were developed in the 1960’s and early 1970’s for large mainframe and minicomputers computers. Throughout the 1970’s and 1980’s, the use of microcomputers rapidly expanded to businesses, homes and universities. Many educational programs were then developed for microcomputers and networks. The first years of computerized education were characterised by excitement and promises for a great enhancement in learning, but several factors hindered the success of educational programs. In addition to hardware and software incompatibility, Allesi and Trolip (2001) mentioned two other important hinders: a shortage of skilled developers of learning material and the disagreement between researchers on how computers should be used for education. Nevertheless, computerized education, both on personal computer and through networks such as the Internet, is continually growing (Jarvis, 2004).
CompEdu is a multimedia educational program developed at HPT/KTH. In the first years of CompEdu it was intended to function as platform for re-use of the best learning material available in the form of Power Point presentations and other material in digital format. Later, the project developed into a stand-alone program providing a wide range of learning materials in Heat and Power Technologies. The project team published several articles about teaching and learning enhancements that could be achieved with CompEdu (Fransson et al., 1998, 2000, 2003a, 2003b). CompEdu’s potential application as a learning and teaching tool poses a number of interesting questions worth to examine.

The design team presents CompEdu as a universal tool for both teaching and self-learning for all types of learner; however, Dillon and Gabbard (1998) noted that there are significant individual differences among users of multimedia educational programs. Barab et al. (1997) found that there exists a certain profile of users who are susceptible to take unwise navigation decisions, and could be distracted by unimportant details and superfluous features in the programs. Chen and Ford (1998) showed that students with different cognitive styles and individual characteristics select different access facilities and follow different navigation paths, which results in different learning outcomes.

Other research pointed out the importance of prior knowledge, experience with computerized education and awareness of the structure behind the material. Chen and Ford (2000) found that students with previous experience in navigation spend less time learning. Hill and Hanafin (1997) found that learners who developed good knowledge about the hypermedia system successfully completed their learning task while those with low system knowledge were unable to develop system knowledge, experienced disorientation, and were unsuccessful. Moreover, the more the learner is aware of the logical structure and the more the students have larger knowledge-base, the more they can learn from structured hypermedia lessons. This later finding was confirmed by MacGregor (1999) who noted that prior knowledge of the structure of system had a positive influence on the complexity of the knowledge learnt from multimedia presentations. Beasley and Waugh (2000) found that when learners are aware of the logical structure of hypermedia lesson, structural knowledge acquisition will increase. Furthermore, when students are at least aware of the logical structure disorientation will decrease. CompEdu program offers a rich learning environment with a special way of structuring the learning material. The lack of insight on how the users actually use it makes it hard to predict the effectiveness of the program. The previous studies mentioned focused on the users’ apparent activity and did not consider either students’ motives and views, nor the driving force towards their learning choice and engagement with multimedia educational programs. The present study will investigate both the views of students and designers; and their effect on design and use of multimedia learning material, and the effectiveness of learning and its depth.
The second educational method introduced at HPT is Problem Based Learning (PBL)\(^1\). This method is one of the most significant innovations in professional oriented education (Boud and Fletti, 1997). Although, the implementation of the first PBL courses dates back to the 1960’s, the debate on the effectiveness of PBL is still ongoing (see for example: (Albanese and Mitchel, 1993), (Colliver, 2000), and (Albanese, 2000)). Moreover certain sensitive aspects of PBL such as group dynamics have not been thoroughly investigated (see for e.g. ((Freeman et al., 1995), (Conlee et al., 1997) and (Dolmans at al., 2001)).

PBL has been introduced as part of the final year of Master’s program at the Department of Energy Technology at KTH since the academic year 1999/2000 (Svensdotter et al., 2000). Internal course assessment showed inconsistency between students’ satisfaction levels expressed in terms of statistics and students’ expressed opinions. It has, for example, been noticed, that despite the high level of satisfaction, students mentioned several problems related to the learning environment and problems related to dysfunction in the group dynamics. It has also been noted that unpredictable group dynamics could negatively affect the quality and effectiveness of students’ learning (Abbes, 2002). Research on PBL revealed similar problems with the application of the educational method in engineering education. Savin-Baden (2000) noted that teachers and students often misunderstand PBL and that teachers’ and students’ opinions are missing in the PBL literature. Conway et al. (2002) have mentioned a shortage of literature considering students’ experience. Hak and Marguire (2000) went further and suggested conducting broader studies in order to describe and analyse the cognitive activities and the group processes that could foster effective performance.

Savin-Baden (2000) found that students usually experience difficulties to position themselves within the PBL groups. Conway et al. (2002) showed that this results from the different views hold by the group members on objectives and understanding of the PBL concept. Research showed that faculty members needed training in some group dynamics’ skills (Freeman et al., 1995). As Dolmans et al. (2001) noted, students were more satisfied with tutors who had good group dynamic skills irrespectively of the performance of the group. Other researchers such as Collier et al. (2001) identified six major problems for PBL students: lectures, dysfunctional group dynamics, superficial research, shortage of time, frustration with non-expert tutors, and lack of support for PBL. Similar problems were pointed out by the course evaluation of the PBL course offered at HPT/KTH (Abbes,

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\(^1\) It is important to note that Project-Based Learning and Problem-Based Learning share much in common, but are two distinct approaches to learning. In Project-Based Learning, students have more control of the project. The project may or may not address a specific problem. In Problem-Based Learning, a specific problem is specified by the course instructor. Students work individually or in teams over a period of time to develop solutions to this problem. Project Based Learning is less open ended than Problem-Based Learning, while Project-based learning is more a "discovery" model than an "inquiry" model as in the case of Problem-based learning.
1.2 Aim:

It is believed that CompEdu design team and using the program hold different views on learning with multimedia educational programs. There are different categories of students and CompEdu users. Each of these categories view learning with multimedia in a different way than others’. The views on what a multimedia is and how to learn with it greatly affect students’ learning outcome and the way they use the learning tools or methods for their learning.

The first case study will focus on both the design and the actual use of the multimedia program CompEdu. These aspects will be investigated from developers’ and students’ perspectives. The study will describe and analyse how different users’ views of educational program and how they actual learn with it.

In the second case, the focus will be on the analysis of group dynamics taking place in a PBL learning context and their effect on its effectiveness. It is believed that students’ views on learning with PBL affect greatly the outcome of learning in groups. Furthermore, the nature of the PBL model used at KTH offers the possibility to have rich group dynamics phenomena that may enhance or hinder the effectiveness of learning with PBL. The present study will investigate these phenomena and their effect on PBL effectiveness and students learning, from students’ perspectives. This second study will also analyse students’ perspectives on how to learning with PBL in order to understand the complex phenomena occurring in large PBL groups from individuals’ as well as from a group’s perspectives.
2 EMPIRICAL INVESTIGATIONS

The present studies have been conducted during the two academic years 2001/2002 and 2002/2003 at the Division of Heat and Power Technology, at KTH. This chapter gives an overview of the case study designs that guided the investigations of the two cases. Due to the nature of the studies, a similar design was used for both cases.

2.1 Case Study One: Learning with CompEdu Program

The first object of study is the multimedia educational program, CompEdu, which has been presented by the design team as a universal teaching and self-learning platform. The program contains several education tools extending from the most basic ones such as texts and pictures to more advanced ones including digital videos, simulations and 3D animations. It has been designed as a self-standing tool and currently exists in CD-ROM for PC. The typical learning tools contained in the program consist in: short theory chapters, lecture notes, simulations, videos, quizzes, calculation exercises and other tools. The theory chapters are usually designed as a self-standing learning element with a short text, hypermedia, images, video and other elements interlinked. The text is presented as short statements summarizing the content of the studied topic with links to other multimedia material. The program has been used for teaching and self-learning since 1996 at KTH and at other universities worldwide. A detailed description of the platform including the interface, the content, and the functionalities is presented in Appendix A.1.

This study starts from a hypothesis related to the program, the developers and the users. It is believed that developers and students (i.e. users) have different views with regard to learning with CompEdu. Developers’ stated objectives could not always be reached with the present software design. Users’ views, beliefs and previous experience with other software affect the way users view and learn with the program. Furthermore, learning with CompEdu differs from a context to another and from a person to the other. In order to verify the hypothesis a set of research questions are suggested. These are as follows:

- How do developers view CompEdu and its use? And what are the designs strategies used in order to achieve the stated objectives?
- How do students view CompEdu as a learning tool? And how do they actually use it depending on the learning context?
- Why do student use the software differently?
- Is CompEdu design able to achieve the objectives stated by the developers?

For the purpose of the studies the following units of analysis are considered. In this case, the individual user and the developers will be used as a unit of analysis.

The present study was performed during academic year 2002/2003. For the purpose of the study 8 students were recorded while using the program for learning. They were simultaneously interviewed. The students were selected from different categories including four graduate students and four undergraduates. This number of student may seem low compared to the number of students that used the platform; however, in-depth interviews
ensure more reliable results than traditional questionnaires, and would provide the researcher with more detailed understanding on how the users learn than what he or she would gather with a large number of questionnaires; he or she would be able to ask improvised questions that would not have thought of in traditional questionnaires. The video recordings took place in an office familiar to students. They were informed thoroughly about the purpose of the study, and that their identities will be kept confidential and that some quotes might be published in the thesis. All students agreed upon the conditions of participation in the interview. The recordings were later visualized and transcribed verbatim.

The duration of interviews varied between 15 and 30 minutes depending on students’ familiarity with the program. They were first asked to show how they usually use the program for learning. A sample of questions that guided the interview is presented in the Appendix A.2. At the end of the interview, students were presented with a new interface of the programs and were asked to describe the differences.

2.2 Case Study Two: Group Dynamics in PBL Course

This study investigates the Problem-Based Course offered at the Department of Energy Technology. The course was first introduced in 1999 as a part of the last year curriculum of both the Swedish Master’s program in Energy Technology (Civilingenjör) and the international Master’s program in Sustainable Energy Engineering. Course participants are divided into different specialisations of their choice including: heat transfer, heat and power technology, sustainable building systems and nuclear technology. The study will focus on the course offered at the Division of Heat and Power Technology.

The course is worth 6 Swedish credits (9 ECT credits) and is offered during spring semester. The problem-based model adopted is an ill-structured and highly student-directed. Most of the problems studied are parts of real industrial projects. The two phases of the project are concluded by two public presentations at department level. At the middle of each phase, students hold a presentation within their group in the presence of a Design Review Team formed of tutors and representative of the industrial companies that suggested the project. Students’ project team is responsible for organizing the formal meetings and for writing down the minutes. Students team members act as consultants and have to organize themselves into a project team. The alternative solutions developed under the guidance of the tutors have to be suggested to the design review team for approval and review. The students have to produce a comprehensive formal report and a presentation for each phase.

The present study was conducted during period January to May 2003. A total number of 22 students were admitted into Heat and Power Technology project (HPT project) that consisted in introducing modification in the Hässelby Power Plant in Stockholm. The group was formed of twenty international students representing 15 nationalities and two Swedish students. Specialisation and project selection took place in November and December 2002 during a meeting at department level. This process is based upon qualification, and choice. All students admitted in the HPT project had selected the project as their first choice.

Based on course reviews and non-systematic observations of PBL groups from previous academic years, the following hypothesis is stated by the present author:

PBL is sensitive to the leaning context. Students view learning differently depending on several conditions some of which are the task assigned to them, the position in the group, group cohesion and the size of the group. Poor group dynamics may hinder student learning
or decrease the effectiveness of BPL method. Student’s views and beliefs on what PBL is, and on the role they assign to themselves or is assigned to them is an important factor that can enhance or hinder students learning.

In order to test the hypothesis and operationalize the study, the following set of research questions are posed:

- How do students view the PBL learning environment?
- How do students act in a PBL learning environment?
- Are there different roles assigned to students in PBL? How does the role assigned to students affect the learning?

The unit of analysis used in this study is the individual student. The sources of evidence used to answer the research questions include open-end interviews, analysis of course and project documentations, information collected through questionnaires, and non-systematic observations.

Open-end interviews were conducted with seven students. These were recorded on tape and then transcribed verbatim. The main questions are presented in the Appendix A.3. Interviewees were selected on the basis of their involvement in the project team. All students that were asked to participate in the study responded positively. They have been interviewed in neutral room. The duration of the interviews were about 30-45 minutes in average. Before starting the recording, students were asked if they did not object to record the interview and to publish some of their statements in the final thesis. All students agreed upon this condition. The identity of the students has been kept confidential.

Four questionnaires were used to collect data during the design review meetings. The questionnaires were identical and aimed at measuring students’ attitudes towards PBL course, the project and their colleagues. In addition to this, students were asked to write down the best and worst learning experiences. A sample of the questionnaire is presented in the Appendix A.4. The response varied between 12-18 students.

The students suggested using the yahoogroups system² consisting in an e-mail list with capabilities for storing files, pictures and all e-mail communications during project. The company agreed to publish non-sensitive information on the yahoogroup. The system also saves detailed information on students’ activities. These consisted in: accessing times, changes operated in the system, uploading files, creating files, and all e-mail communications. Students’ representatives agreed to allow this information to be used for the study.

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² Yahoogroups is a free e-mail group service accessible for registered members through Internet. It offers the possibility for members to save, share and distribute information in electronic form. More information is available on the Yahoogroups’ website: [http://www.yahoogroups.com](http://www.yahoogroups.com) (02-18-2005)
Another source of evidence consists in a variety of documents produced by the department and the student project team. In addition to formal reports and presentations, the minutes of meetings, partial solution of the project were also collected and used.
3 ANALYSIS:

This chapter gives an overview on how the empirical material gathered is analysed and how it is connected to the theory. It begins with a brief introduction of the theories used for each case study. The first case will be analyzed using a combination of two learning theories: the Multimedia Learning Theory (Meyer, 2001) and phenomenography (Marton et al., 1984). As for the second, a group theory based on Rosander’s (2003) groupthink model will be used. A description of the combination of theories and the procedure used for the analysis of the empirical data is presented, thereafter.

3.1 Theoretical Frameworks:

A selection of theories has been chosen in order to explain the phenomena encountered in the studies. This section describes two main bodies of theories starting with learning theories and followed by group theory. A discussion on how to apply the theories is carried out and a set of theories is suggested for the analysis of the case studies.

3.1.1 Multimedia Learning Theory:

Cognitive psychology focuses on non-observable constructs such as mind, memory, attitudes, thinking, reflection and other internal processes (Allessi and Trolip, 2001). There are three major schools of cognitive learning psychology. The first school is the semantic networks which views the brain as a large number of neurons connected with each other in large networks representing information and knowledge learned. These pieces of information are viewed as nodes connected by links with other nodes that have relationship of: similarity, opposition, cause and effect or time.

The second school of cognitive psychology is the schemata theory, which is very similar to the semantic networks approach. The main difference lies, however, in the nature of the relationships that the networks have with each other. In this later theory, they are organized according to categories and classes that are interlinked in larger networks or schemata instead of interconnected pieces of information.

The third approach, which has developed from studies of computers and artificial intelligence, is the most influential school. Cognitive psychologist, try to explain how the brain processes the information incoming from the senses, then stored in a short-term memory, organized; and finally stored in the long term memory (Allessi and Trolip, 2001).

The Multimedia Learning Theory (MLT) presented below has been suggested by Meyer (2001). This model is based on cognitive psychology and the information processing approach. This model presented below will constitute one of the analysis tools that will be used in this thesis.
Definition:

Multimedia is the presentation of material using both words and pictures. The term “words” refers to information presented in verbal form such as spoken or written text. The term “pictures” includes: graphics, diagrams, photos, animations and videos (Mayer, 2001).

Mental processes:

According to the MLT, the learner performs three main cognitive processes during learning session. The first one consists in the selection of information from the multimedia presentation. In the case of verbal information (printed text or auditory material), the learner selects chunks of information and collects a verbal-base. On the other hand, if the information is presented in visual form, the learner develops an image base. The second cognitive process consists in organizing the verbal base and the visual base. In the first case, the process leads to verbally-based model of a system (or concept or “reality”), while in the later, a visually-based model is formed. These two processes usually occur independently from each other, but in some cases such as when processing an image containing a printed text, the processing occur in both channels simultaneously as explained below (see Model). During the third process, the learner integrates the two models to form a coherent model of the system (concepts or “reality”) with each other and links it to other sources of knowledge. This process is the most important one because the knowledge is derived and integrated with other knowledge.

The MLT Model:

The Figure 3.3 below is representation of the MLT. The figure shows two distinct channels: the verbal channel and the visual channel. Multimedia presentations that include words and pictures are simultaneously processed in these channels.

Pictures without text are processed solely in the visual channel. First, the learner perceives the images, and then stores them in visual sensory memory. A selection process is carried before the information is sent to the working memory. The information received is then organized into pictorial model, which will be integrated with the verbal model and other sources of knowledge.

Verbal models are built in two different ways. If the words in the presentations are presented as narrations, the process is very similar to the image processing steps taking place in visual channel. First, relevant information is admitted into an auditory sensory memory, and then selection is carried out. When the admitted words reach the working memory, they are converted into verbal representations, which will be integrated with other knowledge and the visual model.

In the case of printed words, the process differs due to the dual nature of this information. The images of texts are first sent to the visual channel where the selection process takes place. Selected words are then conveyed to the working memory where they are converted into verbal representation. The information resulting from this process is sent to the verbal channel where the processing continues as described above.
**Active Learning:**

Learning is likely to be more effective if the learners are actively engaged with the learning material. Active learning refers to two concepts: behavioural activity and cognitive activity. The first one refers to physical activity while the second refers to the mental awareness and activity. “Research on learning shows that meaningful learning depends on the learner’s cognitive activity during learning rather than on the learner’s behavioural activity during learning.” (Mayer, 2001, p. 18). Mayer (2001) notes that meaningful learning can occur with multimedia messages that promote cognitive activity even if behavioural activity is low.

![Figure 3.1 Cognitive Theory of Multimedia Learning](image)

**Principles of Multimedia Design:**

The MLT suggest five principles used to design and assess multimedia learning material (Meyer and Moreno, 1998):

1. **Multiple Representation Theory:**

   It is better to present pictures in addition to words (in text or auditory form) then to present the information only with words. The learner will construct two mental representations of the learned materials. The process of linking and integrating the verbal and visual representation is likely to result in deep understanding.

2. **Contiguity Principle:**

   According the MLT, words and pictures should be processed at the same time. Thus, students will better understand a learning material, when corresponding words and pictures are presented simultaneously rather than separated in time.

3. **Split-Attention Principle:**

   Students learn better from a words presented auditorily then if presented in text or pictorial form. There are two reasons this: the first one is that the text has to be processed by the visual channel then converted into verbal representation. The other reason is that on-screen text or animation can overload the visual information processing system.
4. **Individual Differences Principle:**

Multimedia effect, contiguity principle and split-attention differ from a learner to another. Learners with more working memory capacity, larger special ability, or more prior knowledge are likely to benefit from a packed on-screen presentations, while others would not.

5. **Coherence Principle:**

Learners can learn quickly from coherent summaries than from longer presentation of the content.

3.1.2 **Phenomenography or situated cognition:**

Phenomenography is the second theory or approach that will be used for the analysis of learning with CompEdu program. This research approach was first used by researchers at Göteborg University in order to study student learning in higher education. The methodology has induced a front of research based on the same methodology in other countries such as in the UK and Australia. The starting point of this approach is to study the learning as it occurs in its context, and based on learners’ experiences. Marton and Säljö (1976a, 1976b) have studied the way students learn from reading selected texts. They investigated what learning meant to each individual and how they proceeded in their learning. Further research showed that approaches to learning and the quality of learning can be generalized to other ways of learning. The studies resulted in a learning theory known as Situated cognition (Marton et al., 1984) or phenomenography (Kearsley, 2003). One of the main principles of this approach are: “In all investigations … whatever phenomenon or situation people encounter, we can identify a limited number of qualitatively different and logically interrelated ways in which the phenomenon or the situation is experienced or understood.” (Official web site of Phenomenography)

The object of research is the empirical study of phenomenon as they occur in their context from the perspective of people involved in the situation. Researchers focus on the way people experience the phenomena and how they understand it. The conception of phenomenon consists in delimiting its components and how they relate to each other and to the whole. This delimitation does not only apply to internal context rather it can be generalized to understand how components relate to internal and external contexts.

**Deep and Surface Learning theory:**

Marton and Säljö (1976a, 1976b, 1984) studied the reasons behind the variation of the quality of learning among university students. The basic assumption was that if the outcome of learning differs between individuals then the process followed must be different. Their conducted an experimental phenomenographical study where they distributed text students

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3 Theory into Practice Database (http://tip.psychology.org/) (01-09-2003)
and informed them that they will have to discuss them with a researcher afterwards. The conclusion of this study was that the “students who did not get “the point” failed to do so simply because they were not looking for it” (Marton and Säljö, 1984, p.39). The study followed a discovery procedure guided by a rigorous qualitative analysis. The study showed that there were two major groups. The first focused on the text itself; a sort of blind focus. The second groups were focused on author’s intention instead, and tried to re-organize the text in their own way. The difference between the learning approaches had to do with the level and depth of processing.

Deep and surface approach can also be viewed as academic personalities that are influenced by the learning environment according to Biggs (1999). This implies that there are no predefined types of students, rather the student tend to behave differently in different environments. Marton and Säljö, (1984) have shown that it is hard to predict the reaction of the learners and that students adapt their learning to fit with what they think is expected from them or suit their interests. The integration of the current theory and the MLT will be discussed in a later section.

3.1.3 Group dynamics:

Project Based Learning (PBL) is characterized by the dynamic associated with interaction between students, groups, mentors, and eventually with external people such as practicing engineers from industry. The learning groups encountered in PBL settings are less stable than teams and other work groups (Savin-Baden, 2000). These unstable groups can become a hinder for students’ effective learning. It is, therefore, necessary to understand the dynamics of groups and the possible dysfunctions that can take place during the lifetime of a working group.

There are different definitions of groups based on the aspects that researchers want to focus on. “A group consist of members having some kind of history as well as future together, continuity in their interaction, a particular task, having boundaries that are definable in relation to other groups, and that the members perceive themselves as being part of the group” (Rosander, 2003, p. 17). The important aspect in a group in this definition is that groups are constituted of more than two people working together. The characteristics of the groups are: interaction, interdependence, common goal and work together for more than a few moments. Generally, individuals exhibit a different behavior when they are in groups then when they act alone.

The most influential description of group formation stages was introduced by Tuckman (1964). He suggested a four-stage model. The first phase starts when the group members meet each other. It is named formation stage and the basic characteristic is consciousness about group relationships, and the development of tasks is a major characteristic of this stage. Individuals tend to hesitate to express openly their opinions on the tasks. This “continues until a point at which people start to become argumentative and emotional”. The phase is known as storming phase. Some conflicts of varied intensity may occur at that point. As a result of the tension in the group, the group tends to develop norms and tasks to minimize the strain. Groups that succeed to overcome the storming phase will come to an agreement on several organizational aspects and start functioning as an effective team. This is the beginning of the last phase named performing stage. In this phase, the group operates as united force where decisions are easily reached and agreed upon, and this can make the group unstable.
The model suggested by Tuckman (1964) describes the basic stages; the dynamic governing the phenomena observed in groups cannot be explained by this theory. Bion (1961) introduced the basic assumptions that can be used for analysing these aspects. Basic assumptions are emotional states experienced by individuals in groups as a consequence of being in the group not because of internal psychological states. It derives from intense emotions induced by external or internal factors to the group and that shape the group organization and the way tasks are handled. It refers also to an emotional state adopted unconsciously by the group to avoid anxiety and pain of learning experiences in which the group struggle to fulfil the requirements of the tasks and objectives while developing a distorted view of the environment (Rosander, 2003). Basic assumption modes are mostly encountered in low-performing groups. Bion (1961) differentiates between work groups state in which the groups focus on their task whereas groups functioning in the basic assumption mode acts irrationally.

Bion (1960) named the three basic assumptions states: “pairing”, “fight/flight”, and “dependence”. Pairing “refers to unconscious belief that whatever the problems are; something or someone will solve it” (Rosander, 2003, p.37). If the group act according to fight/flight, an enemy, a challenge or a threat is assumed to exist. This leads to two possible coping strategies; either to face the situation or to run away from it. Groups functioning according to dependency mode acts on the unconscious belief that the leader has the capability to solve all the problems. Thus, members underestimate their competence to handle the task, while overestimating leader’s ability and skills. In all these cases the group develop a distorted view of the surrounding environment and the requirement of the task at hand.

All groups function on these two modes. The work group focus on the tasks at hand, develop cooperation and administrative structures, keep in touch with the external environment and maintain a balance between internal and external forces in a sort of open system. The basic assumption group acts as a closed system; it develops a distorted view of the external environment and thus engages in an unconscious defence activity based on the basic assumptions unconsciously adopted.

In some cases, groups may get into condition under which negative and even destructive phenomena can occur. Groupthink is one of these phenomena that has been observed and explained by Janis (1972). It can lead the group to ignore realistic appraisal of group actions and to taking disastrous decisions. Members of such groups develop false belief about the group’s absolute power and justify their actions instead of adopting a more balanced rational thinking of alternatives. Groupthink is not a state a group actively chooses; rather it is an unconscious or un-reflected process that group get in as result of internal and external factors. The Figure 3.1 represent Janis’ groupthink model. As it can be seen, the model is divided into three parts. The antecedents’ part describes the prevailing condition before the occurrence of the omnipotent groupthink. These are divided into three types: cohesive group, organizational structural mistake, and provocative situational context. If one of more of these antecedents exist in a group or a combination of these factor will render the group vulnerable to the stimuli coming from the context in which it evolves and works. The cause that triggers the groupthink according to Janis (1972) is concurrence seeking or similar exciting factors in group’s environment. When a group is subjected to this excitement, it loses its capability to have a balanced view of the surrounding environment and it develop symptoms of some typical groupthink symptoms shown on the second column on Figure 3. 1. The result of the groupthink is a malfunctioning group that is most likely to fail in its mission or task.
The general symptoms and pre-conditions of a groupthink manifest in a defensive action towards everything that can threaten group consensus. It is followed with a distortion of the perceived reality, and inclination to take any alternative. There are three categories of symptoms: overestimation of the group capabilities, closed-mindness and pressures towards uniformity (Rosander (2003). Each one of the named categories can be divided into detailed symptoms. Granström and Stiwne (1998, cited in Rosander 2003)) developed and verified a more advanced model of groupthink by adding more psychological elements to it. In this model, highly cohesive groups engage in a competing activity undermining standards and developing a distorted conception of the environment. Groups caught in such phenomena exhibit a feeling of invulnerability and unanimity, belief in the inherent mortality of the group and other negative symptoms that lead to collision with the environment as result of irrational appreciation of alternatives and biased view of the environment.

Other groups exhibit different modes of groupthink when they depart from the working group conditions. In such case, groups’ behavioural pattern fluctuates between two modes. The new model shown on Figure 3.2 describes the symptoms of groupthink in terms of five aspect in which groupthink can manifest. The five aspects are (a) handling information, (b) handling suggestions for improvements, (c) group-esteem, (d) leadership and (e) vulnerability.
Figure 3. 2 Janis Groupthink Model (Rosander, 2003)

A. Symptoms of Groupthink

Type I: Overestimation
- Illusion of invulnerability
- Belief in inherent morality of the group
- Self-appointed mindguards

Type II: Closed-mindedness
- Collective rationalizations
- Stereotypes of out-groups

Type III: Pressure toward uniformity
- Self-censorship
- Illusion of unanimity
- Direct pressure on dissenters
- Self-appointed mindguards

B. Antecedent Conditions

B-1. Structural fault of the organization:
- Insulation of the group
- Lack of tradition of the group
- Insulation of leadership

B-2. Provocative situational context:
- High stress from external threats
- Low self-esteem temporarily induced by recent failures or excessive difficulties

C. Observable consequences

Concurrence seeking (groupthink tendency)

D. Symptoms of defective decision making

- Failure to work
- Information in hand
- Selective bias in processing
- Poor information search
- Initially rejected alternatives
- Failure to reassess
- Predicted choice
- Failure to examine risks of alternatives
- Incomplete survey of objectives
- Incomplete analysis of alternatives

E. Low probability of successful outcome

Ancestral conditions

A. A cohesive group
The new model suggests two types of groupthink: an omnipotent groupthink and depressive groupthink. The model operationalized by Rosander (2003) is shown on Figure 3.2. Three factors are named in this model: morale vs. demoralization, sense of autonomy vs. lack of control, and self-efficiency vs. vulnerability. This model shows the two types of groupthink that can occur during the lifetime of working groups. In contrast to Janis’ model (1972), this model has less detailed information on the antecedents and the causes of groupthink. It, nevertheless, present us with a general model for groupthink (or groupthink) that can be applied in understanding the different dysfunctions that can occur in groups.

**Morale vs. Demoralization:** The former is related to the exhibited in the overconfidence in group abilities, capacity and efficiency. The other side of continuum expresses the lack of confidence in the group’s capabilities. This manifests in the form of collective satisfaction, feeling of insignificance, despair and hopelessness.

**Sense of autonomy vs. lack of control:** Sense of autonomy is the feeling of ones’ ability to always do right and to be convinced that one is in control of one’s fate. Group members show support to each other. On the other hand, the lack of control expresses the belief that the group can achieve nothing. People are ready to accept external criticism and the group readiness to receive expect the leader or even an external person to do everything that they consider impossible.

**Self-sufficiency vs. Vulnerability:** The former refers to the collective belief about the superiority of the group compared to other groups. The group thus rejects any attempt to establish contact with the external environment. Vulnerability is expressed in the attitude to of readiness to accept help from the outside to develop or survive. The group believes in their lack of resource and capacity to face the problems.

![Figure 3.3 Bipolar Groupthink (based on Rosander (2003))](image-url)
3.2 Analysis Methods:

The analysis took difference strategies depending on the data available and the complexity of the phenomenon for which the evidence was collected. Key articles and documents were analysed using a variety of techniques. Some elements of Discourse Analysis were used to understand some of documents. Key terms were collected then crossexamined the meaning and usage of these in the documents. In addition to this, statistics on keywords were collected in order to comprehend the dimensions of the message that the authors of documents were intending to convey. Another technique used in analysing the documents is to isolate all ideas referring to the subjects of interest and to organize them in terms of categories that emerge from the analysis.

The information from questionnaires consisting of two different forms; the measurable data was organised in the form of graphics and tables. The second form consisted of comments and free text, which were classified into categories that emerged from the analysis process. After that, these comments were organised into the form of graphics in tables.

Interviews were treated similarly to documents and comments. First, a review of all interviews resulted in classification of the type of ideas and opinions hold by the students. These were later gathered and classified into categories that emerged from the analysis process. Longer discussions with students were analysed using discourse analysis techniques.

Combining the theories:

In the cases studies investigated a number of theories will be needed for the analysis. Each of these theories was selected to suit the specific focus of different part of the study and the types of data available. A brief introduction on how the combination of theories will be presented below. The definitions of some terms used in this report are introduced.

Views: this term refers to what the individual knows or believes about the educational method, what he or she can benefit from it, and how to use it. An example of this is how a user views the role of simulations and how to use them for learning.

Actual Use: this term refers to how the individual go about to achieve his or her goals based on how he or she views the particular learning tool or method. We assume that individuals act according to their underlying views. An example of this is how a student actually uses simulation program for learning.

The learning theories will be combined as follows. Learning occurs in a given context. For the purpose of analysis, this context will be divided into two sub-contexts or focus. The first one includes the student and the computer program. The focus of the study will be on how the user perceives the learning program. In other words, since users may differ on their focus and attention (to either visual or verbal parts of the multimedia presentation), it is suggested to use the MLT model in order to analyse the cognition aspect of the learning process. The MLT gives a general overview on the process using the terms “active learning” but it does not explain how and why student chose to interact with the material in a particular way or why the users follows a certain learning trajectory. The integration of
the small steps of learning trajectories are not well developed in the MLT theory and for the analysis part these will be replaced by a phenomenographic approach.

The second context refers to quality and depth of students learning. At this level of focus, the MLT theory seems not be suited to explain why a certain student learns in different way from another one under similar conditions or situation. Marton and Säljö (1976a, 1976b) found that students have different learning personalities. They may adopt a different learning personality depending on context of learning (see for example (Bigg, 1999)). The deep and learning theory seem, therefore, more appropriate for the focus in this particular context of the study.

As for the second case, the analysis will be performed using the concept of views on the learners’ position within the group on how this may affect the way he or she perceives learning experiences in PBL. Furthermore, an analysis on how these views affect the behaviour and activity of learners will be explained. Group theory will be combined with the groupthink model suggested by Rosander (2003) in order to explain complex phenomena that may occur in groups’ setting under certain conditions.
4 CASE STUDY ONE: LEARNING WITH COMPEDU PROGRAM

In this chapter the findings related to students’ learning with CompEdu are presented followed by an analysis of the data available. A discussion of the result is carried out, thereafter.

4.1 Results:

CompEdu is probably the most comprehensive learning program in Heat and Power Technology in the academic world. The program uses several learning tools such as simulations, animations, lecture notes, videos etc. All these tools are built around the basic element consisting in the tutorial. A range of support tools such as glossary, a navigation menu etc. organized as a tool bar and are accessible from all the tutorials.

The tutorials are presented and organized in the form of books and these are classified according to specializations named by the developers as “shelves”. There are five specializations: Turbomachines, Measurement Techniques, Aeroelasticity, Combustion and Heat and Power Cycles. The Figure 4.1 represents the main study room.

This study will focus on the elements that have been found to play an important role in learning with CompEdu. A typical tutorial consists of 10-15 pages containing text, pictures, videos, hypertext, and animations. Each of these begins with a statement of learning objectives and it is concluded with a summary.

The tutorials (see Figure 4.2) are usually designed as a self-standing element with a short text, hypertext (i.e. Popup), images, animations, video and other tools. The text is presented as short statements summarizing the content of the studied topic. It is important to note that CompEdu tutorials have a non-linear structure that does not usually follow the established structure of corresponding topics presented in the classical textbooks in the field.
Lecture notes, which are usually more developed than tutorials, are often included as parts of these. They are accessible from the two locations in the program: from the menu and from within the tutorial. They are displayed in an external window as shown on Figure 4.3.

Simulation is another tool that will be analysed in this study. There are presently about 20 simulations included in CompEdu each of them is dedicated to one of the five subjects covered. The simulations vary from one to the other in terms of technical content, pedagogical content and graphical design (see Figure 4.4). Four simulations have been described by Fransson et al. (2003, a). A review of these simulations revealed that students liked learning with the simulations and this helped them grasp the physical meaning of the theory presented in the tutorials. However, the studies presented did not look onto the way students use the simulations for learning. This will be the focus of the present study.
CompEdu also includes digital videos that can be accessed from within the tutorial or from the main room. Figure 4.5 shows a video accessed from within the tutorial.

The hypertext or more generally hypermedia constitutes another part of the learning material included. Every page may contain a number of hypertexts (see Figure 4.6). These also may contain several pages organized as sequence of pages with additional information. The size of the hypertext varies from one line to several paragraphs. It is important to note that a popup may cover a large portion of the screen as shown in the Figure 4.6.
A calculation exercise is presented in the Figure 4.7: a, b. Instructions are accessible through the guide shown in the lower left part of Figure 4.7: a, b. Users are asked to solve a classical exercise and are given the possibility to buy hints as shown in Figure 4.7: b. In that case, students’ score, shown on the top right corner of the Figure 4.7: a, will decrease based on the number of hints bought. Users can also view the complete solution in external file in PDF format.

Before analysing the platform, it is necessary to review the developers’ views on the objectives and aims. The project developers published a number of papers about the program. The key article was published in 2000 and it states the aims and objectives and philosophy behind the program.

The publicly stated objectives of the platform are as follows:

“The main objective of the model presented is to … establish a comprehensive combined learning and teaching tool … The secondary objective is to present a tool which can be used as an international platform for a global learning space.” (Fransson et al., 2000, p. 595)

The developers use the term “platform” for the CompEdu program. It is noticeable that this term is used in a variety of ways in this paper. It is, therefore, important to review all the
meanings in order to understand the underlying objectives, principles and assumptions that guided the development of CompEdu. The term “platform” is used to mean three things:

1. The program that connects the different learning methods.

2. The set of learning tools themselves

3. A proposal for an international collaboration between teachers in heat and power technology to develop learning materials and tools

It is also important to understand the developers’ view on students’ learning:

“Teachers often enhance the teaching with illustrations using these media, and then the students are expected to grasp the full implications of the shown material immediately, as they do not have the possibility to repeat the experience at their own learning speed (mostly while studying for the exam!). Similar with laboratory exercises and study visits. These very often pass by the students as a nice but not very exciting experience in which the students often copy material from colleagues to get it over with as soon as possible.” (Fransson et al., 2000, p. 596)

The authors also wrote:

“Many attempts towards using computers in education have been performed …. Almost all have failed as the students have not been as enthusiastic as the researcher/teacher was. The main reason for this lack of enthusiasm from the students can, the present authors believe, probably be attributed to the fact that the students are very goal-oriented in their studies. However, often this goal (=pass the exam) is not the same as the teacher’s goal (=learn the subject as well as possible).” (Fransson et al., 2000, p. 601)

Evidence from the paper suggests that students are viewed rather lacking interest in learning; and that they usually have objectives different from teachers’. These seem to be passing exams, as much as it is possible, as the author’s statements seem to suggest. Moreover, the failure of educational programs was partly attributed to the lack of enthusiasm of students. The solution according to the authors is to develop an educational program like CompEdu in a way that helps students learn and assess their knowledge:

“The present platform is established to connect all the essential ingredients into a linked package so that the students see the connection between all the different parts of the curriculum and the knowledge to be obtained (i.e. how to pass the exam).” (Fransson et al., 2000, p. 601)

It is noticeable, however, that the authors view learning, as it can be interpreted from the paper, is an activity that occurs in the presence of a large amount of learning tools without saying how to combine the different tools. Students are expected to grasp the learning material in more or less independently from the way it is presented. The analysis of paper also suggests that students are expected to use the program or the learning material in the
way that the designer seem to have intended it since they hold a clear view on how to use each individual tools (Fransson et al., 2000).

The following table shows the constituent of CompEdu version 2.25:

<table>
<thead>
<tr>
<th>Shelf</th>
<th>Tutorial</th>
<th>Pdf6</th>
<th>Quiz</th>
<th>Exercise</th>
<th>Simulations</th>
<th>Video</th>
<th>Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>39</td>
<td>5</td>
<td>15</td>
<td>4</td>
<td>23</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td>11</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td>1</td>
<td>2</td>
<td>15</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>10</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>33</td>
<td>31</td>
<td>26</td>
<td>49</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.1 Learning tools contained in CompEdu

The data showed that the students did not know or use many of the learning tools. They usually mainly use the tutorial and the simulations. This can be explained by the fact that tutorials constitute the major part of the program. An additional explanation is that students probably could not find the tools in all tutorials; and thus they stopped looking for exercises, quizzes or simulations. This is because many of the tutorials do not include exercises and simulations. In other words, it is a situation that they ended up in is a result of the learning trajectory they followed, and it is not easy to get out of it unless the program is complete. However, the old users will always be affected by the way they learned to use the CompEdu program the first time no matter how much new material is included.

The interviews showed that there are two types of users. The first ones are students using CompEdu as a compulsory literature for courses. The second one is the user who chose CompEdu among a range of other learning tools. The first category is also divided into two sub-categories: the students who do the minimum in order to pass the exam and another category who spend more time in learning and who do not stop at the information provided by the program.

The categories are as follows:

**Category 1:** Users who are bound to use CompEdu as a part of the course material

**Sub-category 1.1:** Learning in order to pass the exam

This category is illustrated in the following quote:

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5 It is important to note that the version analysed in this study is 2.2 g as it was in September 2003.

6 PDF refers to the lecture notes included in the program as PDF files.
“Do you read the introductory pages?

‘I read it one time. It’s very general and no need for my exam… I skip the objectives because if I read I will focus my memory. I don’t like this.

Do you read ‘this-you-must-know’?’

‘Sometimes when I read them I get confused and I will think I don’t know. When I am on the exam I concentrate but when I am reading I’m trying not to concentrate otherwise I would think that I don’t know anything.’” (Student 3)

Sub-category 1.2: Common learners

“I start from the beginning then I look into the objectives and look quickly in the chapter. If I need some short information I look into CompEdu but if need more information I look into the pdf files; then the book. When I read CompEdu I go through the whole pages then I read the “this you must know … CompEdu gives just short information and does not give details and you need background information. I studied Aeroelasticity last time; I read the theory, which was very short, then, the case study, then, the pdf file. I usually start with CompEdu in order to get a sort of overview.” (Student 2)

Category 2: Users who selected CompEdu among other learning tools

“How did you go about studying?

‘I try to go quite quick through the introduction page and things like that”

… And the chapters’ objectives?

‘I think it’s more for students studying a course or something if you just want to learn by yourself you may as well just go directly. I know myself what I want to learn so what I do is I read quickly the main slides if there is something I know from before or if there is something I find interesting I just go to the next slide. If you’re taking a course it’s more the material you should know. It’s not only what you would like to know, but what you should know.’” (Student 6)

As it has been noticed, the views of the development team were not exactly as the actual findings about CompEdu users’. The model suggested with students who had different learning objectives than teachers’ and who sometimes do the minimum for learning. Indeed such type of students does exist as a minority, but since passing exams is not as dramatic, as it is believed to be most of the students would not centre their interest on that specific pedagogical event of the course. There are many other motivation factors that drive the learners to learn, and that could be used to trigger learners’ interest.

Interviews have shown that the students mainly use the tutorials, simulations and videos. It has also been noticed that many of them did not know about the lecture notes or about the other tools. The Table 4.1 shows that the tutorials constitute the major part of CompEdu, and that exercises and quizzes are relatively fewer. The same applies for lecture notes and videos. It is, therefore, understandable that students developed this distorted view about the content of CompEdu.

The data shows that students were not interested in using the exercises contained in CompEdu. The reason they mentioned is the lack of interactivity. The students interviewed view the exercises as a something one does on paper then plug in the results into CompEdu.
and get a feedback. Thus, there is a lot of effort to solve the exercise that has to be done by hand before interacting with the program and get simple feedback. Because students view computerized learning as an interactive activity with a program; they therefore may feel the uselessness of such tool that contradict their views of what computerized education should be (i.e. a meaningful and productive interactive process). This results in loss of motivation and consequently they prefer not to use these exercises. One could argue that buying hints may consist in a form of interactivity; however, the interviews showed that this does not attract the intention of students. This feature does not work because the grades used in CompEdu are fictive and thus meaningless, and the potential benefit of getting a hint is low if compared with the manual effort they will have to do for solving the exercise before obtaining a meagre feedback. It is probable that students would be much more motivated to solve an exercise correctly than to think in term of points especially in the learning phase. It can also be said that if the boredom associated in using the exercise is higher than in solving textbooks’ exercises, then students will not be very interested in using these exercises. Students’ opinions and comments are expressed in the following quotes:

“I never used the calculation exercises. I know there is a formula and you have to put the result and see. For me I don’t use it.” (Student 1)

Another student stated:

“Do you use the calculation exercises?

‘It really depends on the exercise but usually I don’t like them too much. … If I have to use a calculator I don’t like it. But if I can get some dialog then I like it.’” (Student 3)

As explained before, it is natural that if the boredom associated with using a particular tool is not justified in terms of potential benefit, then the user will ignore the learning tool especially if the program offers many other learning tools. In order to make students interested in using any of the tools available and in particular the exercises, one has to design them with the idea to provide students with a concrete benefit, such as a the application of knowledge and with high levels of meaningful interactivity. It is also important to consider diverse type of benefits and incentives, than only reward in the form of grades, which are but one form of reward that may trigger students to do some effort. This is a negative strategy since it is an external motivator whose effects exist only as long as the exam is expected to be taken. Instead, intrinsic motivators should be sought and used. This can take different forms such as inspiring students, awakening their intellectual curiosity, engaging them in interesting applications of their knowledge etc.

The developers highly value the simulations included in CompEdu. Students generally like to use these tools, and all the students interviewed recognized and used at least one simulation, which points to their interest in learning with these tools. The investigation showed that none of them read the instructions on how to use them. Students usually start with clicking randomly on the display and searching for the parameters that can be controlled. If they succeed to find some of these, they start varying them and look for the effects and they look for more parameters to change. However, as noticed, they often end up in a messy situation especially if the simulation does not handle calculations errors or if it has some bugs. They, then, become confused and start looking for the help menu or simply quit the simulation and start it again.

“How do you use simulations?
‘I click … I have to see how the response of the program and I want to know which are the features that I can control.’

If you were presented with such a simulation would you follow the guide?

‘The way that I see this simulation is just [that] this simulation creates interest; what’s happening? And then you may decide ok I want to go in there [the student shows a component on the screen]. What means that? ok I understand what’s on there!’” (Student 7)

The design team included a pedagogical agent represented by a famous scientist to help guide students in using the simulation. The agent presents instructions on the objectives of the simulation, different suggested steps, and other information on how to perform the simulation:

“In each of these simulations, a "guide" gives advice to the students of how to use the simulation in the most effective way. This guide “simulates” the teacher during the student's home studies, but is not intended to ever replace the interaction with the teacher during normal lectures.” (Fransson et al., 2000, p. 596)

As it can be noted, the guide is supposed to function as dialogue partner for the user. However, the interviews and observations of students using these simulations showed that none of them noticed the presence of the guide or the guiding messages displayed.

“Why didn’t you notice the guide?

‘The picture is not informative. There are no colors, even if I noticed I would not think about it. I was focusing on the simulation itself I tried to get it started … I tried to click everywhere.” (Student 3)

Other students made other assumptions regarding the presence of the guide:

“I think it was just an icon to make it look nice. You can not assume there is something behind.” (Student 2)

It is interesting to review students view on why and how designers uses schematic or decoration on the learning environment. It is not easy to understand the reasons behind this view, however. It might be that they noticed similar icons with no apparent function on the one shown on the tutorials.

Figure 4. 8 Simulation in Heat and Power cycles
A review of the simulations available showed that many of them are well designed in terms of screen design and graphical interface, except for the help menus and the pedagogical agents. This applies, in particular, to the simulations on heat and power cycles shown in the Figure 4.8. They are easy to understand and use. The results of varying parameters are presented on a graphic. So the user gets feedback on each action taken immediately and in meaningful form. The only weakness in these simulations is that they fail to guide students’ query towards more meaningful activities due to two reasons. First students preconceived views on how to use a simulation. The second reason is that the guided messages were, as mentioned previously, ignored by the user, the help functions provided are hidden and students were unable to find them even when they needed them. One would tend to agree that the problem with these simulations is not inherent only to the design rather to students’ use of them.

As mentioned by students, simulations are there to trigger students’ interest and let him or her explore the effect of different parameters, which means that, from their perspective, the presence of guided messages is superfluous, and the designer implicitly takes some freedom of learning from the user. This may explain why the students ignore the guided messages and the agent. But it might also be that some of these messages are simply too detailed, as noted in one of the simulations where 17 messages were displayed. There is not doubt that such a large number of guided messages would make student avoid following agent’s instructions because this will take the control over his or her learning and this results in loss of motivation in using the simulation.

4.2 Analysis:

An overview of CompEdu platform shows that it is an educational program developed with an instructivist approach (Allessi and Trolip, 2001) and in particular the tutorials, calculation exercises and quizzes. The designers have attempted to develop a comprehensive learning program through gathering a large amount of learning material and tools of different sort and linking them through tutorials. This was a direct result of the instructivist view on learning. According the developers’ stated views reflected by the papers written about program, the presence of learning materials and tools in considerable amounts necessarily leads to enhanced learning. Nevertheless, the platform has some constructivist tolls such as simulations (Allessi and Trolip, 2001) although the design does not implement some of its important principles such as collaborative learning.

Figure 4.9 CompEdu page 1
The most important aspects in learning is being able to understand the small elements of information presented, and being able to connect it to learner’s knowledge-base and the previous knowledge one has been assimilated during the learning session Bruner (1966). Presenting a large amount of information or tools in a non conventional structure, such as the one used in textbooks in the field, will make the advanced learner confused or loose interest in learning with the program since he or she will find a lot of redundant or un-adequately organized information or tools that requires them to make sense of the whole material. Since the amount of material in CompEdu is very large, the difficulty of restructuring this information is high compared to the expected gain; and thus this will make this category of learners avoid using the program unless it is part of compulsory material for a course or an exam.

As for the less advanced or average students, they may not be able to see the connection between the large amount of tools and material, which is not good for learning. In the best case, these students will try to understand the material, at the best of their capacity, but what exactly will be assimilated and how this would be connected to the previous knowledge is not always clear. In any case, these students may and will most probably pass the exam on the basis of the amount of information that they can show on the exam paper. The conclusion is that of course students can learn with CompEdu or any other program or book that has some kind of intelligent design or structure behind, but the concern is how effective and deep is that learning? Would learners prefer to use such a program or rely on books? And how intellectually disagreeable or pleasant the whole learning experience is? These are interesting question to investigate further.

Generally, it can be said that CompEdu follows the principles of MLT except on some aspects such the absence of verbal explanation. As the Table 4.1 indicates, only two chapters presently have this capability. In addition to that designers sometimes
overestimate users’ capability to handle a large amount of visual information. The Figures 4.3 and 4.4 shows two overcrowded screens. This was probably the result of economy in the size of tutorial, where the developer tries to limit the length of the chapter by putting more information on the same page even though it may, in some cases, affect the structure of the screens. This is in fact one of the design rules widely used by the CompEdu design team and the process is repeated until the number of page is minimal. It is important to note that there are no standard guidelines for that process. One of students expressed his opinion on the structure of the learning material:

“Sometimes I find that the slides are a little bit difficult to get a picture of what is going on” (Student 6)

Although it is very hard to make a general judgment on the platform due to the large amount of material with varying quality, it is necessary to take some examples based on the most common weaknesses. One of these is the lack of logical structure in tutorials’ pages. The Figure 4.9, 4.10 and 4.11, illustrates this problem. The program uses short sentences and bullets. It in fact reminds more of a slide show presentation, in which the little information presented visually is completed with verbal explanations. Material designed for self-learning should be logically structured sufficient for effective self-learning. The presentation structure used in CompEdu would be very desirable for experts who already know all the basics and most of the advanced knowledge in their field, and could benefit from a short summary. However, for learners it would be difficult to assimilate the structure of the material since they do not already know or understand all the information presented. Moreover, since the way tutorial pages are structured is not always conform with textbooks; it would be difficult for students to assimilate the knowledge.

Since the program was primarily intended for teaching and self-learning, as publicly stated by the developers, the effectiveness of learning is questionable at least for the self-learning students. This is because teachers’ verbal comments and explanations of the tutorial pages will provide a pattern and additional hints on the structure that students can follow. Thus, they will be able to continue learning with CompEdu on their own. But, if the learners are to learn totally by themselves or that the teachers’ time is limited, then those tutorials that do not follow the MLT guidelines, would most probably result in poor learning. In the best cases, students would learn a number of facts and formulas, but without knowing how to connect it to previous knowledge. This means that this knowledge cannot be transferred to another contexts and it is not integrated into the permanent knowledge structures in students’ brains.

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7 Considering students’ relatively limited cognitive capacity in comparison with the large amount of information presented (see for example Dillon and Gabbard (1998))
Figure 4. 11 Fragment of text on CompEdu page

The Figures 4.9, 4.10 and 4.11 show typical CompEdu pages. As it can be seen, the text is short and the grammatical rules are not fully respected. The sentences are cut in inappropriate places and bullets or other symbols were used instead of punctuation. Moreover, the writer assumes, in many cases (as in Figure 4.9 and 4.10), that students know a lot of background information and would be able to follow the tutorial. However, the most common reaction of a learner is in short range is to view this as an odd mistake. Therefore, they have to and, at least some of them, will put more effort in making sense of fragments of information. Of course this would have been a very interesting learning experience if it was meant to be so, and designed in way to trigger students’ reflection on how to integrate and structure their knowledge in new ways. However, since this was not intended by the designers, it can add more confusion to the new learner who does not have the time to look for a hidden meaning or structure to help him or her understand or remember the material to learn. The long-range effect on frequent CompEdu users can be more problematic; it can lead them to adopt this way of structuring the material despite its unsuitability for rich learning. These users will simply be lead to opt for a surface learning (Marton et al, 1984) by ignoring the discontinuity in logical structure of the learning material presented and trying to remember, as best as they can, the information contained in CompEdu. This is of course negative because it gives the impression of learning to both the learner and the teacher, but at the same time the material learnt is not kept in memory for a long time. And many of the learners may not be able to remember its structure immediately when they are confronted with the same material because the material has simply not been assimilated. One of the students noted this:

“It’s not so difficult [i.e. to learn] but from pedagogical point of view it’s not really very useful. It’s very simple, so you can learn very easy and you can forget also.” (Student 4)

Similarly, the tutorials’ pages do not follow the standard way for organizing the material in textbooks consisting in interlinked logical steps and agreed-upon classifications etc. This is illustrated in the Figure 4.9 for example. The page shown contains an animation and a set of information with several hyperlinks. On this page also, the grammar is not respected as explained previously for other figures. It would have been interesting if all the chapters adopted some standard hierarchical classification such as the one used in textbooks, which
would have been very beneficial for frequent learners who would be able to integrate and build upon new knowledge based on their previous interaction with CompEdu. On the same Figure, one can see that information is spread around the central animation for graphical design reasons, which does not help the learner to differentiate between important information and the less important parts. This will lead to the same behaviour among learners; quick and surface learning but that does not last longer than the exam, in the best cases. But would student have behaved in the same way if they were provided with a program that is organized in way that allows new and old learners to build upon their knowledge instead of building and re-building constantly new structures of knowledge because the standard structured of textbooks is not used? The answer is no, it is the designers’ fault that probably many students would end up in such situation that the only choice available is to follow the existing material and provide it on the day of the exam exactly as it has been taken from the learning material perhaps not even understood, and then perhaps to do ones best to forget it as soon as the exam is taken so that not to keep non useful information in memory. Nevertheless, it is important to note that deep learners (Marton et al., 1984) are able to re-structure the material according to their way or adapt it to the established standard structure of textbooks in the field. Such a case will be presented below.

The problem related to the bad structuring of pages applies for a limited number of pages contained in the program. Thus, given the large amount of material and the diversity of interests it would rather be relatively rare that a person ends up in the situation presented above. Moreover, what has been said regarding the effects of bad structure greatly affect students’ learning if the program is used as the main learning medium and in particular during for self-learning.

The interviews showed that most learners, especially those with interest in learning, use the platform intelligently in their quest for information and knowledge. The program is then viewed as a tool with a great potential that help them acquiring an overview on a certain field. These students uses the tutorials as an advanced organizer that help them gather key words, basic understanding of certain phenomena, and also a list of references. Some learner also chose to run the simulation in order to get a more tangible understanding of theoretical formula, power cycle or other phenomena. An illustrative example of this type of CompEdu users is shown bellow:

“First I read the book then I read CompEdu and when I prepare for the exam it helps me to remember and helps me to structure and organize in my head. But if I'm looking for information I look first in CompEdu because it easier to find it. If I have time I’ll read CompEdu, then the book then CompEdu again.” (Student 3)

For this student, CompEdu plays a double role. First it helps him to get an overview of the learning material and he can easily read and assimilate more advanced material contained in the book and prepare for exams; and after having read the book, he prefers to read CompEdu again as sort of memory aid. This is probably because that student may not be able to judge on his own what material is important for the exam or that the complexity of the book renders it unusable for structuring the information during a short course. Therefore, CompEdu is good in that aspect and this has been also confirmed by another student:

“Probably I’ll combine [i.e. CompEdu and the textbook]. Maybe it’s better to use CompEdu because the information is very short and brief. And if there is more
information available in the book or more detailed explanation of some topic it would be useful to go and read the book but first of all I think it’s good to look through the chapter [i.e. in CompEdu] and see what kind of information is available” (Student 4)

Again in this case, the information provided by CompEdu alone is short. Based on students’ comments, learning from CompEdu is easy but can easily be forgotten. This comment implies that the information provided cannot be well integrated into a students’ knowledge structure. Learning occurs by adding new knowledge to the one already assimilated by the learners from previous learning experiences Allessi and Trollip (2001). If a learner does not have a rich knowledge-base in a certain field, it is usually difficult to learn from fragments of information or brief statements.

As mentioned previously, CompEdu users can be divided into two types similar to the ones found by Marton and Säljö (1976a, 1976b). Although the original names (i.e. Deep and surface learning) refer to the depth of the analysis that was carried out on a text, the similarity in using an educational program can be drawn. The first category was already mentioned previously. These students usually focus on the material presented in CompEdu program and try to learn as much as possible from it, without going beyond its shallow level. This category is similar to the surface learners described by Marton et al. (1984).

The second category of learners is exemplified by the following discussion:

“So you don’t usually access the popups you already know?

No, no! Sometimes I repeat … because maybe when I see it the first time I maybe did not get the complete understanding of what it is [about] but if I repeat two, three times I understand okay yes! That’s the point! … for example [student 4 shows a sequence of the video on Tacoma bridge] do you see this [line]? It’s almost in the centre of the video; this line is not [moving] … that I didn’t know the first time.

How do you usually study with CompEdu?

It depends actually … if I want to get a more general knowledge[…] then I use CompEdu. But, if I want to go into the details of the words and the precise definition of the words also mathematical problems then I prefer the book. … It actually depends on what is problem … [or] what I am looking not. If I am looking for something […] in detail … then I use everything; CompEdu on the screen, PDF files and the books also ...

Simultaneously?

Yes! Simultaneously … for example if I have some problem or I didn’t get the definition from [CompEdu] or didn’t understand what is there, then I just go […] to another book…

How do you use the existing tools?

Usually is use the theory chapters 70-80% … then if I want to see things in the detail, I’ll go through the PDF files, some of the simulations and some other [tools]. Videos and simulations come in the third rank. First CompEdu, then PDF files, then videos and simulations. Maybe in some cases I’ll refer to videos first along with this CompEdu.” (Student 8)

As it can be noted this is a more complex learning strategy than the previous ones. It does reflect a deep learning using the program as one of the main source of information. However, it is important to note that the learning here is a result of intense and planned
activity of the student not a result of the presence of learning tools themselves. As it can be seen, the learning is not at all sequential as it is the case with surface learners mentioned above (See student 3 for example). Student 8 does not stop at the information given, rather he crosscheck the information and the explanations provided in the tutorial against other tools such as the simulations, videos and books. In that way, the student tries to find explanations on his own and do not accept the conclusions presented in the program. This is illustrated in the case of the video where pointed to a central line of a bridge that did not move (see the statements of student 8 above). In that case, the popup did not provide information on how to use that video, but the learning occurred as a result of active engagement of Student 8 with video and other tools.

Deep learners do not take the explanations presented literally and they try to combine the information given in order to derive existing knowledge or even new knowledge that is not contained in CompEdu. Another important aspect related to this case is that it reflects a typical constructivist view on learning where the learner is not expected to learn a large amount of information that they give back to the teachers on the exam. Rather it is an aware process of negotiating meaning, by crosschecking information, inventing a task consisting in explaining the video is this case, and to guides ones discovery of new knowledge that did not exist in an explicit form. This also shows that the deep approach also exists and can be generalized to other learning settings such as multimedia education.

4.3 Summary and Conclusions

This study has contributed to show the existence of different ways of learning with the same multimedia tools. Some learners opt for simple and effective way to prepare for the exam. These students would mainly rely on the CompEdu tools, which are organized in way that allows this category to learn quickly what they need to know. The second type of learners is interested in more than the exam. This category showed a more complex way of using the program, which consists in combining it with other materials and tools. And finally, this study found a last category consisting in learners who freely chose to use CompEdu for learning. This category can be very innovative in its way of learning and uses the program in combination with several other tools.

The other finding of this study showed that students view on a certain tool might hinder them from using it in original ways. The example is the calculation exercise, which despite different techniques used by the developers to engage students; they could not succeed convincing the users to use them. As explained previously, the reason is that users had a strong view on how should a multimedia learning tool be used (i.e. meaningful interactivity).

As for simulations it has been shown that users do not wish to follow guidelines or pedagogical agent unless they get stuck in a problem. But even in such cases, some would opt to continue they discovery of the simulation after restarting it. This attitude is also a result of strong belief on what simulation is and how one learns with it. The users are not willing to change their strong views on how to learn with simulations at least for those simulations that are relatively easy to learn.
5 CASE STUDY TWO: GROUP DYNAMICS IN A PBL COURSE

In this chapter the main findings related to the PBL course are presented. These are then analysed using different methods. A discussion of the result and analysis is carried out, thereafter. The major finding and recommendation will be presented in the summary.

5.1 Results:

The PBL project for the considered year consisted in the modification of an existing power plant. Students were requested to analyse the implication of introducing a number of modifications including: adding a new boiler, replacement of a set of gas turbines, and introduction of a new heat pump. The studies are both technical and economical. Students have to use PROSIM\(^8\), a simulation program for heat and power cycles for the first two tasks (i.e. the introduction of the boiler and the gas turbine). With regard to the economical part, students were requested to select the method that best suit the problem at hand. The Figure 5.1 below shows the original power plant.

![Figure 5.1 Current Power Plant](image)

Mentors suggested to students to divide themselves into three groups. The first one, formed of 7 members, collects and organizes the data. The second group (or PROSIM group) is specialised in simulation with PROSIM. This group has 8 members. The third group formed of 8 members works independently from the two other groups and its task consists in introducing a new heat pump. The project is divided into two phases.

\(^8\) The students actually used Ariane\(^{TM}\) power plant optimization simulation software from Prosim ([http://www.prosim.net/](http://www.prosim.net/)) (2005-02-23). However, due to practical considerations the software will called PROSIM in accordance with the name students used during the interviews.
Project leaders were selected during the kick-off meeting organized on January 16th 2003. The main project leader was selected after a short discussion between students. All the students accepted him due to his experience and personality. In turn, sub-groups’ leaders were selected during separate meetings. Due to the difficulty to agree upon a specific candidate, students agreed to select a subgroup leader by chance. The students were informed that new leaders will be selected for the second and final phase of the project.

The tasks performed during phase 1 were as follows: gathering data, building a simulation model of the current power plant, building other simulation models for the modifications, and suggesting a variety of ways of introducing the new heat pump. The different tasks of the PROSIM group are summarized in the Table 5.1:

<table>
<thead>
<tr>
<th>Model No. (Grp. 2)</th>
<th>Description</th>
<th>Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>Current power plant</td>
<td>1</td>
</tr>
<tr>
<td>Model 2</td>
<td>Incorporating boiler 4 without new turbine</td>
<td>3</td>
</tr>
<tr>
<td>Model 3</td>
<td>Incorporating boiler 4 with new turbine replacing turbine set G1 to G3</td>
<td>10</td>
</tr>
<tr>
<td>Model 4</td>
<td>Incorporation of a new turbine for boiler 4</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 5.1 PROSIM models

The PROSIM Group presented 17 models during the first phase as shown in the Table 5.1. It is important to note that the model for the current plant was not satisfactory as it is shown in the Table 5.2. Students calculated a deviation of about 17% of heat production from the results provided by the manufacturer of gasturbine 1. During the Design Review Team, they explained that the divergence is due to the lack of data points in the cycle and also the difficulty of modelling losses in the PROSIM program.

<table>
<thead>
<tr>
<th>Turbine</th>
<th>Measured data, Hässelby set 1</th>
<th>Data from PROSIM model</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MW, heat</td>
<td>MW, el</td>
<td>MW, heat</td>
</tr>
<tr>
<td>G1</td>
<td>55,5</td>
<td>26,7</td>
<td>65,3</td>
</tr>
<tr>
<td>G2</td>
<td>64,7</td>
<td>26,8</td>
<td>64,3</td>
</tr>
<tr>
<td>G3</td>
<td>62,0</td>
<td>20,2</td>
<td>65,7</td>
</tr>
<tr>
<td>Sum</td>
<td>182,2</td>
<td>73,7</td>
<td>195,3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>District heating</th>
<th>Temp, ºC</th>
<th>Temp, ºC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply (after G3 condenser)</td>
<td>89,3</td>
<td>84,7</td>
</tr>
<tr>
<td>Return</td>
<td>39,1</td>
<td>39,0</td>
</tr>
</tbody>
</table>

Table 5.2 Simulation results for Model 1
In contrast to group 2, the workload of group 1 was rather low during the beginning of phase 1, consequently the leaders decided to merge the two groups and form a set of sub-groups of three persons each. Each one of these had to develop a simulation model. Leaders kept original division with a group leader for the simulation and one for the data group. This new division of groups gave the impression of a huge capacity since leaders assumed that the effectiveness of the new group would remain the same. Results from the interviews showed that this was not an appropriate choice:

“I mean I tried to let three people do one task that I could do in one afternoon and then it took them three afternoons to do it because they are three and everyone has to get through this thing and they have to find time to work together.” (Student 1)

Group 3 was more stable during the whole project. Students had communication problems with the contact person from the company. They mentioned lack of confidence in students’ ability to carry out the project that resulted in slow response from the company. This has also been noticed, by the present author, during the study visit to the power plant. The data and schematic needed was provided later than for other groups. Consequently, the group did a survey of existing heat pump solutions. This problem was later solved and the group succeeded to develop five alternative solutions. Three options with two alternatives for each one of them were suggested. The Table 5.3 below summarises the suggested solutions.

<table>
<thead>
<tr>
<th>Model No. (Grp. 3)</th>
<th>Description</th>
<th>Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>One heat exchanger in the flue gas condensing unit Cooling is provided by the heat pump and by an heat exchanger connected to lake Mälaren</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>One heat exchanger in the flue gas condensing unit Cooling is provided with a secondary refrigeration circuit connected to the heat pump, the lake and the district cooling network</td>
<td></td>
</tr>
<tr>
<td>Option 2</td>
<td>Two heat exchanger in the flue gas condensing unit. One heat pump</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Two heat exchanger in the flue gas condensing unit. Two heat pump</td>
<td></td>
</tr>
<tr>
<td>Option 3</td>
<td>Two stage heat pump (two compressors and two evaporator)</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5.3 Alternative solution for introducing a heat pump

It is important to note that the quality of the report and the depth of the theoretical analysis made by group 3 were deeper than the ones carried out by the two other groups. This is due to the low effectiveness in groups 1 and 2. Moreover, four of the five models presented by group 2 had mistakes with orientation of the flows in the heat exchangers. Despite this, the models were technically viable and after correcting the flow directions, calculations were redone. These errors were not discovered because the groups did not check the models; and they did not have any contact with the mentors during phase 1:

“The only time that we contacted lecturer 1 or lecturer 2 is whenever we needed somebody’s e-mail or something. Yeah! But we didn’t contact them on anything because
we were so confident on ourselves. It wasn’t like the lecturers were not available. They were there but rather the idea was that we thought we could do it.” (Student 2)

The whole group made many inadequate decisions not only on organizing the tasks, but also on the overall approach to solve the problem. Neither the representatives of the company nor the mentors were satisfied with the results submitted at the end the phase; however, for academic reason the DRT agreed to let students continue performing analyses of the different models even if they were to be unable of improving the model.

During phase 2, the leaders and group leaders were changed in accordance with the course requirements. The team members of group 1 and 2 were mixed. The objectives of the tasks for group 1 and 2 changed significantly with the elimination of most of the options developed in phase 1. Only two models out of the seventeen suggested were to be further developed. As for the group 2, it had to refine three of the five alternative solutions suggested, and to perform sensitivity and economical analyses.

As a result of the leadership shift and other changes in the project, students went through a chaotic period resulting in tension within the team. Students lost confidence in the project, the course and the new leaders. Some of them withdraw partly from the project activities. Others were relying upon the old leaders and did not trust the new ones. Students were looking for old leaders’ help or some other leaders to emerge and lead the project. This situation lasted about two weeks:

“[It] really took them (i.e. the new leaders) two weeks to really find their feet. And this really affected everyone because then people were not sure what the goals were they weren’t sure which people needed help they weren’t sure on the new goals themselves.” (Student 3)

The phase 2 was shorter than the first one if one takes into account the two-week break in Easter. The new project leaders decided to finish the simulation and analyses before the break, and presented the findings in the public presentation four weeks later.

At the end of the phase 2, the accuracy of the plant model developed was still unsatisfactory. But as agreed, it has, however, been used for the simulation of the different alternative models. The economical part was more developed if compared to the relatively less developed sensitivity analysis of the models. Generally, the work of Group 1 and 2 was more focused than in phase 1.

The Figure 5.2 below shows students’ activities measured using data from the yahoogroup. The term activity refers to an operation on the yahoogroup system. This can consist in uploading a file to the system, creating a folder, or some other activity recorded by the system. The first graphic represents the number of activities performed by all the members. The second one represents the number of e-mails exchanged through the system. These results are indicative of the intensity of the activities, but do not capture the workload with high accuracy. Nevertheless, it represents a good estimate of the intensity of groups’ activities since all calculation, report, and models produced were saved on the system.
It is clear from the Figure 5.2 that students’ activities were concentrated at the beginning of the project and during the week 7-8 i.e. at the end of phase 1. The number of e-mails exchanged was rather equally distributed through the whole period of the project with regular picks shortly before the deadlines. The figure also indicates that there were no major activities during the last two weeks, whereas it is expected to be a time of high workload such as at the end of phase of 1. This was confirmed and explained by the interviews where students and project leaders:

“We had to act very quickly because we set the goal that we should be finished for Easter and we wanted to keep it. [This is] [b]ecause people were getting very tired from the project and have people set their mind that we would get it done by Easter.” (Student 1)
The Figure 5.3 above indicates students’ individual activities in the yahoo group. As it can be seen about 11 students out of 22 can be said to have actively participated in the project. As indicated in the figure the sub-group leaders ranked first in the number of activities, followed by main project leaders. This can be explained by the fact that sub-groups’ leaders were responsible to put the pieces of work together resulting in more measurable activities in the yahoo group. However, this is not sufficient to explain why there is such a large difference between the students’ and leaders’ activities. Moreover, we can see that some students named Key Actors were also active in the yahoo group although they are responsible for a part of the project. An additional explanation is that students’ activity depends on the role they ascribed to themselves or that is ascribed to them within the group. Thus, students who have less responsibility tend to do the minimum, while those with more responsibility or motivation will participate more actively.

The Figure 5.3 suggests four categories of students in the PBL: leaders, key actors, active students and social loafers. It is important to note that these categories represent a tendency among the student to behave according to one of them depending on internal and external factors.

**Leaders:** These students are highly motivated; they are highly involved in the tasks and they lead their fellow students.

**Key Actors:** Are highly motivated students that actively participate in the project in different positions and are highly committed to the project. The difference between leaders and this category is that this later does not have a formal position in the group.

**Active Students:** This term designate students that are involved in the task attributed to them and do their best to achieve it, but are less proactive than the two previous categories. In other term, these are the common students.

**Social loafers:** This category refers to students that rely on the motivation and activities of the group. They try to avoid participation in the tasks and do the minimum possible.

The interviews conducted confirm the existence of these four categories as it can be shown in the following quotes:

“Some people did more because they saw they were [1] the leaders they have responsibility to steer the group that is what they were doing [2] some of us did more because we had the interest it was like it was nice using PROSIM and all that basically why some people did more but [3] those who did less maybe they looked at it as more like an academic work once they finished their part they did see why they should go for another job or try to even do more …” (Student 2)

Another group leader confirms the existence of the last category:

“I’ve always seen this in my group there is a [4] person who hasn’t done anything really.” (Student 1)

Social loafers have also been mentioned many times in students’ comments such as in:

“Too big [the groups] people tend to disappear.”

“Some group-mates rely on the group not on their own motivation”
“Some people were not as committed to the project”

The questionnaires handed out during the middle and the end of each phase resulted in a number of interesting data. Students were asked to write down their best learning experiences as well as their worst experience in the project. For the purpose of analysis, students were divided into two categories: leaders and students. The reason is that as explained previously, leaders are viewed as responsible for the projects by the other three categories. These later are also expected to have a rather similar perspective on the course.

Four categories emerged from the comments. These are:

**Project Management, PM:** This term refers to the tools and techniques used in project management such as: project objectives, time charts, project plans etc. Students mentioned a number of such experiences: “Organization”, “Meetings”, “time-planning”, “How to do a project”, “group coordination”, “running a project” etc.

**Real-world Experience, E:** This term refers to those learning experiences that are usually learnt outside the university and that are different from academic and technical knowledge. An example of some experiences mentioned by students are: “Client contact”, “Visit to Hässelby power plant”, “working in real problem”, “responsibility” etc.

**Group and Social Process, GSP:** This aspect refers to the softer aspects encountered in projects including: human relations, team building and group dynamics. Students mentioned a number of such experiences: “Amazed how the group came up with solution”, “team-building”, “team-work”, “sharing responsibility” etc.

**Technical and Academic Knowledge, TAK:** These experiences include both technical knowledge such as developing simulation, and academic knowledge such as writing a report and performing a presentation. The following expressions were mentioned by students: “Building models in PROSIM”, “Learn about turbines”, “I learn a lot of what you can’t get from the book” etc.

![Leaders' Best Learning Experiences](image1)

![Leaders' Worst Experiences](image2)

**Figure 5.4 Best learning experiences**

The Figure 5.4 shows that leaders reported mostly experiences on PM and GSP. This means that these aspects affected them positively especially at the beginning, and the overall impression about them remain positive even at the end of the course. It is noticeable that PM related experiences decreased with time, while complains remained high and stable. On the other hand, there is a clear increase in complains on GSP. This might be partly explained by the high levels of social loafing and the chaotic situation after
the leadership shift. It is, however, noticeable that the leaders mentioned a large number of GSP experiences.

The leader did not complain on TAK and E, rather as one can see on Figure 5.4, their response was positive on these two aspects. In the middle of the project, leaders were probably not focused on new learning experiences as much as they were concerned by performing the tasks. Consequently, very few comments were reported, as it is shown in Figure 5.4 a.

As it can be seen on Figure 5.5, the number of positive TAK comments has increased with time, which indicates that students’ activities resulted in interesting learning experiences worth to mention. A closer look at the TAK comments shows the variety of learning experiences:

“Discussion with supervisors”

“I learn a lot of what you can’t get from the book”

“Technical discussion”

“Building models in PROSIM”

“Make a presentation”

“Learn about turbines and PROSIM”

“Presentation of project work”

“Good understanding of economical knowledge “

“Knowledge about heat pumps”

A comparison of Figure 5.4, b and Figure 5.5, b shows that there is similarity in the pattern of the response on GSP related experiences. However, as it can be noticed all complains were made by project leaders. This has probably resulted from high social loafing and the chaotic transition after the leadership shift during which leaders were students lost motivation. It is important to note that, although students reported many complaints on GSP, they also mentioned much more positive comments. This applies both for leaders and students. The explanation of this phenomenon is twofold. First, it shows that the leaders’
viewed GSP in two different ways. On the one hand, they viewed GSP as positive especially in the beginning of the project and at the end because PBL is one of the rare education methods that involve such learning experience, and it was, thus, very interesting to experience. The fact that the response was high at the end confirms this explanation because despite the difficulties, these experiences were perceived as positive. On the other hand, the leaders complained on those aspects as a consequence of frustration that resulted from loosing control over the events and disappointment with their plans. In conclusion, GSP was an interesting but uncomfortable learning experience for leaders. This is illustrated in the following quote:

“If you want to have such conflicts so that they could learn something because then that’s all you know. The more people see these things happen it is better to learn it right now because you won’t loose a job but you know in the future were actually you could loose a job.” (Student 4)

Regarding other students, their view of the GSP was positive during the whole project (see Figure 5.5, a). This is because from their viewpoint, students could not notice the negative part of GSP since they are part of phenomena and, thus, they were unable to see the whole picture. Despite that the students worked together and had several meetings, they were not aware of each other’s tasks. Thus, they were also unable to see the negative GSP associated with the tasks they were involved in. One of the leaders said the following:

“Sometimes people sit in the same room close to each other doing simulation and they do not know what the others are doing. They do not communicate.” (Student 5)

Another explanation is that the negative GSP were negligible if compared to the positive ones in their views; and, thus, they did not mention them. In any case, these different views on the same phenomenon points to the existence of a divergence of perspectives between leaders and students that depends on the role that they attribute to themselves or that is attributed to them.

As for PM, it is clear from the Figure 5.5: a, that the positive experiences reported by leaders decreased during the project, while the number of complains remained at approximately the same level. This can be explained by the fact that most of these learning experienced occurred at the beginning of the project. The number of responses decreased in the middle of the project, the overall response was still very positive at the end, which points to the high level of satisfaction. It is noticeable, however, that most of the complaints were made by leaders, while most of the positive experiences were reported by others students. Moreover, there were no negative comments on PM from students. As in the case of GSP, there is a clear divergence of perspectives between students and leaders on this aspect.

The leaders were behind the PM tools and, thus, they felt responsible to make them work. Therefore, they complained when their views on how the project should be run and how it was actually running. This has resulted in many complains from their part not only on PM but also on GSP, as it has been mentioned before. Other students reported very positive PM learning experiences because from their viewpoint, they were only seeing part of the project being carried according to the plan. Moreover, it was perhaps one of the rare occasions where students were given high control on their learning process resulting in high satisfaction with their work, without feeling responsibility for shortcoming related to PM because the responsibility for this aspect is attributed to the leaders.
5.2 Analysis:

Before analysing the results, it is interesting to review the course description (See appendix A.5) that was given to students at the beginning of the project. This document is likely to have affected the views of students on what/how they should learn in PBL. It is also important to note that this analysis can only be used to partly explain the phenomena observed during the project. Other explanation will be carried out using a combination of evidences from other data.

The course description gives an account of the objectives of the course at the beginning of the document. At least half of these are related to project management, organization, and group work. In a later section of the document the objectives were re-stated by the author. The technical aspects were only mentioned once, while project management-related objectives were broken down into several sub-objectives. This probably resulted in a reinforcement of the message on project management, what PBL is according to the author of the course description and what students are expected to learn from it.

It is worth noting that the document uses stimulating expression when it describes engineering projects. An example of these expressions follows:

“engineers most often work in teams to solve complex technical problems”9 (Course description, p. 1),

“One of the main goals of this course is to expose students to team working within a project engineering context”10 (Course description, p. 1),

“Please note, however, that this is not just another calculation from a textbook. It is a real-life project”11 (Course description, p. 4),

“Each group will be responsible for carrying out the assignment for a client”12 (Course description, p. 1).

Such expressions are likely to stimulate the fourth year engineering students who are usually very enthusiastic to test their theoretical knowledge in solving real engineering problems. The course was offering them such a possibility. Consequently, they became more receptive to the message conveyed by the document.

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9 The emphasis has been added by the author
10 Ibid.
11 Ibid.
12 Ibid.
The Figure 5.6 shows the frequency of the keywords used in the document. As it can be seen, most of the keywords with high frequencies were related to project management, organization and group work. Moreover, leaders and students are mentioned much more frequently than teachers and instructors. This implicitly underestimated the role of the mentors in view of the reader. Furthermore, the overall impression that one gets from document is rather confusing on this particular aspect, especially if one considers the students’ and mentors’ role. Therefore, students had to interpret it relying on other indications from the learning context. They could, thus, have had a variety of interpretations depending on their background, interests, and other factors. This has contributed to misunderstanding of what PBL is and how students should learn with it.

The following quote describes what PBL is in the view of the course description author:

“PBL differs from traditional methods in that the students are instrumental in defining and solving problems. Aspects of traditional teaching like lectures can be a part of PBL, but students are now very active in deciding the detailed content of the course.” (Course description, p. 1)

As it can be seen in the paragraph above, PBL was distinguished from other types of courses through criticising these later. The author also gave students a higher status in the expression: “but students are now very active in deciding the detailed content of the course.” This expression also entails that the role of the instructors is less important. In contrast to that, the role of the “client” is emphasised elsewhere such as in the beginning of the document:

“Each group will be responsible for carrying out the assignment for a client (typically represented by an external company)” (course description, p. 1).
In addition to this, the author always mentioned the instructors indirectly. Furthermore, when teaching was mentioned, it was associated with negative attributes such as “tradition” and “traditional”. The three expressions used in conveying instructors’ role were as follows:

“… with the guidance of the appropriate instructors.” (course description, p. 1)

“… the instructors have the critical task of guiding the students in their problem solving path.” (course description, p. 1)

“… students are given comments and guidelines from teachers …” (course description, p. 2)

The misunderstanding of the course description has been noticed from the beginning of the project. Students were supposed to have formal meetings during only four times, whereas they organized several formal meetings on their own:

“I think the big meetings were really seen as a waste of time and that’s what we tried to emphasise in the beginning as well and I have tried to have as few big meeting as possible … we spend half Thursdays and Mondays on having big meetings.” (Student 3)

The group followed all the formal meeting procedure including sending meeting agendas and writing down the minutes. Other students complained against these meetings: “meeting about meeting (too many not so important meetings)” (a student). This shows that the misunderstanding was general among the students. Generally, they reinforced group cohesion and contributed to strengthen a feeling independence and power among the students.

The analysis of interviews and observations, confirms that the group ended up into a phenomenon of groupthink. A simplified schematic of this is phenomenon is described in the Figure 5.7 according to Janis (1972). The interviews prove the existence of major symptoms of an omnipotent groupthink in the first phase namely: sense of autonomy, morale and self-sufficiency. The interviews confirm the existence of such symptoms:

“Initially we were all very enthusiastic so the contact was good … so people were saying lets go do it! Let’s go and do it! You know it’s like … exciting! I mean a new way of doing things. We felt so important!” (Student 2)

This quote shows that the students were very enthusiastic about carrying out the project for a company and working in the group. The connection with the course description is also confirmed in the quote: “I mean a new way of doing things” and “we were doing something for a company”. As it can be noticed, both expressions show a high motivation among students, as it was expected to be considering the course description document.
The formal group meetings had a strong impact on strengthening group cohesion. This consequently resulted in favourable condition for the occurrence of the groupthink. Another symptom, namely closedmindness, has also been mentioned in the interview with student 2:

“I remember when we went to Helsinki we did a presentation on the boat and yeah we talked about that this condensing thing and he said ok you can look at it if it’s ok … I was always saying we shouldn’t do it. They said Contact-Person said that … so we kept on adding more work because Contact-Person has said so it was right from the beginning.” (Student 2)

In addition to closedmindness, this quote confirms that the group also misunderstood the objective of the company. This might be due to two factors; first the group was already in an early stage of groupthink at the time when the client suggested doing some additional tasks. And secondly it might also be due to a simple cultural misunderstanding of the client’s comments. Nordic communication style is more indirect than in most of the other countries, which may have resulted in the misunderstanding of client’s answers and comments. This means that the response from the client regarding additional task should perhaps have been understood negatively, but due to the cultural differences and also perhaps to the groupthink, students interpreted the answer as positive. The result of this misunderstanding is evident in the development of alternatives that were not needed by the company.

The other symptoms considered are “pressure towards conformity” and “rejection of criticism from internal as well external members of the group”. The following quote shows that this also occurred in the group. It also indicates that the group discarded Student 2’s comments and despite warnings, the group decided to develop a large number of models:

“In the first part we did a lot of work that really didn’t matter. We had 10 alternatives for one and 10 for another … I was one of the few that were telling look let’s look at the point and do it. But they said we should use Prosim because Prosim will complete them all.” (Student 2)

This situation persisted until the end of phase 1 where it became evident that the group had mismanaged the project. As mentioned before, the group produced unreliable simulation models and other technical solutions with obvious mistakes. The project leaders and the whole group were unable to make a lucid judgement about developing the models.
“We have tried to be a little bit too independent … if we had contact with instructor a little bit sooner we could have had likely less alternatives in the first one … this is not easy to see … I think that is our own fault. They made it clear that they were available.” (Student 3)

The existence of several symptoms confirms that the group deviated from the balanced state of workgroups (see Bion (1961)) and ended up functioning according to the groupthink process. The whole group entered into the state of groupthink and developed a distorted view of the external environment leading to misunderstanding of information and mismanagement of the project. It is possible that the leaders were more affected by the groupthink mentality than other students. Thus, the rest of students just followed the general tendency in the group because internal criticism was either quickly rejected or that critics remained silent, as it is often the case in groupthink phenomena.

The analysis of phase 2 revealed the existence of a second type of groupthink phenomena, namely a depressive groupthink. When groups are disturbed from the balanced state of workgroups such as after failure or major event in the group, they show a number of symptoms such as: demoralization, vulnerability and lack of control. Students lost confidence in the leaders and were constantly waiting for the old leaders to do something. This affected negatively both the new leaders as well as the other students. The students lost confidence in the task and in the capability of the group.

“I would think like for the first week people were not really trustworthy of each other I mean because of course you know you tend to go through the pervious group leader or you know the previous project leader more because for you know at that stage it seems to work and now you have someone new you tend to be a little bit not trustworthy.” (Student 4)

Demoralization was evident in another interview:

“It was like we just doing it for academic reasons and [this] took the enthusiasm out of the students. Then now we’re pushing it just to finish it, just because they wanted to keep the deadline not because they wanted to do something for the company.” (Student 2)

The loss of control is illustrated by this quote:

“ … they (i.e. Leaders) really took them two weeks to really find their feet. And this really affected everyone cause then people were not sure what the goals were, they weren’t sure which people needed help, they weren’t sure on the new goals themselves getting into it was really awkward and I think it was not very pleasant too.” (Student 3)

As noticed, the PBL group went through different states. Interviews show that individual students perceived the events differently. Some of them understood that something was wrong with how the project was run, but could not understand the phenomena they immersed in. It is important to mention that none of the students interviewed understood this phenomenon even after the end of the project.

It is possible that the much of social loafing that took place in the project was a reaction to the groupthink. Student who did not agree on the tasks withdraw and did the minimum. But this might have also induced a similar reaction from true social loafers. Another explanation of the social loafing can be connected to the leaders mismanagement. As a result of feeling leaders’ choice, some of the tasks were actually performed by leaders themselves or other students who had more insight in the project. One of the students
complained about this behaviour of leaders: “leaders should delegate responsibilities/tasks more instead of doing them themselves.” (a student).

This is shown in the quote below:

“… Then you have also some people who take more responsibility because they wanted to or they liked it or purely they understood what was going on whereas others didn’t.” (Student 3)

The conclusion is that the groupthink accounted for at least the major part of the disturbances in the project. This confirms the hypothesis on the high sensitivity of PBL to the learning context. It has been for example shown how students misunderstood, the objectives of the course, and how they managed the whole project. The present case can be used to better understand some of the phenomena or at least it points clearly towards a source of problems encountered in PBL settings.

5.3 Summary and Conclusions

Experiencing group dynamics phenomena, such the ones described in the present study, is very interesting for fourth year engineering students. It is clear that the PBL offers a range of possibilities for learning these social processes. However, if such experience accounts more than the technical and academic knowledge that students are supposed to learn, the model then is problematic. Generally, the model at hand has many positive sides and especially the group dynamics affects. Nevertheless, PBL models aiming at increasing the social skills poses some ethical questions. Among these one can mention the moral damage that might be caused by improper group dynamics; and as it has been shown, the behaviour of groups and individual can become odd in certain PBL settings. Consequently, this may lead to internal conflicts at group and personal levels.

Another important aspect that has been seen in this study is related to students’ categories. As it has been shown, four categories of students were suggested to classify the types of learners. For simplification, one could actually use two main categories: Leaders and students. This second classification helps in understanding some of the phenomena such as the diversification of perspectives. As mentioned before, students viewed the various types of tasks in two different ways. Students mentioned most of the positive comments on TAK. They have mentioned all positive comments on PM while leaders mentioned mostly negative comments on this aspect. The leaders mentioned most of the negative experiences related to GSP, while they also accounted for about half of the positive comments. This is due to the way students and leaders viewed their role within the PBL group.

Leaders and students have a certain expectation on what a learning environment should look like, based on previous experiences with PBL, the course documentation that describes the course and the information they received during the contact with mentors and other students. During the beginning of the project, students were affected by how the other colleagues understood and acted. Leaders were very concerned in running the project according to the plan they established. Thus, their negative answers are a reaction to the disappointment with the actual events, which obviously was projected on students. This explain why they have complained more on the GSP and PM. Students had no expectations or did not view PM in the same way and experienced this aspect very positively instead. They also did not consider GSP as an interesting experience as much as the leaders did,
and they did not report negative experiences on that either because they perhaps did not notice it or that they perceived it as something normal.

It is possible that this applies to all experiences that take place in the PBL. Savin-Baden (2000) mentioned a similar classification of experience she named “interactional stance”. She defined it as the way that students interact with other learners in the learning situation. This includes the way students view themselves as learners and the way they view other students. During a PBL course, students tend to re-evaluate their position within the group. Each student evolves in the group and together with the group. This is a continuous process where ones views and expectations are constantly re-evaluated and readjusted with the environment. The disturbances occurring in the group may hinder this process that is important for the effectiveness of the PBL. If much energy is lost during unnecessary interactions, the course objective, which is leaning from a project, will be hindered.

The second classification of the students with its four categories can help understand how the PBL environment can be affected by the external factors. When a student enters into a learning situation he/she has already a view on how to learn with PBL. Thus, if the these expectations remain stable which mean that the majority of students hold similar views on the learning situation and on their own role, then the environment will be favourable for learning. While as in this case, the misunderstanding was clear from the beginning, thus students had to interpret PBL according to their views. Since the information from the course description and from the teaching staff was not consistent, and due to the distorted view of the reality that resulted from the groupthink, students’ views on PBL were also unstable. This resulted in a chaotic situation where they reacted according to their prevalent tendency. Those who viewed themselves as leaders or were viewed as such had to act according to that view. Key actors and others also acted in accordance with their view. Social loafers remained by the side of the mainstream not because they are social loafer rather because this tendency was strengthened by the learning environment.

The classification of tasks suggested by students’ comments were also a result of the reaction from the events that took place in the project. When students read the course description, they developed personal views on the PBL course, how they should learn within it, what to expect from it etc. This at the individual level, but as in other group processes, these views were continually reviewed in order to adjust to the group cultures, at least by the majority of students.
6 DISCUSSION AND SUMMARY

This report presented two studies on educational innovation introduced at the Division of Heat and Power Technology at KTH. Learning is the process of becoming aware of the things, ideas, relations or simply the reality surrounding one in his or her daily life in different way. The state of awareness of something may not only affect the effectiveness of a person but also it defines first of all a new person who may adopt a new way of doing or learning things Marton et al. (1984).

The perceptions of a tool or ones role within a group can have a dramatic effect on how one uses that particular tool or act and learn within that given group or context. It is certain that a person who does not consider for example CompEdu as an interesting or useful learning tool would not use it for his or her learning. Similarly if a person perceives PBL course as an opportunity to get credits points by relying on his or her fellow students’ effort would adopt a certain stance in learning within that particular environment. But the question that one may pose is what does the educator to do with these aspects? The answer is simply that educators should see to that learning can really occur after that a student go through a course or use a particular learning material or tool. This means that one has to make sure that all conditions for learning are present during the learning sessions. It One should start by defining the context or learning, the different ways that student may perceive that context, and by providing consistent information in order to guide students through the process.

One of the main findings of present studies is that much of the effectiveness of learning depends on the context in which the learning occurs. One of the most important aspects of this view on learning is that everyone should be given the right or at least put in favourable conditions so that to be able to benefit from the learning experience. This is because in unclear learning context students can easily be diverted by some means from favourable conditions that are needed in order to achieve a deeper learning in a certain context. Therefore, it is very important to understand all circumstances surrounding the learning and see to that the learners do not end up such a situation. This study showed that one of the most important aspects that affect how students position themselves in a learning experience is their views on what this leaning is about and how they are supposed to be within that learning environment.

The present study showed that CompEdu program was developed with a broad perspective. The design derived from what the project team viewed as important for the learners, but during the development, they added new elements to these views. This combination of views has resulted in a more complex design aiming at accommodating several objectives in one tool (i.e. learning and teaching). Although this might be possible theoretically, it is generally not reasonable to expect high quality and effectiveness in all the aspects. Moreover, the development of the learning materials and tools opens another door for difficulties that might compel the designers to leave the main objectives or the requirements of good learning material, at least in some cases. These are challenges of real projects subjected constraints of different types. It is recommended to follow some known rules and guidelines such as the MLT because it would be easier to evaluate and learn new things from the experience of the project.
The study has also shown that some of the tools were not regarded by some of the learners as very interesting. This was for example the case with calculation exercises in their current version of the program. The error done by the design team from the beginning was that they may have focused mainly on the idea that students would like to have the maximum number of tools and that they will use all the tools according to the designers view. This does not seem to reflect the reality of students and thus the design does not work at least in case of calculation exercises in their current design.

The design team uses short sentences and statements in order to briefly explain the phenomena, which is theoretically advisable according to the MLT. This idea has been widely accepted by students; however, in some cases where its implementation was not fully successful, it became a hinder for students’ learning. Moreover, it can also be said that the strategy of short sentences has another drawback, which is to indirectly compel the learners to adopt a surface learning approach and to do the minimum in order to reproduce what they have learned without really assimilating the material. As it was explained before, this strategy gives the impression to students that they can easily and quickly learn a large number of facts and information, while in reality this is not real learning rather a shallow learning during which only a small portion of information that is being actually assimilated. In other cases, this approach may make the advanced learners who would like to deepen their understanding leave the program in order to seek learning with other tools or material due to some differences between the logical structure used in textbooks and the one used in CompEdu. One might argue that there are other learning tools within CompEdu and that will benefit this type of learners. The answer is that indeed there are many useful tools of this type; however, the current version does not allow these students to find these tools easily. Furthermore, they have first to know that such tools may exists which is not always the case in the present CompEdu version (i.e. 2.2 g).

The concept of view and uses has been found in the learners’ perspectives where they had a determined view on what learning with simulation should be. The position held by the students interviewed is that simulations should be freely explored by the users. Therefore, they override all instructions and suggestions made by the development team and explored the content of the simulations directly. This determination affected their ability to notice and judge some elements in the design such their un-ability to recognize the pedagogical agent or finding help information when needed. This is an example where student self-concentration of his or her views awareness becomes a hinder for more effective learning. However, it is not always easy to explain or change such a tendency among the users of CompEdu presently. It is thus suggested to use these findings in different ways in order to help students benefit better from the platform. The example of this is students’ view on that simulations are merely learning tools that attracts students’ attention and trigger them to test and to randomly experiment with varying parameters. It is suggested to develop simple simulations with one of very few control parameters so that the user may quickly discover the effects of these parameters that they are able to control. This would help them to understand the phenomenon without wasting much time in finding the control parameters as it happens in some of the complex simulations. It is then suggested to have a set of higher levels for the same simulation where more parameters can be controlled, or to suggest using the simulation in performing some simple calculations. This might trigger a number of interested students to use the simulation in more meaningful way. But in general it is highly advised to keep the quality of the tools at high level, which would then help building confidence on the high pedagogical quality of the program among students. Otherwise, they would not trust the quality of the learning materials and tools, which would result in low interest in learning with the program as a whole.
Learning with the tutorials presented the most diversified views on how to use CompEdu. Not only it showed that students viewed it as being central but also as being simply CompEdu itself while other peripheral tools remained in the background and did not constitute for the learners more than additional tools. This was not only a result of the large number of tutorials included in the platform if compared to the number of simulations but it was a result of the design that did not allow students to easily find the other tools in the CompEdu version 2.2 analysed in this study. However, it is important to note that version 3.0, which was released after the end of the study, provided users with a powerful search engines that allows them to easily find all the learning tools, the formulas, and the pictures. In any case, students viewed the version 2.2 of the platform as a collection of tutorials equipped with more or less sophisticated features to help them learn.

Students basically used the tutorials in two different ways. Some viewed them as compulsory literature for courses where they had to learn everything in order to pass the exam, while others viewed them as a learning material to learn without focusing solely on the exam as a center for their awareness. Other students were not taking any courses or exams and these students used the platform for their own learning. This last category resulted in the most interesting and innovative ways of using CompEdu. Some of these students used it as starting point for their learning where they start by assimilating all that is offered in the platform then start looking for further information on the parts that interests them. Information about the additional material they needed for their learning was provided by CompEdu putting it into the centre of their learning.

The second category of students used the platform as a help tool to understand some phenomenon. Although they relied on books for more advanced explanations, they used the tutorials as an advanced organizer. The outcome of learning for these students was a result of complex set of learning tasks where they tried to understand and organize the bits of information from several sources. It is probable that they had to overcome some difficulties related to slight difference in the formulations and explanations etc. However, this probably resulted in deeper understanding due to their re-evaluation of their older knowledge structures and building them again on broader basis. Learning does not only consist in the absorption of new information and formulas and facts and saving it in the memory in an arbitrary form and structures, but a more complex task of readjusting old information, eliminating false explanation and finding where and how to integrate the new information Allessi and Trollip (2001). The flexibility offered by the tutorials gives a possibility for such complex learning to occur when these students are not under some kind of constraints that hinder their free learning. It has also been shown that in some cases, learners prefer to learn directly from the tutorial without reading any learning objectives because these students would feel freer and could thus use the knowledge-base they already posses in order to analyse new information and integrate it. This process could have been negatively affected by the learning objectives by putting more focus on what students should learn in order to pass the exam. It also sometimes more interesting to let thoughts flow freely while learning so that more deep learning can take place as a result of reflection using other types of knowledge that would have been deactivated by focusing on the objectives.

This study confirmed the findings of Marton et al. (1984) on the existence of two types of learners. The first type represents those students doing the minimum effort in order to pass the exam and those who do not go beyond the existing information both in the form and on the content. In the case of CompEdu, these students were mainly focused on learning the key information presented as necessary for passing the exam, they did not exerts effort in
order to go beyond the tutorial. The simulations were used in way allowing them to run and obtain results without really understanding the formulation or phenomena behind. For these students the operations suggested by the teachers are carefully followed as if they were the objective in themselves. Often, it is this type of learners that are likely to forget the knowledge learned with CompEdu, which offers them an easy way for learning.

Deep-learners use the platform and the tutorial in a variety of ways and try through out their learning trajectory to crosscheck their understanding of phenomena with other internal and external sources of information. The outcome of such activity is more likely to be deeper than the previous category’s. It has also been noticed that these students were intrinsically motivated and with higher motivation than the surface-learners.

It is important to note that the Deep and Surface learning approach has provided an insight into the learning that other theories do not explain. While the MLT is straight forward when it comes to analysing cognitive process taking place in computer-learner context, it does not satisfactorily explain what and how the learners is actually learning. It only explains if learning can be achieved with a given programs. This was a difficulty encountered when applying the theory to a learning context where the user is actively engaged in several activities. Furthermore, the MLT only explain static learning, while the second approach (i.e. Deep and Surface approach) is more suitable for describing the quality of the learning and it also explains what and how the student is learning. It is, thus, recommended to define the focus of the study before choosing the learning theory or theories to apply. If the focus is on the cognitive (visual and auditory) then the MLT is more reliable than the Deep and Surface approach. Whereas, if the focus is on the quality of learning then Deep and Surface approach is better. And as it has been shown in this study both can be combined without difficulty.

It is important to note that, in this case, the aspect that affected most the learning is personal views on the design or on learning. These views are very strong and could not easily be affected by the designer once they are established in students mind; however, they could be used to understand users’ behaviour; and thus can guide the future design of learning tools and developing CompEdu program further.

In contrast to the CompEdu case, the study on PBL showed another aspect on how students’ views, whether they are correct or incorrect, can have a dramatic effect on the outcome of learning. It has been shown how the PBL learning context can easily be affected and could become unstable, and decreasing consequently the effectiveness of it as a result of holding several views on how to learn within the PBL environment.

Students’ behaviour in the PBL course was affected strongly by how they viewed their and others’ role within the group. These views did not result from previous experience, as one may expect, but were the consequence of multiple interpretation of an ambiguous description of the PBL course and other factors encountered in the learning context. However, the misinterpretation of what PBL is played an important role on how the students viewed the whole experience by allowing multiple interpretations to take place. Other circumstances contributed to the misunderstanding of how one has to learn in PBL, which lead the students into the groupthink phenomenon that decreased significantly the effectiveness of the learning with PBL, at least in the technical part. Nevertheless, it has contributed to illustrate some interesting group dynamics phenomena and students were satisfied with their leaning despite all what happened. And even from an academic perspective, it can be considered that since the course had several aspects, the relatively
poor technical results of the project could be replaced by a rich learning environment that allowed students to learn other aspects.

The Groupthink theory by Janis (1972) is more developed and was easier to apply since it includes details of the phenomena observed especially the antecedents. It is thus easier to apply this theory than to use Rosander (2003) model. However, this later model is still applicable and it in fact gives broader view of how work groups moves from a state to another. It, however, important to note that this model is more difficult to apply and requires knowledge of the case study and ability to judge the situation in the group. It can be concluded that the theory can be used to explain group dynamics phenomena in learning context such as the PBL.

In the PBL environment studied, four categories of students emerged: Leaders, Key Actors, Common Students and Social Loafer. Each of these categories viewed the learning environment differently from the other ones, and thus they were ready to behave and actually learned different things and in different ways from the other ones. In addition to that, each category had ones own understanding of the learning experience.

The study revealed that four main categories of learning experiences were mentioned. Two of them were related to project management with its hard aspects consisting the management tools and the softer ones consisting in the group dynamics and group relations. The two other ones consisted in practical experience such as contact with an industrial customer, and technical knowledge. It is worth to point out that students had different experiences depending on their views on the context, the role they attributed or was attributed to them and their involvement in project tasks. As an example, a student who viewed her self as a leader had to take more responsibility, participate actively and help other students to position themselves in the project. This category of course had a different perspective on how the project was carried out, and experienced the learning environment differently than the other students who were mainly involved in technical calculations.

It is important to note that except for the leaders and key actors, the student were not fully aware of what was taking place in the PBL course. The later categories were forming the majority, thus it can be said that the students were actually participating in a group whose understanding of reality differed from was considered as the common view. They evolved within the group and learned many aspects including not only technical but also some project management techniques and group dynamics. However, all these occurred unaware of them which shows that learning trajectories cannot always be planned in advance but they still lead to satisfactory learning.

Finally, it can be said that the concept of views and actual use of learning tools or methods provides an interesting framework for understanding dynamic phenomena. And since learning is a mater of changes occurring in the awareness of the individual, which is dynamic by its nature, then such a view is suitable for analysing the learning processes.
7 CONCLUSION

The present thesis started from two closely related hypotheses. It has been suggested that a learner’s views on what or how to learning with a certain method determines the ways this learner will act in the learning environment and the outcome of the learning experience. It has been shown that the stance adopted by learners in a certain situation strongly depends on the way they view it from the beginning and it is also path dependent. Students’ views on a multimedia program depend on the way they viewed it from the beginning and also from the view developed as result of frequent usage of the program. The design also had a strong effect on students’ expectation to find material and tools. In the second case study, misunderstanding of how to learn with PBL, lead students to develop distorted view on the project and the learning method. All this confirms the dichotomy of views and actual use of a learning method or tool.

The study attempted to answer a set of questions. In the case of the CompEdu program, it has been shown that the designers perceived the program a universal stand-alone package for learning where the user can obtain all necessary materials and tools for learning. It has been shown that the team viewed the users as a homogeneous group and attempted to develop the tool for several purposes. The study revealed the existence of two types of learners. The first one can be called surface-learners. These students follow the structure suggested by the designers of the tutorial even though it may differ from a standard structure encountered in the classical literature in the field. This category usually focuses on the material available in the multimedia program and uses it almost exclusively. The second category can be called deep-learners. These learners go beyond the information and the structure suggested in the program and combine different learning tools. They also do not follow the tutorials’ structure and they use the tools independently from the way the design team seems to have intended them.

This study also revealed that students who had a strong view how to learn with a multimedia program or a learning method benefited less from the learning tools available or method used for learning. Students with weak views on how to learn from educational program or leaning tool benefit less from the presentation and engage in more surface learning. The study has also shown that self-motivated learners use the multimedia presentation in novel ways and crosscheck the information given with other material. It can also be concluded that learning depends on the active involvement of the learner in re-structuring the information. Less motivated students use the program in poor way and may avoid engaging with less rewarding tools or tools that do not reflect their views on educational multimedia programs.

As for the second education method investigated, the study showed that students have unclear and weak views on how to learn with student-directed PBL. There are four types of learners in PBL project: Leaders, Key Actors, Common Students and Social Loafers. Leaders and Key Actors are self-motivated individuals and participate most in the projects. Students who viewed themselves or were selected as leaders are held responsible to take most of the decisions and students expected them to work more than the average student and to solve most of the problems. The students are very responsive to suggestion from both the tutors and from leaders. Students who viewed themselves as common team members expected a lower workload than leaders’. Key Actors are self-motivated students
who do not view themselves as separate from other group members but who participate more than others.

Students and leaders view differently the learning environment and the type of knowledge and experience they should learn. Four major learning experiences were revealed:

Project management

Real-world experience

Group and social processes

Technical and academic knowledge

Leaders learned more group and social processes that they did not fully take part in, while common students learned more on project management aspect that they were not actively involved in. The study also found PBL groups can become very cohesive, and can develop distorted views on how to learn with PBL, and un-common group dynamics phenomena such as groupthink can occur in PBL learning setting.

Finally, it can be said that the studies presented fulfilled the mission that was had laid out from the beginning. The findings of the two cases studies confirmed the suggested hypotheses, and the research questions posed were satisfactorily answered.
The present author recommends the following:

Tutorials:

It is recommended to have a slightly longer and more logical structure in the tutorial. This will lead to more effective and deep learning than shorter ones. In general, it is recommended to follow the MLT guidelines for the development of individual page and other tools in general. Although, the current way used to structure the chapter is logical in it way; however, it is recommended to adopt a logical structure similar to the structure used in classical textbooks in the field. Important information, video and the like should not be hidden in hypertext. The writing style should be conform with plain English.

Simulations:

Simulations are very important tools that help students understand complex phenomena. However, if the design of simulations is complex, students would not be able to reach the goal (i.e., understand the phenomena). There are some of such simulations included in CompEdu, but it also contains a number of well-designed simulations such as the ones describing propulsion cycles (see CompEdu shelf 2). It is recommended to have more simple simulations with a few controllable parameters in order to illustrate simple phenomena. The graphical interface should be identical or in the worst case very similar to the well-designed simulation already included in CompEdu.

It is also recommended to have a more complex set of simulations in order to provide advanced learners with more sophisticated tools. Since the pedagogical agent functions are not working, it suggested to start the simulation with instructions. One might argue that this might also not work; however, it is much better since interested students would notice these instructions. It is recommended to review the guided messages and instructions and to simplify them. The present author believes that a simpler but meaningful learning activity is not likely to result in a better learning than a more complex one that students would not fully grasp and that they would forget quickly.

Calculation exercises:

The present design of calculation exercise does not seem to be successful with students. It is therefore suggested to the design team to review this tool. It is recommended to simply provide the full solution in PDF format and to have at least one calculation exercise (i.e. after reviewing the design) for each tutorial.

It is suggested to have a more interactivity in the exercises. This could be achieved by using the simulation in combination with the exercises. This will lead students to learn both the simulation and the calculation exercise. It will also help students with learning in a new way by combining different tools at the same time.
PBL with group dynamic component:

As it has been mentioned before, after that this study revealed the possibility of unexpected group dynamics effect that can take place in PBL setting, ethically unacceptable to let student be subjected to intense group dynamics experience that may hurt some of them or may result in intense conflicts. It is important to emphasize once more that the courses and course description to be developed in a way that takes into account all aspects likely to influence or alter the learning environment. As it has been shown the learning context can be affected by all types of information that students comes in contact with especially at the beginning the PBL course. Given the current studies, it is possible that similar misunderstanding of learning objectives and methods may occur in some other courses offered in heat and power technology division. It is, therefore, recommended to review the courses descriptions, course material, references and all information distributed to students at the beginning of each course or at least to review the course in more detailed and comprehensive way than it is usually the custom.

It is recommended to re-write the course description in a way that exactly reflects the PBL model and that is not open for interpretations. It is recommended to organize a seminar with students with expert in group work or with tutors in order to discuss the situation in the groups. It is recommended to follow closely the evolution of the groups in manner that would not interfere with the objectives of PBL. It is also recommended to use an individual assessment system and to have large variation in the reward. The present author does not recommend to use peer assessment due to the subjectivity it is characterised by.

Future work:

The present author suggests the following direction of research:

Multimedia education and CompEdu:

Learners seem to be heedless of much of what is taking place in the multimedia learning environment. It is suggested that learning is highly path-dependent and occurs in unexpected ways. Students sometimes become aware of certain detail in a multimedia environment un-intentionally. In certain cases, these unpredictable events play key role in the learning path. It is suggested to investigate how much these experiences the learning account for the whole learning. It is also interesting to investigate on what do these change of awareness of learning depends on.

PBL:

Awareness of ones learning may occur suddenly as a result of information that was accessible to the learner. Individual students differ from one another with respect to the nature of the information that contributed to move up to higher level of awareness. It is suggested to analyse the depth of learning of individual students by following a number of student during PBL course and observe how their awareness (of their learning, the project and group work) varies overtime, and to find out the types of events that contributed to the changes of their level of awareness. It is suggested to map the contributing factors and to construct a model for the variation of the level of awareness.
9 REFERENCES:


10 APPENDIXES:

Appendix A.1: Description of CompEdu program:

Appendix A.2: Sample of interview questions

Appendix A.3: Sample of interview questions (case study II)

Appendix A.4: Questionnaire (case study II)

Appendix A.5: Applied Energy Technology Project Course
APPENDIX A.1: DESCRIPTION OF COMPEDU PROGRAM:

The current chapter describes the CompEdu platform version 2.2 g and its main educational tools, a new version 3.0.

Program components:

The CompEdu is a teaching and self-learning platform established as an effort to enhance the learning and teaching in heat and power technology (HPT) (Fransson et al., 1998). The platform contains several education tools varying from the most basic ones such as text and pictures to more advanced ones including digital videos, simulations and 3D animations. It has been designed as a self-standing tool and currently exists in CD-ROM for PC.

The main room:

In order to access to the platform, users have to register and login first. The login procedure is similar to commercial software. If it is the first time that the program is used in a certain computer, it will be required from the user to enter the registration key provided with the CD-ROM. Then the user will be asked to enter a login name and a password. Non-registered users will can either to register or use the default login “guest” without tapeing any password. In this later case, some of the functionalities such as collection of statistics will not be accessible.

After the login procedure is completed, the user is admitted into the main study room shown in the Figure A.1. Five main features are accessible from this interface. These are: the books, the toolbar, the whiteboard, online-help (red-phone) and a video display. The main educational tools are accessed from the books placed on the shelves according to the subject to which they belong. Typical elements contained in a book are: a short theory chapter, lecture notes, simulations, videos, quizzes, and calculation exercises. Each of these elements as well as the technical content will be presented below. The content of books and chapter is accessible through a menu as shown in Figure 8.3. It is important to note that the default size of the CompEdu window is 800 x 600 pixels and it is not re-sizeable in a flexible way. A full screen view can be shown; however, the resolution of the pictures and text are not very high, which usually make user to prefer the smaller version.

The Whiteboard:

The whiteboard presents a brief description of the platform with links to a number of articles on the whiteboard on how it is suggested to use the platform for teaching or learning. When the user clicks on one of the shelves on the bookcase, a short description of its content is shown on the whiteboard. Similarly, if a book is selected by clicking on it, its content will also be. The content of chapter can also be shown on the whiteboard if one clicks twice on a menu of a chapter.

The Red-phone (Online-help):

This feature is designed to help the user to get information on technical support that can be obtained either through a forum, e-mail or net-meeting. It addition to that, it could also be
used to contact teachers, fellow students or to submit the review form available there to the design team.

The videos display:

This tool can be used in two ways. The first one is to display the video associated with a selected book as shown in the Figure A.1. The second function is to display all the video selected through the link “Chose video” as shown in lower left corner of the computer screen in Figure A.1. It is possible to view the videos in a larger screen as shown in Figure A.2.
The toolbar:

The toolbar contains the support material and functions. The History part contains a short historical background on some of the machines studied in the field. The Glossary provides users with information on the nomenclature, keywords, units and biographies of scientists. In addition to that, a multilingual dictionary in seven European languages is included. As for the Gallery, it shows a description of the main machines used in energy conversion and related fields together with technical data and pictures of each machine. In the Custom option users can chose between different options related to platform colors, sound preference, toolbar etc. The Quiz button gives a direct access to the quiz associated with the book selected. The Database gathers statistics on the learning process. These includes; the time spent on learning a chapter, quiz results and exercises. The Browser provides a direct access to all the chapters through a visual display. The content is available for each book to the page level. A table of content in PDF format is also available through this feature. The Print option converts the chapter into HTML document that can be printed.

Bookcase, shelves and books:

The bookcase shown on the left side of the room contains five shelves (see Figure A.1). Each one is dedicated to a topic with Heat and Power Technology.

**Shelf 0: Introduction and project of the year:**

This shelf contains general information related to the platform and field of heat and power technology.

**Shelf 1: Heat and Power Cycles:**

This shelf included most of the thermodynamical cycles studied and used in industrial applications as well as basic power plant technology. It includes also some chapters on air-breathing propulsion, which also are related to power cycles. A virtual study visit to a power plant in Stockholm city is available.

**Shelf 2: Turbomachinery:**

This shelf is dedicated to turbomachines in general including several chapters on basis compressor design, turbines design, pumps and more advanced topics on numerical methods, and more advanced topics on turbines, gas turbine maintenance and risk management.

**Shelf 3: Measuring Techniques:**

Four major topics are included in this shelf. These are: pressure, velocity, and temperature measurement. A book on flow visualization is also included as well as a general introduction to basic principles and methods used in the field.
**Shelf 4: Combustion:**

This section includes the major aspects studied in combustion such as combustion chemistry, flames (laminar and turbulent), solid combustion and other topics such as thermal radiation, combustion devices, catalytic combustion, and fluid and energy carriers.

**Shelf 5: Aeroelasticity:**

The main content of this shelf includes an introduction book, basic aero-elastic system, classical flows and a comprehensive book on experimental techniques used in the field. Other topics are planned to be included in this shelf as well as in other shelves.

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**Educational tools:**

CompEdu is a multimedia-learning environment that uses several learning tools. Some of them are based on instructivist approach while others are more constructivist. This section will include a brief description of the major tools used.

**Theory chapters:**

The chapter is presented in very concise way with basic components including an introductory page, study objectives, the main content -including text, figures and hypertext, and a summary. An additional summary called “this you must know” is included as a set of questions or brief statement of the technical knowledge learned in the chapter and that student have to know, according to the designers.

The theory chapter pages are usually designed as a self-standing element with a short text, hypermedia, images, video and other elements. The learning material is presented as short statements summarizing the content of the studied topic. Individual pages can be organized in the form of chapter that the user can build as individual chapters.
Lecture notes in PDF:

The educational material presented in the theory chapters is further developed in a PDF format and they include more advanced content, formulas, tables and other types of information needed by learners. The files can be easily accessible from the two locations in the platform and are displayed independently from the main CompEdu window as shown in Figure 8.5. User can have access to these external files and can use them in combination with the program or independently.
Simulations:

There are presently about 20 simulations included in ComEduHPT each of them is dedicated to one of the four subjects covered i.e. Turbomachines, Measurement Techniques, Power Cycles and Aeroelasticity. The simulations vary in from one to the other in terms of technical content, pedagogical content and graphical design (see Figure A.6). Four simulations have described by Fransson et al. (2003, a). A review of these simulations revealed that students appreciated learning with the simulations and this helped them grasp the physical meaning of the theory presented in the chapters (Fransson et al., 2003 b).

Animations:

Animations are used in some complex cases where 3-D machines are difficult to imagine. The example of a gasturbine is shown in the Figure A.7 below.

Videos:

The videos included can be accessed from the video-display in the main room as in Figure A.1 and Figure A.2, from the menu attached to a chapter, or from within the main theory chapter as shown in Figure A.8.
Hypertext or “Popups”

The hypertext or more generally hypermedia is a dominant part in the theory chapters. Every page may contain a number of popups (see Figure A.9). These also may contain several pages. The popup concept is intended to avoid filling up the main pages with information not directly related to the flow of ideas such as unnecessary details including detailed equation derivation, or to present extensive information that would not be possible to put on the main pages. The size of the popups can be one line to several paragraphs or figures. A popup may cover a large portion of the screen.

Calculation exercises:

A calculation exercises is presented in the Figure A.10 a, b. Instructions are accessible through the guide shown in the lower left part of Figure A.10 a, b. Users are asked to solve a classical exercise and are given the possibility to buy hints as shown in Figure A.10 b. In
that case, student score will decrease based on the number of hints bought. Users can also view the solution in PDF format.

(a) The text of the exercise  (b) Buying hints

Figure A. 10 Calculation exercises

Quizzes:

A typical quiz is shown in the Figure A.11. There are three levels of difficulties. For each level ten questions are randomly selected from a poll of 30 questions according to the level of difficulty. Learners have the possibility to get online help from the guide shown in Figure A.11, a. After the completion and submission of the quiz, the learners get their score feedback on the answers indicating the right answer and a link to the CompEdu where the information has been explained as indicated in Figure A.11, b.

(a) Quiz with guide  (b) indication of right answer with link

Figure A. 11 Quizzes

The new interface and functionalities:

During this study a new version were under development and the new interface and functionality were developed. The main changes include: a window re-size option, new browser with search engine, new layout and a new menu. The new default size is larger
than in the one in the previous version (see the Figure A.12). In addition to that, several window sizes are suggested in the new version.

![Figure A. 12 New vs. old CompEdu interface](image1)

The appearance of a page chapter is slightly different in the new version (see Figure A.13). This may have some influence on users’ perception of the platform. The Figure A.13 shows the same page on both the new and old version. As one can notice, the margins are larger on the new pages. Consequently, the learning material on the page may seem to be squeezed or it might be perceived as if the learning material is less in these pages. Other effects may be noticed by users such as the variation in learning sessions since users may feel more comfortable in learning with the new environment.

![Figure A. 13 New vs. old CompEdu page](image2)
The new menu shown in Figure A.14 seems to be more standard and thus might probably it would look more familiar to users. It is also noticeable that the learning context represented by the platform might easily integrate the standard MS Window environment. This would avoid the switching between two environments given that CompEdu interface is smaller than the monitor. However, a small concern should be mentioned related to the number of levels in the menu. The current versions as well as the older one include chapter pages. Although, this might be considered as advantage when the users already knows the content of individual chapters i.e. lecturers, it would be somehow confusing users unfamiliar with either the platform or the learning material existing in CompEdu.

The new browser makes it is also easier to find the text, pictures, formulas, chapters and pages in the new version. The browser shown on Figure A.15 it easy to look for learning tools and other information contained in the platform. This feature is becoming indispensable due the expansion of the learning material included. The features accessible through this browser are:

This you must know

- Chapters
- Pictures
- Simulations
- Animations
- Videos
- Quizzes
Finally it is important note that during this study the full working version has not been released. Students’ interviews focused mainly on some interesting aspect and do not claim to be comprehensive. Students interviewed had the possibility to compare only the interfaces of both the versions; however, they did not have time for a deeper exploration of the new version.
APPENDIX A.2: SAMPLE OF INTERVIEW QUESTIONS
(CASE STUDY I)

The open-end interviews were based on the following questions:

Can you show me you use CompEdu for learning?

Do you read all the popups?

Do you use the calculation exercises?

Could you show me how you usually use simulation for learning?

Did you see the picture in the corners? Why do you think the designers put them?

Did you notice these “dots” on the left side? Why do you think the designers put them?

Do you usually follow the instructions?

Can you access the new version? What do you think about it?
APPENDIX A.3: SAMPLE OF INTERVIEW QUESTIONS
(CASE STUDY II)

A sample of questions posed to students in the PBL course:
What is your general idea about PBL?
Was the company interested in the project?
How was the contact with the company?
Could you tell me how the groups formed from the beginning?
How often were you meeting? Was everyone attending?
Were there some conflicts within the groups?
What did you think about the leadership shift in the group?
Could you tell me what exactly happened within the group when you changed leaders?
How are the groups performing now?
How were the students perceiving the leaders?
Why do people get into leadership position?
How was the contact with teachers?
Was there a fair distribution of workload?
Why did some people do much?
How are the groups’ relationships now?
APPENDIX A.4: QUESTIONNAIRE (CASE STUDY II)

Student review: Name (Optional): ............................................  This is an early review of the course that can help the teaching staff to introduce possible improvements. Please answer the following form as quickly as you can. Thank you for your help.

1. It is the first time that I participate in a Problem Based Learning (PBL) course. Yes [    ] No [    ]

2. I like working in a group. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

3. It is very exciting to study with the PBL concept. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

4. The Master's program at KTH is easy. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

5. I like the way of teaching at KTH. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

6. My group is working smoothly and doing very well in the task. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

7. The group leaders seem to be well qualified to lead the tasks. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

8. In my group we follow strictly the guidelines in the course description. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

9. Some group members seem to be not enough qualified for the present line. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

10. I do not see any problem to fit the PBL workload with other courses. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

11. I think we are going to do a successful project. Strongly Agree [   ] Agree [   ] Not Sure [   ] Disagree [    ] Strongly Disagree [    ]

12. My best experience with the PBL so far are: (1) ………………………………. (2) ………………………………. (3) ………………………………….

13. I had some not so agreeable experiences in the PBL. Yes [   ] No [   ]

If Yes, could you name it briefly? (1) ……………………………….…………. (2) ……………………..………..……………….. (3) …………………………………………………….
APPENDIX A.5: APPLIED ENERGY TECHNOLOGY PROJECT
COURSE 2002 ( 4A 1609 )

Introduction:

The course comprises 6 Swedish credit points or 240 learning units. It will give training in working in a project team, writing reports and making oral presentations. The course will also give exercise in dealing with problems in an engineering way in contact with a Buyer inside or outside KTH.

The course includes common parts as how to work in projects, writing reports, oral presentations etc. It is divided into separate project groups in relation to interests. The project groups ought not to enclose less than 5 persons to give team work exercise.

The course will start with a common seminar at which the students are divided in project groups and tasks. During the first weeks the common compulsory lectures will be held and the groups get organized.

Each project group has contact persons from the department. The groups can be given additional support in the applied courses, which are given in the same periods as the project course.

Reports from ongoing and finished work will be given by the students at four occasions, two times within each project group and two times in front of the whole course including teachers and experts from industry. There will be written reports and oral presentations. Special care should be given the final report from each project group.

Objectives:

The objectives of the course are to give the students the possibility to specialize in a chosen area by taking part in a project, often in close connection to an industrial company. The project deals with some actual tasks related to energy technology. The knowledge needed to carry out the project is acquired by complementing lectures and literature studies.

Content:

Block 1: Introduction and common compulsory lectures

1. Course introduction, dividing in projects
2. Project and team work
3. Written and oral presentation
4. Technical ethics and risk philosophy
Block 2: Project work phase 1

Organize project
Define tasks
Acquire information, select methods
Status report to the project
Preliminary project work
Report of phase 1 to the course

Block 3: Project work phase 2 and final reports

Continuous project work
Status report to the project
Concluding project work
Final report to the course

Reporting the findings and results:

The students are the persons performing the project. They will themselves select the task-leaders for the various tasks that have to be performed. The task leaders are responsible for delivering certain results at specific meetings, where students are given comments and guidelines from teachers and people from industry forming a Design Review Team (DRT). The task can be divided into sub-tasks with leaders.

There will be meetings at regular intervals (see specific chapter on the time schedule). Each sub-task team will produce a report and give a presentation at each meeting. The overheads should be made with PowerPoint, and handed out on paper to each Design Review Team member at the latest 24 hours before the meeting (preferably the students will use the computer for these presentations, but hand-written information in PowerPoint slide frames are accepted if necessary).

A meeting agenda should be sent out, by the leader for the actual task, a week before the meeting. This agenda should follow a certain form (see section four in this document). The agenda must clearly have a 'D' for decision or an 'I' for information under each point on the agenda. The various task leaders designate a secretary for each task who takes the minutes of the meeting. Every minutes of the meeting must have an Action Item list attached to it, which clearly identifies the actions expected from each task-member and when these action items should be completed. The minutes should be distributed within 24 hours of the end of the meeting.
The task leader should designate a member of the team to be a reviewer of the reports before they are presented to the DRT.

At the end of each task, the corresponding task-team will hand in a final task-report. The task will be considered as ended, and the task team dissolved, once the Design Review Team has accepted this final task-report. All task reports, as well as sub-task reports, shall be saved as appendices to the final report.

A final report of the project should be written, with all the corresponding task reports as appendices, and submitted to the Design Review Team within a week after the final meeting.

Final presentations, covering the main issues in all the projects, shall be made at a “conference” at the end of the course, with all students in the course participants as well as teachers and representatives from industry.

The detailed information about the different projects is specified in the section 6-8 in this document. This should be enough to start the project, but more information will be given during the development of the project, as well as during the DRT meetings.

Please note, however, that this is not just another calculation from a textbook. It is a real-life project, which you will have to study. As such there is of course not only one possible solution. The students will thus have to take a lot of 'engineering' decisions. The students will have to come with clear suggestions / recommendations before the Design Review Meetings, so that a detailed discussion can take place and a decision can be taken.

There will be no written examination, but the students will be evaluated according to their activities in the project work, the reports and the oral presentations.

**Terminology:**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>DRT</td>
<td>Design Review Team</td>
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<tr>
<td>DRTM:</td>
<td>Design Review Team Meeting</td>
</tr>
<tr>
<td>Project coordinator</td>
<td>Person coordinating the contacts between the students and the DRT and administrating various aspects in the projects</td>
</tr>
<tr>
<td>Task leader</td>
<td>Person in charge of a task (project phase)</td>
</tr>
<tr>
<td>Subtask leader</td>
<td>Person in charge of a subtask, reporting to the task leader</td>
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