

# Educating Pulp and Paper Engineers for the Global Forest Industry\*

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*As the business of the Finnish forest industry companies expands increasingly over the borders of our country, a newly graduated engineer must possess professional skills, know the international business and marketing, understand multicultural business life situations and speak English fluently. In this paper the authors describe an International Pulp and Paper Technology (IPPT) specialization option at Tampere Polytechnic University of Applied Sciences and pedagogical means that have been adopted as a response to the challenges that globalisation causes to engineering education in pulp and paper technology. The main idea of the IPPT specialization option is to achieve content and language integrated learning (CLIL). In order to achieve this, versatile pedagogical means have been adopted such as pre-lecture assignments, cooperative learning sessions, miniseminars and seminars, negotiation simulations and writing learning journals. The first implementation of a renewed pulp and paper specialization option is described as well as the impact of the changes on student learning. The pros and cons of adapting quite a few different teaching methods are also discussed. This research is a case study and can be classified as action research with evaluative features.*

**Keywords:** CLIL; content and language integrated learning; developing teaching methods; student-centred teaching methods

## GLOBALIZATION OF THE FINNISH FOREST INDUSTRY—A CHALLENGE FOR ENGINEERING EDUCATION

CONSOLIDATION AND INTERNATIONALIZATION PROCESSES have been prominent in the Finnish forest industry during the latest decay. The Finnish forest industry companies have acquired mills and subsidiaries abroad and as a result, today about 60 per cent of the total capacity of the Finnish paper industry is located outside Finland. Globalization of the forest industry still continues and, in addition to Western Europe, covers North and South America and the fast-growing North-East Asian markets, amongst others. This offers international assignments and job opportunities all around the world for engineers with good professional and language skills who know international business and marketing and understand multicultural business life situations. In addition to the paper industry, interesting career opportunities for pulp and paper engineers are also offered by corporations within the forest cluster, such as machine and machine clothing manufacturers, graphic industry companies, chemical producers, as well as engineering and consulting offices.

Tampere Polytechnic University of Applied Sciences has responded to the need for graduates who have appropriate global skills. Our Paper

Technology degree programme offers students the opportunity to study in English in an International Pulp and Paper Technology (IPPT) specialization option [1–2]. Students of paper engineering may apply for the English specialization (IPPT) option and approximately ten Finnish and 2–5 foreign students with paper making background are selected for this specialisation option. The engineering studies are allocated to take four years (eight semesters) and the IPPT programme is situated at semesters six and seven.

In this paper the authors describe what pedagogical means have been adopted as a response to the challenges that globalisation of the pulp and paper industry causes the engineering education of this field. The first implementation of a renewed pulp and paper specialization option is described as well as the impact of the changes on student learning. The pros and cons of adapting quite a few different teaching methods are also discussed. This research is a case study and can be classified as action research with evaluative features.

## AIMS OF IPPT

The main idea of the International Pulp and Paper Technology (IPPT) specialization option is to achieve content and language integrated learning (CLIL) [3]. The aim is to:

- promote deeper understanding of concepts;
- promote a good mastering of professional skills

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and knowledge on raw materials of the paper industry, pulp and paper making processes, paper converting and printing technology and environmental effects of manufacturing processes amongst others;

- provide students with good communication and reporting skills;
- give students possibilities to train in English and to use English in a professional manner;
- give students business understanding and an international view of the pulp and paper industry;
- promote students' human relations skills and skills to communicate with representatives of different cultures.

The students have to communicate in English all the time during class, when dealing with each other and the lecturers. All professional subjects are taught in English and in addition two courses called Business skills 1 and 2 (BS 1 & BS 2) are designed to specifically serve as a forum where students can communicate with each other dealing with professional pulp and paper issues. In order to achieve these goals, versatile pedagogical means have been adopted.

### **PEDAGOGICAL SOLUTIONS IN BUSINESS SKILLS 1 AND 2**

Most topics of Business skills 1 and 2 (BS 1& 2) deal with professional issues. Negotiation situations, discussion sessions, cooperative learning sessions, seminar presentations and reports are all conducted in English. The issues are chosen so that they sum up topics that have been dealt with in other courses, such as de-inking process, chemical pulping, paper manufacturing and converting, as well as paper marketing. This enables the students to get a holistic picture of the essential issues of pulp and paper engineering. One essential goal is also that the students learn what joint responsibility means. They have to take responsibility both for their own and their peers' progress during their business skills studies.

One common feature of the chosen teaching methods, which were adapted in Business skills 1 and 2, was to promote frequent student—student interaction and teacher—student communication dealing with subject matter during class hours. The lecturers' one-way information was thus restricted to short information sessions or introductory speeches. Another common feature was that students work regularly throughout the courses and get regular guiding feedback. The students were given pre-lecture assignments, for example, beforehand reading and writing assignments so that they would always come well prepared to class having the necessary vocabulary and subject matter at hand so that they were able to discuss and argue subject matter issues in a professional way. This helped to build the students' self-confi-

dence and efficacy. [4–7] Applied teaching methods and key features of Business skills 1 and 2 are as follows:

#### 1. Get together and start-off lecture

The students that were chosen for the IPPT specialization option were gathered in a start-off session some two months before their first lecture. The IPPT programme and teaching methods and arrangements were introduced. Special focus was on motivating and committing the students. The students were given a chance to do the Felder-Soloman learning styles test [8] and Guglielmino's self-directed learning readiness test [9]. The students were given personal feedback on their test results.

The first lecture of BS 1 started with a discussion on rules, duties and forms of assessment. The students were asked to make mutual decisions and commit themselves to respecting timetables and deadlines. The lecturers introduced their criteria for assessment. Attending this first lecture was compulsory. It was also decided that skipping lectures in the future could only be approved if there was an insuperable obstacle and some compensating tasks were handed in. It was emphasized to the students that the goals of a course like BS 1 or 2 cannot be achieved by mere reading from books. Communication, negotiation and language skills can only be learned by active participation and getting as much practice as possible.

#### 2. Pre-lecture assignments

The philosophy of always coming to class well prepared was adopted throughout both business skills courses. The aim of pre-lecture assignments is that students get acquainted with new subject matter which they will need during an upcoming lecture and/or recollect some old issues which they have to master for when they process new knowledge. Pre-lecture assignments play a significant role in learning. In some cases the pre-lecture assignments were handed in and checked by the lecturer beforehand and in some cases the students' diligence was only measured by their successful participation in class.

#### 3. Cooperative learning sessions

To promote students' understanding of joint responsibility and to apply theories of both cognitive and social constructivism many cooperative sessions were carried out during the business skills courses [10–16]. The aims of cooperative working were also to raise the students' achievements and to build a good relationship in class.

One example of a cooperative learning session was the one dealing with paper grades. This session was carried out so that the students could be first divided into four home groups (I-IV) [12]. Each group had three members (A-C). The home groups had to achieve knowledge of wood-free papers (A), wood-containing papers (B) and speciality papers (C). The home groups sent their members to get

the expertise needed and thus new group formations were built, specialist groups, which started to work on their special topics. For this, the teacher had prepared material such as handouts, books and copies of PowerPoint slides for the expertise groups so that the students did not have to look for suitable texts on their special issues on their own. This phase included mainly learning by reading, discussing and clarifying difficult issues for each other by asking questions. The teacher was available to guide the students when questions arose that the groups were not able to deal with on their own. This, however, did not mean that they got any direct answers, only guidance where to look for answers. The aim of this phase was that, in the end, everybody knew the subject matter so well that they were able to teach it to their home group.

In the next phase the home groups came together and the group members took turns in teaching their special issues to the other group members. The work was intense and as could be seen later on, also fruitful. After the home groups had dealt with their issues and all members felt confident, the summing up could start. The lecturer asked the students random questions on central issues dealing with all three topics.

#### 4. Mini-seminars

Students were expected to prepare themselves for several mini-seminars. One, for example, dealt with marketing terms and concepts. They had to find out what some twenty marketing terms such as differentiation, segmentation, green marketing, B2B marketing, mean. They had to learn the relevant essentials and be prepared to explain and illustrate the terms so that both a novice and expert would understand. They were given some hints on where to find suitable information. One such mini-seminar was on the issue of recycling.

#### 5. How-why seminar

Basic issues of papermaking were studied and discussed using a how-why format. The students were given pre-lecture assignments as usual. They had to prepare answers to 30 questions for class. They handed in their answers beforehand. Some of the questions were such that the answers could easily be found and others were more laborious and needed more processing.

A few examples of the questions are:

Why are dilution head boxes used?

How can you increase the brightness of mechanical printing papers?

Why is it important to control fibre orientation?

To practice giving exact answers and descriptions and to be able to explain things to others, the students had to take turns in giving answers and explanations to these questions in class. The lecturer had divided the questions into two caps, a red one was for the more difficult questions and a white one for the easier questions. The students

were to draw their test questions from either of the caps. At the end of this how-why seminar the students were given a short quiz, which included some essential issues that had been discussed. The students answered first individually and, having handed in their answers, they took the same quiz working in groups of three (Fig. 2).

#### 6. Seminars

The aim of seminars was that students learn more about some professional topics of pulp and paper engineering, learn how to write a paper and give a presentation in class on their chosen topic for which they had researched the information by themselves following certain precepts [17].

The students had to choose their topics from some professional course, ideally integrating information that had been dealt with in several courses. Additional information search had to be included; merely summing up lecture notes was not sufficient. The aim was also to specifically train skills in writing a seminar paper and giving a presentation. Directions were given that the basis for the written and oral presentation should be professional, educational and intelligible. The work was done in pairs, which also trained skills in working together and taking joint responsibility. The recommendation for the length of the written presentations was approximately ten pages, including abstract and references. Altogether 45 minutes was reserved for dealing with each topic. Directions were also given that the ideal oral presentation would be about 15–20 minutes. This time limit was negotiable, if, for example, a video or a demonstration was included. One important goal for the presentations was that all fellow students learn more about the presented topics [17].

Two opponents were appointed to every presentation. The opponents' task was to ask clarifying questions, make remarks and give a summing up. They had to evaluate the credits of the presentation and give a few constructive suggestions on how to make the work still a bit better. The evaluation had to include both the written report and oral presentation. The opponents had the floor for approximately ten minutes.

Ten to fifteen minutes were reserved for general discussion in which everybody was expected to take part. The students were thus advised to be well prepared. In grading the students, both their written and oral seminar presentations were assessed, as well as their performance as opponents and how actively they participated in all discussions.

#### 7. News flashes and article reviews of professional magazines

During the first IPPT semester, students were expected to follow some newspapers and general technical journals and introduce a few current issues of their own choice to the class (oral presentations). These were called news flashes. For preference, the issues dealt with pulp and

paper. The work was done in pairs and special focus was on the students' ability to tell the essentials in an interesting way. One or two news flashes were dealt with at each session. During the second semester the focus was on more professional issues and the students had to read articles, which specifically dealt with professional and more scientific topics. The aim was to learn how to use databases and be able to write and present a short review on a specific topic.

#### 8. Negotiation simulations

Good negotiators know what the goal of a negotiation is and they plan to reach that goal. A first essential is good preparation which requires amongst other things that the subject matter is well mastered and that the aim of the opposite party is anticipated and understood.

The students had several negotiation simulations. In one session, the students were given different roles, such as acting as chairman, secretary, negotiator or observer. Some students represented the customers and some the manufacturers. The observers took notes and evaluated and commented on how the negotiation had proceeded and how successfully the participants had achieved their goals.

Students had been introduced to the background of the negotiation situation earlier as well as given a description of what was expected of a person in different roles. As background, the students were told that a fashion house needed a ten page brochure for the new summer fashion line. The specifications were: four colour offset printing, matt surface, high brightness, high stiffness, inexpensive. When developing the recipe that met the specifications, basis weight, smoothness, gloss value and brightness had to be especially considered. The print run was 500 000. A special issue that had to be dealt with was that the paper used should not originate from a virgin forest. All students had to prepare themselves, for example, by learning as much as possible about the subject matter, its economics, etc. relating to the issue. Regarding subject matter, the goal was to show that one had mastered the particulars of paper grades. As a conclusion to the negotiation simulation one student, the secretary, wrote a summing up of the decisions made and a description of the situation. The next week a self-assessment and feedback discussion was held in which every student had to discuss and answer the following questions:

- How did I prepare for the negotiation?
- How did my preparation influence my performance in the negotiation?
- How did I make sure that the goal of the meeting was achieved?
- What could I improve in my preparation and participation?
- How did the groups work in the negotiation?
- How did the others help me do well?

#### 9. Learning journal

The learning journal was aimed to be a tool for self-assessment and a method to improve metacognitive skills. Students were required to write two learning journals over a sixteen-week period, each covering eight weeks. It was explained that they should each week analyse what they had learned and why they had learned it. They should also discuss in their journals why they had found some things difficult and what had hindered their learning of some topics. They were to discuss several courses in their journal and include both highlights and sorrows of each week. It was emphasized that they should mainly focus on their own learning and on the subject matter, giving the lecturers and teaching methods less attention. The aim was to make the students reflect specifically on their own learning and to give the lecturers a better view of what difficulties the students faced and why some things are experienced as more difficult than others.

#### 10. Hosting an educational visit

A group of forestry engineering students visited the paper laboratory to obtain a wider understanding of paper making. The IPPT students prepared and hosted the visit. The tour started by a presentation of some general issues of paper making in class. After this the venue was the paper laboratory where the IPPT students demonstrated the different unit processes and explained some analyses that could be carried out and the information that could be gained. The forestry students were also given a chance to make paper and perform different kinds of measurements.

#### 11. Excursion

One aim of the IPPT specialization option was to ensure that the students have opportunities to make contacts with forest industry companies as well as to create opportunities in which representatives of the industry get acquainted with the IPPT students. Thus many excursions to different forest industry companies were included in the programme. Most destinations were chosen by the students.

The philosophy of pre-lecture assignments was applied when preparing for the excursions. The aim was to get the students acquainted and interested in the special features of the excursion destination. This would help them to focus on the right things during the visit. The pre-lecture assignments were assigned to the students usually a few weeks before their excursion and required them to search for:

1. technical information about the excursion target, such as machines, grades, raw materials and special processes;
2. commercial information about the excursion target, such as historical background, ownership, turnover, economic performance and organization;
3. market information such as production, capacity, end uses and competitors.

## 12. Professional training period abroad

Training periods in the industry are an important part of the studies. Those that are directed abroad can be especially fruitful. The students will be able to apply their knowledge and get beneficial experiences. Half of the students had acquired summer jobs outside Finland, in Europe and in South America. Most students had jobs that met with their wish to be able to do something that was relevant to their studies. Before their training period the students had a coaching session in which they had to plan what to focus on during their training period. The aim was to prepare them to extract as much as possible both professionally and socially from their training period, approximately three to four months between semesters six and seven. When the students returned they gave a presentation (10–15 minutes) to their peers on their training period abroad.

## 13. Assessment

The criteria for passing the courses BS1 and BS2 were agreed on during the get-together session. The main idea was that the assessment was spread through the courses and that everything the students did influenced their grades. The students received guiding feedback regularly throughout their Business skills courses. The two lecturers were both involved in the assessment. Students' peer assessment and self-assessment were also included. Three aspects of their performance were assessed:

1. Mastering and understanding subject matter;
2. Communication skills;
3. Ability to take responsibility for their own learning and actions.

The students had to be present at all BS 1 and BS 2 lectures. All assignments had to be handed in. If they were forced to miss some lectures they had to hand in some compensatory work. They themselves had to suggest what this work would be and also justify their suggestions. This requirement made non-attendance rare. There were some objections to this strict practice, but it was agreed on and also carried out.

## COLLECTING FEEDBACK

In BS1 and BS 2, students' opinions and feedback were gathered regularly using different types of questionnaires, short interviews and discussions in class. Some of the students' opinions and suggestions were taken into account during the course, some in the next implementations. The first inquiry dealt with the students' expectations and wishes and it was delivered two months before the start-off. During the course, inquiries were made dealing with methods employed, workload, time use and learning. A feedback questionnaire (Fig. 1) was distributed at the end of the

semester which surveyed the students' opinions on all courses of the IPPT specialisation option. The aim of the feedback questionnaire was to survey the students' opinions about the content of the courses, what teaching methods were used and how the teaching methods met the goals and students' expectations. The students were also asked to evaluate their own input.

## RESULTS AND DISCUSSION

The results are based on questionnaires, which were distributed during the courses, on a feedback questionnaire, that eleven students filled in at the end of the semester including all the 14 IPPT courses, and observations of the lecturers and researchers attending the lectures. In this first implementation a big variety of student-centred teaching methods was adopted.

### 1. Get together and start-off lecture

Doing the Felder-Soloman learning styles test [8] and the Guglielmino's self-directed learning readiness test [9] had given the students some insight on why the IPPT programme was executed as it was and specifically why the BS1 and BS 2 courses were so rich in various teaching methods. The students could see that no two learners are alike and that they should accept the fact of diversity. It could clearly be seen that the get together and start-off lectures helped increase motivation and commitment. The discussion on mutual rules and assessment, however, was colourful and to some extent more of a debate than dialogue. The students were innovative in generating reasons why they should have their academic freedom and come and go as they please. In the end, however, they agreed on rules that were acceptable and actually students were very conscientious in attending class and doing their duties. Their diligence increased as the courses proceeded.

### 2. Pre-lecture assignments

In all sessions, where students had had pre-lecture assignments it could be seen that students were far better able to actively participate in the class work. They were prepared to answer questions, discuss and argue matters. This included deeper discussions on subject matter. It occurred, however, once in a while that not all students had done their pre-lecture assignments. In such cases they could feel their peers dissatisfaction as the work in class proceeded. Peer assessment was fruitful and as the semester proceeded it was obvious that the students' diligence in doing their pre-lecture assignments increased.

### 3. Cooperative learning sessions

Students gave written feedback on how efficient and beneficial they found cooperative learning to be. The students found it very valuable that they had prepared themselves by doing their pre-lecture

**Feedback questionnaire of IPPT**      Student number: \_\_\_\_\_      Date: \_\_\_\_\_

Evaluate all courses included in the IPPT specialisation option by filling in the following feedback questionnaire.  
You should evaluate the content, teaching, interaction etc using the following scale:  
1 = poor, very little, very seldom, 2 = satisfactory, 3 = good, 4 = very good, 5 = excellent, very much, very often.

**1. Name of the course**

**1.1 Content**

1.1.1	Up to date	1	2	3	4	5
1.1.2	Number of new issues	1	2	3	4	5
1.1.3	Difficulty/Depth	1	2	3	4	5
1.1.4	Logicity of the course	1	2	3	4	5

**1.2 Teaching**

1.2.1	Clarity and intelligibility of the lectures	1	2	3	4	5
1.2.2	Usefulness of the teaching methods and arrangements in view of learning	1	2	3	4	5

1.2.3 The following teaching methods and arrangements were adopted:

Pure lecturing	<input type="checkbox"/>	Enquiry lecturing	<input type="checkbox"/>	Lecture + exercises	<input type="checkbox"/>
Lab work	<input type="checkbox"/>	Emphasis on exercises	<input type="checkbox"/>	Lots of group work	<input type="checkbox"/>
Group work now and then	<input type="checkbox"/>	Other methods, what kind? _____			

**1.3 Interaction**

1.3.1	Was there an open atmosphere? Was it easy to ask questions or make comments?	1	2	3	4	5
1.3.2	Was there student – student interaction during the lectures?	1	2	3	4	5
1.3.3	Was there teacher – student interaction during the lectures?	1	2	3	4	5

**1.4 My own activity / input**

1.4.1	I was present at the lectures	<15 % <input type="checkbox"/>	15-40 % <input type="checkbox"/>	40-65 % <input type="checkbox"/>	65-90 % <input type="checkbox"/>	>90 % <input type="checkbox"/>
1.4.2	I handed in my tasks and assignments on time	1	2	3	4	5
1.4.3	I deserve the grade for this course	1	2	3	4	5

1.5 What was most rewarding in this course? Why?

1.6 What was most problematic in this course? Why?

1.7 Free comments.

Fig. 1. Feedback questionnaire of IPPT

assignments. They had looked for answers and sought information from several sources. The students also understood that one reason for their successful work both in the specialist groups and home groups was that they had beforehand attained enough knowledge on the essential issues so that they could focus on the more difficult issues of their topics. This also brought about situations, where the students had the ability to discuss matters, process information, raise questions and bring different points of view to the table. They discussed very actively and confidently. The benefits of peer interaction could be seen. The students felt that they were on the same level and did not have to be afraid of asking each other. Even the shy students felt that they had something to give but also that they could freely ask when something was not clear to them.

The students, however, were not as satisfied with their work in the home groups as they were with their work in the specialist groups. Most students

felt they learned much more when working in the specialist group. One reason for this was the slight lack of time that had been available for the home group working phase. Many students felt that acting as the specialist and teaching the other members helped them learn and better internalise their special issue. They, however, did feel to some extent, that they did not learn enough about the issues that the other home group members taught them. The students could see that teaching others may be difficult.

The authors see that the home group phase can be improved by the following:

- Giving the students slightly more time.
- Giving the students some hints on how to teach, for example structuring the issues clearly, using illustrations and giving examples.
- Giving the students time to prepare themselves to teach the others, teach to learn—learn to teach.
- Guiding the students to use the knowledge they

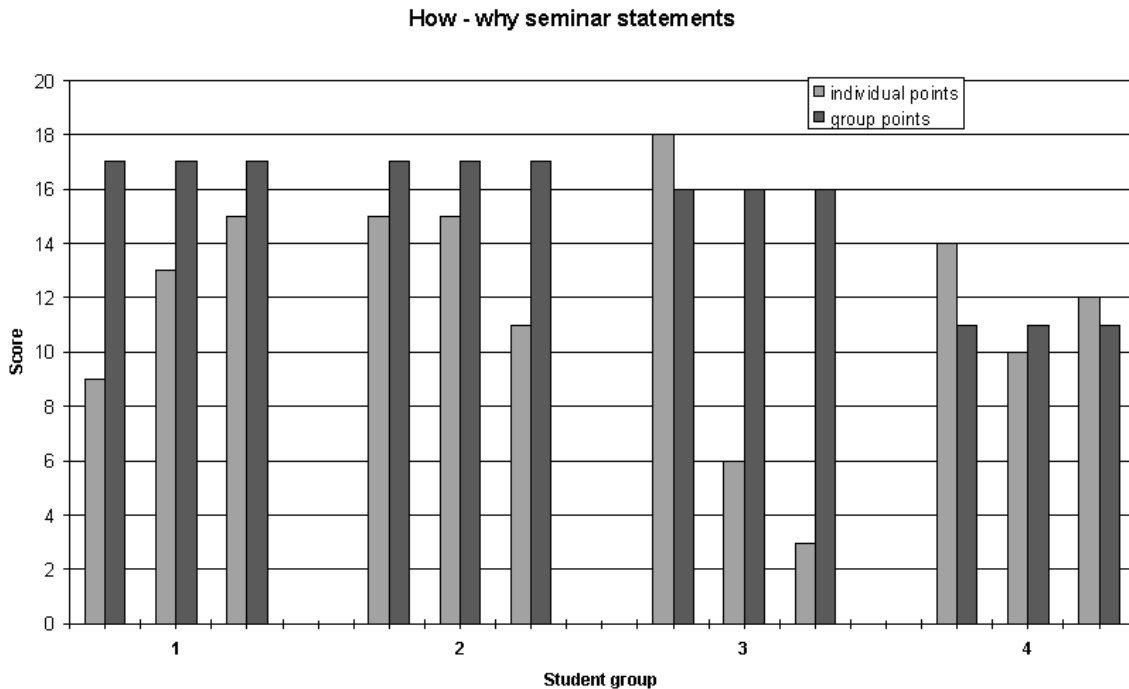


Fig. 2. Students' results of their how—why seminar quiz. Maximum score was 18.

had received about learning styles, when they got their feedback on their ILS and SDLRS tests.

- Compiling questions which the home group members have to be able to answer after the session. These questions can be made by a specialist group member or the lecturer.
- Summing up the home group session by a small quiz that the students answer individually, in pairs or in small groups.
- Making sure, that all students have an understanding and holistic view of the issues concerned by doing a clear summing up. This must be done within the time limit.

When observing the students' working on their topics it could be seen that they did their best. The students had taken responsibility for their own learning and for the learning of their peers. The students worked cooperatively not competitively. They were worried that they had understood some things wrong and that they were left with some wrong information or interpretation. Most groups dealt with this problem in a responsible way. They discussed matters until they had reached a solution they could all agree on and if there was any doubt, they asked the lecturer for advice. They asked, for example, if supercalendering is always a separate unit process or not. The question was very relevant. There are already a couple of references where it can be utilized as an on-line process but in most cases it is still, and will probably remain, a separate process. One problem that the students brought up was the absence of some group member during the home group working phase.

Thus the group missed some of the information, which was intended to be dealt with. At the end of this cooperative learning session the lecturer asked all students questions on essential issues. The students' answers showed that they had learned what was intended and thus the set goals of knowledge of subject matter had been achieved.

#### 4. Mini-seminar on marketing terms

The students had taken time and prepared their answers on average for three hours. The teachers, on the other hand, had evaluated that the students' time use would vary from 2½-5 hours. Most students had spent three to four hours preparing, a few only one to two hours. The students were asked to evaluate how, on the one hand, preparing for the seminar and, on the other hand, attending the seminar had helped them learn and understand. All students said that both preparing for and attending the seminar influenced positively their learning; 67 per cent of the students felt that preparing and attending the seminar had clearly deepened their learning and understanding. The rest of the students thought that preparing and attending had helped them slightly.

It could be seen that those students who were well prepared were also able to explain and visualize even large blocks of knowledge. It also seemed that the students explained the understanding they themselves had built, not copied from books. The student groups had been active, when preparing their mutual answers.

A problem, which is difficult to tackle, could be seen also during the mini-seminar. The active

students take their place and the quiet ones do not spend enough time discussing and explaining to others. The time is difficult to divide evenly. We have not found a good solution to this problem.

#### 5. How-why seminar

The seminar started with the students taking turns in drawing questions, for which they had prepared answers, from the caps and answering them. The students answered most questions in a satisfactory way, but far from perfectly. Some of the answers were very good, exact and descriptive. Many answers, however, needed to be supplemented. The first question and answer showed the typical attitude that students are not so keen on pointing out their peers' mistakes or imprecision. Although the answers which had been handed in before class clearly indicated that some students had a somewhat better and precise answer, nobody offered any improvements. The students, however, quite quickly learned that they should improve the answers, and learnt how to do it in a constructive way. Once the work got going you could see that most students had prepared their answers well and enjoyed the challenge. They continued to describe and illustrate the essential points of the questions. When the lecturer could see that answers were precise and extensive enough and that consensus had been reached the next question could be picked up. The aim of this mode of working was to practice sharing information clearly and intelligibly and to ensure that everyone masters the basic paper making issues.

At the end of the how-why seminar, students were given a short quiz which included some basic issues of paper making. The students answered first individually and after having handed in their answers they took the same quiz working in groups of three. The results of the quiz are presented in Fig. 2. The quiz included eighteen questions. Twelve students (there was one visiting student) took this quiz. They answered the questions first on their own, after which they handed in their papers. After this they formed groups, four groups with three students each, and did the same quiz once more together. At the seminar, as in many other learning sessions, the students were asked to estimate their own knowledge. Most students overestimated their performance slightly. There was only one student, who was modest; he clearly underestimated his scores.

When considering the results of the group work in the how-why seminar we can be satisfied with groups 1 and 2. Group work improved everybody's results. The differences in individual scores were largest in group 3. Group work resulted in one student getting a poorer result and two students getting a huge improvement. The reason for this, as we see it, is the dominating behaviour of one student probably combined with the tendency of the best student not to push his opinions on others or maybe being insecure about the one question in which he let his mind be

changed. In group 4 the results of two students were lower after the group work. For this we don't have any explanation except for the visiting student from another culture which probably influenced the communication and dialogue in the group. The student who had the best individual score was probably not so confident about his answers and thus he was not able to justify his opinions and convince the other group members. The discussion was active in all groups.

These results raise the question of how to assess the students fairly. Some value has to be given to the results of the group work, but certainly the individual results have to be taken into account. Including a grid in which students can evaluate how confident they are about their answers being correct could have brought more information about the causes for the results in groups three and four [5-7].

#### 6. Seminars

When students work on their seminars, the working mode should be planned so that the students have possibilities to understand what they read, write and what they hear. They should be expected to interpret and analyse the information and to make comparisons. They should also be able to see connections between different things, recognize problems and in some cases find solutions to problems. If educational and fruitful results are pursued, it is important that the students get sufficient guidance in their independent work. The students should also be able to get constructive feedback on their work, both their written and oral presentations and on how well they seem to master their topic. If the learning atmosphere is positive and constructive, the students are able to give each other feedback and also the lecturers can give their feedback publicly in class. In this way the feedback is open and transparent and students are able to learn from each other and each others' mistakes. Learning how to give positive, constructive and relevant feedback is a useful skill, which an engineer might have to manage. Feedback also brings out different interpretations and opinions, which develop critical thinking. How well lecturers are able to balance between guidance and independence and between positive feedback and developing ideas is a part of their pedagogical content knowledge [18-21].

Seminar working enabled guiding feedback on a regular basis so that all students could deepen their knowledge of issues that they found difficult to understand and improve such skills in which they had shortcomings. A critical approach, which is typical of scientific work and which should be complied with in all reading and writing of professional texts, is a result of practice. Inexperience in reading and writing scientific texts can be seen as defining concepts inaccurately, justifying arguments inappropriately, using obscure verbal expressions and unintelligible language, amongst



others. The students expressed in their feedback that they found seminar working very beneficial from their learning point of view. They were able to acquire versatile skills during the seminar process. It could be seen that the students took responsibility for the outcome which included both writing and presenting. Many students clearly took pride in their work.

When the lecturers in subject matter and communication skills are able to cooperate, as in this seminar, working as well as in most BS 1 and BS 2 learning sessions, the learning results are good, in some cases even excellent. The learning environment is meaningful in view of the students' future profession as engineers. Integrating engineering subjects and learning communication skills motivates the students. Seminar working also promotes the development of the students' metacognitive skills and critical thinking.

#### 7. News flashes and article reviews of professional magazines

The goal of article reviews was to train the students to find information from professional magazines and databases, to get used to fluently reading professional issues and writing reviews. The students were expected to introduce their reviews in class with special focus on visualization.

The first round was no particular success. The students had not taken time to search for information and their news flashes seldom included anything on pulp and paper. Mostly they had used a weekly magazine that deals with common matters of economy and technology. The second round was far better. The students had been given better instructions and a clear demand that the presentations must be improved and visualization must be used. They had also taken time to search for information.

#### 8. Negotiation simulations

The students had taken approximately five hours preparing themselves for the negotiation skills session on paper grades. They had studied mainly subject matter and collected information relating to the upcoming negotiation situation such as coating, pigments and printing. Most students were satisfied with their preparation and thought that they were able to contribute to the negotiation situations. Students expressed strong opinions based on facts from literature. Many students, however, thought that their preparations should have been still somewhat better and that their level of knowledge on the matters involved could have been improved. In the negotiation situation they had not been able to show a wide enough expertise and deal with all of the issues as professionally as they would have wished. Some students had difficulties in understanding the meaning of all relating concepts, for example virgin forest. The students had evaluated their participation in the negotiation situation. All students wanted to improve their skills. They felt

that they should be better able to express themselves clearly, listen to others, show more respect for the opinions of others, make relevant comments and ask clarifying questions. Very few were satisfied with their small talk skills. Some students knew that they had a lot to say both on subject matter and socially, and that they could have contributed better if they had used Finnish. This of course is a matter of practicing English more and being confident in language skills. All in all this session was well appreciated by the students and they looked forward to the next negotiation skills session in order to improve those matters with which they were unsatisfied. One important result, when the students analysed their learning and success in the negotiation simulation session, was that it would have been wise to prepare for the negotiations together with their peers, in pairs or in small groups.

#### 9. Learning journal

Writing a learning journal did not fulfil expectations. One would have thought that the students, at this stage of their studies, would be able to analyse their own learning and understanding and be able to reflect on what they should do in order to improve their knowledge. The students had probably not understood the aim, and thus focused more on irrelevant details than their own learning. They were also quite unfamiliar with writing learning journals. They were probably so used to somebody else assessing them traditionally and grading them for what they know or how much they know. When self-assessment was done in small portions in some specific session, it had been more successful, but still far from excellent. The journal on the second period was slightly better than the one on the first eight weeks.

#### 10. Hosting an educational visit

The IPPT students had prepared the visit well. It could clearly be seen that they were able to present their own field well and with pride. Most of the IPPT students had taken responsibility for introducing some phase of paper making. The visit included both theory and lab exercises. Topics, such as paper machines, mechanical and chemical pulping, were introduced to the forestry students. Preparing for the visit had improved the IPPT students' learning. When the forestry engineering students reflected on their visit, they concluded that they also had learned a lot. They were well able to prove this. In class the forestry students had had to prepare for their visit by making drawings on paper making, all that they knew. After their visit they made new drawings. It could clearly be seen that their knowledge of paper making had improved. The drawings included a good general view of the subject and many important details. In spite of this, the forestry students did say they could have prepared themselves better for the visit.

## 11. Excursion

One of the excursion resorts was the oldest operating paper mill in Finland, Tervakoski Mill. The mill is owned by the Austrian Trierenberg Group and has six specialized paper machines, producing an annual capacity of over 110,000 tons of tailor-made papers. Tervakoski produces thin print papers, paper for tobacco-related products, release base paper, electrical insulating paper, graphical paper and watermarked specialities. Their unique paper is still produced by a handmade paper mill.

The aim of this excursion was to learn that speciality products need modern technology and most of all experience and traditions. It was a great opportunity to see the production of handmade papers for exclusive purposes such as invitations and personal purposes. Tervakoski Mill is one of the few mills in the world where paper is still today handmade using the original method.

The excursion to Tervakoski Mill was successful. It started in the guest rooms with an introduction by the hosts. Preparing for the excursion and doing pre-lecture assignments had led to more awareness by the students than usual. They were able to get a better picture of the company and production processes and they asked lots of relevant questions. The hosts gave very positive comments and said that they were not used to student groups being so well informed and active. Excursions are one opportunity for the students to build contacts and networks when preparing for their future working life.

## 12. Professional training period abroad

Reports on the professional training periods abroad gave useful information for fellow students. They were able to talk about the special features of their destination company, the area and country. Most students had focused on the specialities of pulp and paper production, but some had been more interested in cultural issues. Personnel policy and labour union matters were of great interest and led to active discussion when dealt with in class. These can differ a lot from what students are used to in Finland.

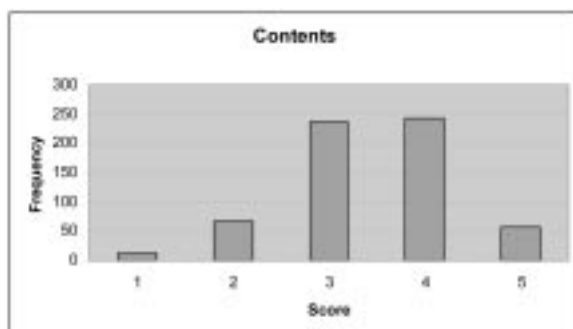


Fig. 3. Summing up students' evaluations of the contents of 14 courses (N=616)

## 13. Assessment

Students appreciated the fact that everything they did was evaluated and influenced their grades and also that they got regularly feedback on their work. This type of evaluation also forced the students to work evenly throughout the semesters. The students liked this kind of 'positive forcing'. Only too often we see that students mainly study for exams leading to poor and unsustainable learning results. Self-assessment did teach students to recognize their strengths and weaknesses and improved their metacognitive skills. This could be seen both in their oral and written evaluations. Peer assessment in turn taught the students to act in a responsible and constructive way. Especially giving public assessment at their seminars and negotiation situations developed remarkably during the courses. When comparing the grades, which the students gave themselves and their peers, to the grades given by the lecturers there were no big differences. If there was a difference, it was usually caused by modesty.

### FEEDBACK FROM THE STUDENTS

Figures 3–6 show summing ups of the students' opinions collected from the feedback questionnaire (FQ, Fig 1). The students' scorings from 1 (= poor, very little, very seldom) to 5 (=excellent, very much, very often) are presented and the frequency of each score. The scorings are summing ups of all the numerical data in FQ. For example content scoring (Fig. 3) included four questions (Fig. 1).

The students' evaluation of course content included how up to date the contents were, how much new information was included, how difficult the issues dealt with were and how logical the content was. The students of the IPPT group had been worried that they would not achieve the same goals on subject matter as their parallel class in which the lectures were in Finnish and where mostly conventional lecturing was used. At the end of their IPPT year, they seemed, however to be satisfied. The mode of the evaluations was four (243/616, 39 per cent, Fig. 3). During the training period, it had also become evident to the students, that their course contents had been relevant.

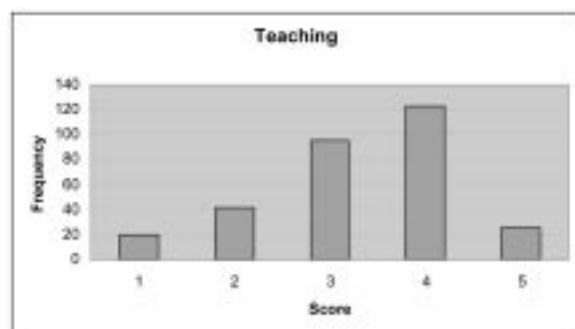


Fig. 4. Summing up students' evaluations of teaching 14 courses (N=308)

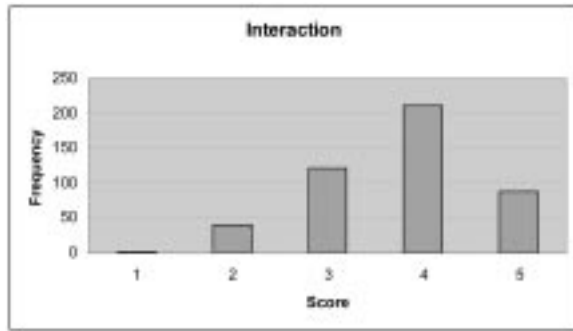


Fig. 5. Summing up students' evaluations of interaction in 14 courses (N=462).

Students' evaluation of teaching included the clarity and intelligibility of the lectures and the usefulness of the teaching methods and arrangements in view of learning (Fig. 4). The results show that the students accepted the teaching methods quite well and it seems that the methods also met the students' versatile learning styles. The mode of the evaluations for teaching methods was four (123/308, 40 per cent). Taking into consideration that all courses were taught in English, and that not all lecturers were familiar with modern teaching methods, we can be satisfied with the outcome.

The part of the feedback questionnaire which surveyed interaction dealt with comments on how open the atmosphere was, if it was easy to ask questions and give comments and if there was student—student and teacher—student interaction (Fig. 5).

The students had been able to achieve feelings of success in many courses. The atmosphere had been open, and successful cooperation had been achieved. Obviously the test results (ILS and SDLRS) had helped the students to understand and accept the diversity of their fellow students and also their lecturers. Receiving feedback regularly had helped the students to work efficiently. The mode of the evaluations for interaction was four (211/462, 46 per cent).

In evaluating their own activity most students were realistic (Fig. 6). The mode of the evaluations for student's own activity was four (222/308, 72 per cent). They had been active and committed to doing their share in the learning process. The same students who were modest in their evalua-

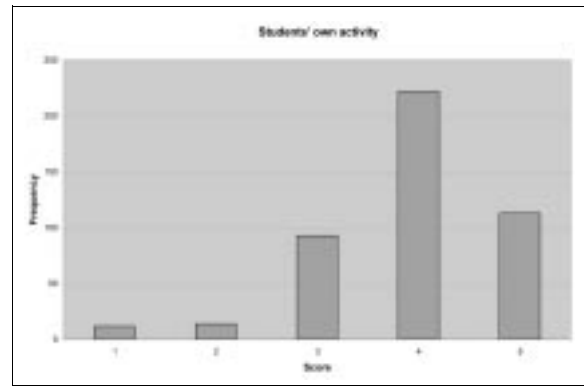


Fig. 6. Summing up students' evaluations of their own activity during courses (N=308)

tions in other instances were also modest in evaluating their own input. There were some slight overestimations, as well. All in all the results of this part of the questionnaire were what the lecturers and researchers had expected on the basis of their former feedback questions and observations.

Students expressed positive comments and appreciation in the open-ended questions. They also suggested some improvements and revealed some problems that they had had. These comments are summarized in Table 1.

All results helped the lecturers reflect on their courses and plan improvements for the next implementation. As usual, open-ended questions revealed the most. Interaction was evaluated as having been quite successful in most courses, but there are still some courses that need improvements in this sense. On the one hand, the content of some courses needs improving; on the other hand, it might be that not all students understood the chief points and highlights of all courses. The reason for this can be the use of a foreign language or a poor command of some of the requisite courses. The lack of sufficient language skills can relate either to the student or teacher.

## SUMMARY

According to the constructivist learning theory and the information processing model, learners construct meaning when they read and write.

Table 1. Summing up comments on the open-ended questions in feedback questionnaire.

Positive/Appreciation	Problems/Improvements
<ol style="list-style-type: none"> <li>The professional know-how of the lecturers (up to date, practical examples). The pedagogical skills of the lecturers (enthusiasm).</li> <li>Learning through experiences /learning by doing.</li> <li>Excursions</li> <li>In addition to learning subject matter and English language skills, the students felt that their group work skills, presentation skills and interaction and argumentation skills had improved generally and especially in the field of pulp and paper.</li> </ol>	<ol style="list-style-type: none"> <li>The absences of a lecturer which led to more independent studying.</li> <li>The content of some courses did not match their expectations.</li> <li>Lack of language skills or professional skills of some lecturers.</li> <li>Difficulties in student self-assessment.</li> </ol>

Constructing understanding requires that students have opportunities to articulate their ideas, to test those ideas through experimentation and conversation and consider connections. [20–26]

A reflective study environment had been created and the students had possibilities to train various skills needed in the engineering profession. They had to search for and process information, increase their knowledge on some specific issues, train their writing and presenting skills and critical thinking. Using a diversity of teaching methods and many different forms of group work, where interaction was a necessity, met the students' diverse learning styles. The many forms of teaching methods and group work had caused some prejudice among the students and some stress amongst the lecturers in the beginning, but everything turned out successfully. The students learned how to work in groups and the possibility to have several rounds of, for example, cooperative learning, negotiation skills training, seminars and other forms of presentations, was appreciated by both students and lecturers. In some cases breaking in was needed, but after that no extra time was consumed for practising a new working method.

A careful and laborious planning played a significant role in the success of the first implementation. The lecturer in charge of the pulp and paper engineering education at Tampere Polytechnic University of Applied Sciences had made plans and cultivated her ideas for two years in good cooperation with representatives of the pulp and paper industry. The two researchers had joined the site nine months before start off. The responsibility of the researchers was to suggest teaching methods and arrangements that could be applied, introduce means of assessment that suit this type of working mode, give feedback to the lecturers on the basis of their observations in class and plan and carry out the feedback collection from the students.

Collecting feedback, making observations and open discussions on pros and cons have made it possible to develop the IPPT specialization option so that the next implementations have improved. This has demanded reflective thinking and analysing on a continuous basis. This is a spiral process, which is illustrated in Fig. 7. When we apply the ideas of Fig. 7 we can ask, what will be after ten years. Research and development is rewarding to all parties. The department is motivated and this has a positive influence on the work of the whole institute.

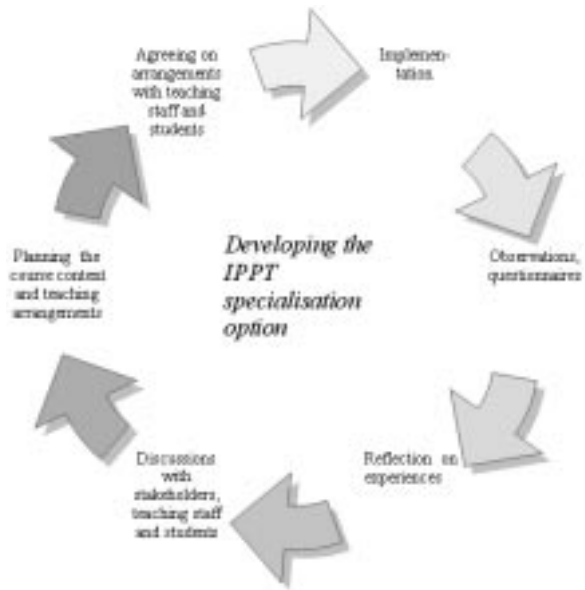


Fig. 7. Development cycle of IPPT specialization option

Lawrence Stenhouse, a British educational thinker, who has sought to promote an active role for teachers in educational research and curriculum development, and who has helped lecturers to develop the classroom as an innovative learning environment, has said that if a teacher is a learner each day of classroom life, intellectual and emotional growth can be stimulated. The teacher can even rejoice in being overtaken and passed by the growth of students because they have been provided with the positive environment for learning. Stenhouse continues to say that teachers should not be expected to accomplish all this on their own.

Cooperative and well-organised effort is needed, and teachers working cooperatively together have the same right and needs as other professionals—such as doctors or engineers—to have access to consultancy and to draw on research. [27]

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