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## **“Active learning in Engineering Education”**

BEST Symposium on Education, Porto

1st May – 6th May 2006



## Summary

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<b>SUMMARY .....</b>	<b>2</b>
<b>PEOPLE INVOLVED.....</b>	<b>3</b>
FACILITATORS: .....	3
PROFESSORS AND EXPERTS: .....	3
PARTICIPANTS: .....	3
<b>ABSTRACT - SUMMARY .....</b>	<b>5</b>
<b>THE DISCUSSION .....</b>	<b>6</b>
GROUP 1 .....	6
GROUP 2 .....	7
GROUP 3 .....	8
<b>CASE STUDIES.....</b>	<b>10</b>
INTRODUCTION .....	10
CASE STUDY DESCRIPTION: .....	10
CONCLUSIONS .....	10
<b>REVE PROJECT.....</b>	<b>12</b>
DISCUSSION .....	12
LOCALISATION ISSUES.....	12
LANGUAGE .....	13
TECHNICAL ISSUES .....	14
TIME AND SCHEDULE ISSUES .....	15
CONCLUSIONS .....	16
<b>CONCLUSION .....</b>	<b>17</b>
<b>CREDITS.....</b>	<b>18</b>

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## Abstract - Summary

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BEST Events on Education are the fundamental building blocks of the educational programme of the Board of European Students of Technology. These events, commonly referred to as “Symposia”, usually last for a week and gather twenty to thirty students from different parts of Europe to discuss educational matters.

A Symposium consists of daily lectures, which are given by professors or other professionals working closely with the discussed theme, then followed by discussion groups where each topic is handled from various aspects in order to bring up the different views of the participants. The conclusions and results of these discussions are then gathered and summed up into reports which present the opinions of the participants and offer hints or proposals on what kind of development and/or improvement could be made concerning the topic at hand. Such reports are consequently forwarded to the interested stakeholders in education, or directly presented by BEST members in educational-related conferences around Europe.

These last years, there has been a shift in the orientation of European Engineering Education. Developing a new way of thinking of the educational process as a cooperative process of the teachers and students, a process in which all participants are creating something new and in which everybody is participating became a challenging task to a lot of education related people. Active learning methods appeared to be preferred from both students and teachers and their development and application increased in the last years. E-learning methods complete that new interactive and with no doubt more effective way of teaching. Research clearly supports the widely accepted proposition that students need to do more than just listen to learn - telling is not teaching. When using active learning students are engaged in more activities than just listening. They are involved in dialog, debate, writing, and problem solving, as well as higher-order thinking, e.g., analysis, synthesis, evaluation. To prove and evaluate that statement students from all over Europe are welcomed in May 2006, in Porto

BEST organized a Symposium in Porto under the topic “Active learning in Engineering Education”. Daily lectures given by professors working closely in this field are followed by discussion groups, case studies and simulation of Active learning classes and the conclusions are later presented to the entire audience and third party stakeholders. In the beginning of the symposium, all students were divided into three groups. Each of these groups discussed and debated in parallel about active learning, and then presented the highlights of their discussions to the entire audience. In this paper we present the findings of the students gathered for a week in Porto.

## The Discussion

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### Group 1

The discussion began with the question: "What comes to your mind when you hear Active Learning?". Students brainstorm for 5 minutes and shared their first associations with Active Learning ( or shortly AL).

Young people expect to be able to express themselves through active learning, to be part of one dynamic, creative, interactive and interesting studying environment. This method is expected to be more students' oriented - students participating and therefore remembering and accepting better their lessons.

Active learning method is still quite new for most of the students in Europe. Students participating in the discussion group gave examples of it mainly in language courses. Different example was classes' preparation in Ukraine where sometimes students had to prepare in advance their classes and then present them to the others - this method gives the learners feeling of responsibility which is also important part of effective active learning methods.

The most important feature of active learning is involvement of the students and this is the word which all of them included in their definitions to AL. AL is not even so innovative method, it could be simply traditional way of teaching with students' participation in it.

Teachers' role should be changed so they would guide the teaching process, inspire and support students to learn and search for more information. The main challenge for the teachers involved in AL is expected to be students' motivation.

"Ask when you don't understand something" - that seems to be problematic part of the nowadays traditional education. Students' normally are not proactive in asking questions during lectures due to different reasons, but in general it is not common in most European universities students to be active during lectures - they are expected to listen and remember!

From the other hand the way interrogation session are leaded normally is not effective – just asking questions is not enough to make lessons interactive and interesting. Discussion session after each session might be better possibility for both students and teachers since at the end of the lesson questions are always exciting.

One more attractive factor for AL courses organisation could be company's involvement in lectures. Companies' input is always interesting and motivating for students.

Working in groups is a part of AL process. Students prefer to work in groups, but not all of them are used to that and in some cases that might be also a difficulty. Group working is more demanding and interactive for young people. Responsibility of studying/developing project is spread among small group of people who are motivating each other all the time.

One concern came from the fact that people accept information/study in a different way and AL is expected to be a bit more individually oriented. AL process is expected to be more efficient when it is made in a small group of people.

Interesting aspect of AL process is evaluation. Students feel absolutely excluded for it and they would prefer to give their opinion at least, that is a big motivation factor which is completely missing from the current educational system.

Students are not convinced in the self assessment and they don't see it as effective method of evaluation, teachers should be more involved than students in all the cases.

Different ways of examination could make it more efficient: oral, written or solving tasks during the examination time – it depends on the subjects as usually so it is again up to the teacher.

On the question could AL be combined with e-learning students had different opinions.

Common attitude was that distance way of learning is not preparing students that well as the normal one. So e-learning could be useful, complimenting AL, but at the end it is not better for students.

Students don't have learning goals at the beginning of their education – they came with the years, teachers should be able to support students in this and AL is for sure making this process easier since students have more space for self development and creativity.

Implementation of new teaching methods as AL should start from schools or even earlier because children are building their expectations and way of thinking in their early age ... later on AL could seem unserious for them and they might not accepted it. Always for AL interaction with outside world is necessary.

Proposed models of interactive learning are: games, awards, debates, conferences, workshops (thematic) combined with e-learning if that is necessary. Information about the classes could be given in advance in case to make the learning process easier.

Students do like AL method. Its concept was completely missing in the education in the most European universities in the last decades. AL could give students better chances to think and develop, to know more and to grow faster in their career. No matter the efficiency of the AL methods, the traditional ones should not be underestimated and if possible they should be combined with the new teaching methods among which AL is.

## Group 2

The discussion started with the students sharing their idea about the concept of Active Learning (or shortly AL). They gave their own idea about the concept writing it on post-it's and arguing it, they wrote that students should be involved by academicians on practical tasks, organized in working groups focusing the concept that for learn students have to do tasks, be active, interact and be motivated. They also spoke about the importance of their own initiative, how students should improve their problems, their tasks and their results criticising in a constructive their way to be on a task, a student will be much active and productive if he/she has initiative.

The AL concept it's still not known and implemented, there are a lack of practical tasks on the majority of the universities, Professors have difficult to motivate students and students in general doesn't have initiative. Students should be integrated on learning issues in order that they can understand the importance and the reason why they are learning that subject.

Professors should interact with students increasing the relation with students in lectures and supporting in flexible way students ideas and projects. Being available for questions and connecting in the best way theory with practice.

The importance to be collaborative was also focused; students should work and learn in a collaborative way on a working group, students have to be motivated in order to be active and productive. The role of the teacher is very important on this issue, teacher should work with students helping them to find way to work as a team and supervising their work without influencing it to much.

Student's ideas and their improvements on tasks as well new tasks they want to implement must be considered. This proposed tasks should been taking into account by the teachers, it's not considered realistic that students should decide it only by themselves. Students and teachers should work together on the development of new tasks discussing them and motivating students to search for new tasks. Before involving a student in a new task the student will need some background knowledge related with the task, this essential knowledge defined as a theory should be teach in an active way. Theory must be taught in order to goad activeness among students using for that new tolls as internet, library resources and multimedia support.

Cooperating with companies will open a bunch of new experiences to students and professors. All the information shared will help the academicians and the students to their self development and to improve

the education. The fact that students will be working on real tasks will fortify their motivation and give a better view of the professional world that many times students don't have any idea about.

Teacher should show and explain to students their mistakes in order to avoid future mistakes and help them to develop their auto evaluation skills. Working as a team and being self-responsible students should participate in their evaluation giving their opinion about them selves and about their classmates in constructive and mature way.

Improving dynamics instructional models & structures, students will become more responsible and aware of their knowledge. They will feel more self-confident and more conscious about the engineer reality dealing with more practical works and cooperating with companies.

### Group 3

The discussions started with the students talking about the situation in their home universities. Currently, the use of Active Learning ( or shortly AL) in European universities varies much. For example, in Italy such learning methods are starting to be employed, yet they face a difficult and slow start. The reason for this, the students say, is that professors are reluctant to embrace big and significant changes quickly. In France, AL is not considered to be of particular importance to the teaching staff, although such learning methods are employed when it comes to laboratories and projects. A student from Estonia told us that at her university it is up to each teacher. Some of them make use of AL, especially when it comes to having students work in teams. In Romania and Slovakia active learning is also only employed occasionally. To conclude, we could say that most European students have had few contacts with active learning and that for most of them the term itself is new.

The students were asked to brainstorm and think about what AL means to them. They were then asked to write each idea that they came up with on a post-it and explain it to the group. The results of their work can be found below.

- Self development: students develop their skills of working together, working in a team, organising themselves.
- Reactivity: both students and professors are more involved.
- Learning by doing: students remember much better what they have experienced themselves, rather than what has been told to them.
- Practice: while theory provides the basics, practice is the next step for fruitful learning.
- Broad focus: students broaden their focus from only pure technical aspects to other issues, including ethical, cultural and policy issues.
- Group work: students get the chance to work in small teams, very similar to the way in which they will work once they become engineers.
- Sharing: in a traditional learning environment, students learn from professors; by use of AL both students and professors can share and debate points of view, thus learning from each other.
- Education for autonomy: one should not depend on the information provided by others, but rather go and seek for what he or she needs to know.
- Responsibility: students are much more responsible for how their work in order to reach the desired learning outcomes.
- Initiative: as a start point is not always given, students have to find out by themselves where to start from with their work.

The vision for AL would thus be the shift from monologue to dialogue, so that the information is no longer simply transmitted, but actually shared between the stakeholders of the educational process.

When it comes to defining more precisely how AL should take place, students feel that the most obvious means are projects. However, it is important to realize that while most of learning in an engaged way takes place within projects, AL itself is much more than project work. Students feel that it is impossible to cover all learning aspects by simply by lecturing, and that AL can help gather more knowledge and skills.

Students support the idea of having universities cooperate with companies, both for internships and project topics. In this way the students have the chance to work on real world topics, which would be an experience that would allow them to make the transition from student to employee much smoother. However, it is still a challenge to find enough companies willing to accept students' work in their projects, especially considering that it may be necessary to pay the university for such work.

Students consider that it is difficult to find objective criteria for evaluation of AL. They suggest that there could be a set of guidelines, or general expectations of what and how the students will be learning. It is also possible that professors together with the students set some learning objectives and then later evaluate whether these objectives have been reached. Even though a very precise way of measuring outcomes of active learning is difficult to define, students feel that at least part of their learning should take place in an engaged way.

## Case studies

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### Introduction

The involvement of students in their learning process will enhance their freedom to decide on their own learning process, help them to have a clear purpose of all learning activities, improve their communication skills and help them to achieve a balanced support from technical experts to overcome knowledge barriers.

During the second day of the symposium were delivered two presentations, one about Active Learning (or shortly AL) in engineering education and a second one about the balance between teaching and facilitating the learning process. These presentations and an experience with a Program Based Learning were delivered by Professor Erik de Graaff during the morning sessions.

Afterwards the participants of the symposium participate in a case study about how to design an AL course.

### Case Study description:

The participants were spited in three groups, separately the groups worked in the design of an AL course during two hours. Later they presented and played it. The objective was to make an effective and interactive course according to some guidelines that were given to them in the beginning and using as background knowledge the morning sessions as well the topic introductions.

The follow guidelines were:

- Choose the topic
- Design the structure of the course
- Which Active learning methods you are going to apply and why
- How many learning hours your course will consist of
- For how many students it will be
- What kind of institutions you are going to include in your course
- E-learning tools application
- Active Learning tools application in the course
- Active learning environment details
- Assessment

### Conclusions

During the working sessions the participants found some doubts about the content, the guidelines delivered and the concept. It was clear that some participants were more familiarized with this concept then others that never had any experience with AL at their educational institutions.

The groups follow the guidelines carefully designing very structured and organized courses always taking into account the activeness of them.

The courses were made focusing an active participation of the students and with a bid percentage of practical lectures. They included working group sessions, e-learning tools and team projects as part of the structure. It was also focused the environmental details of the course, they conclude and include different environmental scenes on the courses.

The assessment was defined by the participants as: “by the students, for the students”. The student’s role was considered crucial but the final decision should remain as a role of the professor.

In the role play of the course the participants took into account the improvements needed to deliver it in an active way improving their communicative skills to gather the attention of the audience and taking into account the importance of the audience participation.

## ReVE Project

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The purpose of the Thematic Network ReVE (Real Virtual Erasmus) is to enhance the impact and the efficiency of the traditional Erasmus programs through the development and support of virtual Erasmus actions. It has two main goals: to complement the traditional Erasmus program and to embed them in the mainstream of higher education.

The expected results of the project are:

- Real working virtual mobility actions within the real environment of mainstream education of the partners;
- Concrete and validated procedures as well as recommendations at institutional, network (local as well as trans-national and European level), published in a manual about a global framework for networked e-learning, as a further development of the existing Manual for a Collaborative European Virtual University (finished cEVU project);
- Tools and techniques that support the virtual mobility actions, including training materials;
- Effective dissemination to stimulate the uptake of the outcomes inside and outside the partnership.

For more information you can check the web pages: <http://www.elearningeuropa.info> or <http://reve.europace.org/>.

E-learning is any learning that utilizes a network (LAN, WAN or Internet) for information/knowledge delivery, interaction or facilitation. This would include distributed learning, distance learning (other than pure correspondence), CBT (Computer Based Training) delivered over a network, and WBT (Web-Based Training). It can be synchronous (real time), asynchronous (self-paced), instructor-led or computer-based or a combination. It began around 1996 with appearance of the first web courses. The most important benefits of e-learning are: Best-of-both-worlds solutions; Online flexibility; Real-world interactivity; Personalized learning. Until now university management has not been concerned with ICT and e-learning, as they did not think of it as a core business area. But in future e-learning will tend to evolve from individual projects and experiments into an integrated feature of the universities

### Discussion

One day of the event was entirely dedicated to the purpose of the Thematic Network ReVE (Real Virtual Erasmus). This day started with presentations from the Thematic Network experts about the project and localization issue. The presentations were delivered during the morning in order to improve the student's knowledge about the issue.

The student's were organised in smaller groups according to their preferences about localisation issues. They selected a localisation issue that they were more concerned about. In smaller groups they share their own opinions, thoughts, brainstorming and giving new ideas about the issue that they felt more involved and concerned about.

The localisation issues that they focus were:

- Language,
- Technical issues and
- Time and schedule issues.

### Localisation Issues

Virtual Erasmus courses allow students to participate in courses offered by another university anywhere in Europe. Possible settings range from courses offered by one university to students located

anywhere to courses offered by a network of universities, which all provide teaching and tutoring support. In all cases, institutions, teachers and students are confronted with the problem of localisation.

Localisation means adaptation of the course to the local needs of the participating students and institutions. Localisation can take place with respect to several aspects, such as language, culture, teaching methods, and learning environment.

## Language

The main focus of this discussion was on what language should be used for the *materials* of a virtual Erasmus course. More specifically, the two options discussed were whether to provide all materials in a single, common language (possibly not the native language of the participants) or whether to make available the materials in all native languages of the participating students. As a first step, the advantages and disadvantages of each option were discussed and collected in a list, reproduced below:

- Common language:
  - Advantages
  - More economic
  - Time-efficient
  - Easier communication between language groups, fewer misunderstandings
  - Participants will improve their knowledge of the common language
  - Participants have to overcome their fear of speaking a foreign language, thus developing their personality
- Common language: Disadvantages
  - Unfair, due to possible inequality in knowledge of the common language (particularly if it is the native language of one group but not the other)
  - Steeper learning curve, if the language is not the native one
  - Knowledge of the language is required: those not knowing it at all are excluded
  - Translation issues, both for writers (teachers) and for readers (students)
  - Potentially reduced participation due to fear of making language mistakes
- In all native languages: Advantages
  - No misunderstandings when reading
  - Students have fewer problems learning the actual content of the course (language not being a barrier)
  - Easier to communicate with fellow (local) students using your own language
  - Accessible to more people, even those without language skills
- In all native languages: Disadvantages
  - More expensive and complicated
  - Increased workload for teachers to translate materials

- Communication between students of different languages is harder
- Interaction between teachers and students might be reduced if they do not speak the same language

Following the creation of this list, the group proceeded to evaluate the two alternatives. The conclusion reached was that each option is more suitable for different situations. More specifically the following distinction was concluded upon:

- Common language:
  - For specialised topics
  - For topics requiring teamwork
- In all native languages:
  - For general topics
  - For topics that require individual work

## Technical Issues

The discussion was structured around the following issues:

- Pre-Erasmus
- Post-Erasmus
- Course structure, different educational systems,
- Social issues, cultural issues
- Technical issues related with ICTs

Within the discussion the group tried to settle which of the issues was relevant for either traditional Erasmus or virtual Erasmus. Most issues are common to both, but ICTs are clearly an issue to virtual Erasmus, whereas living conditions and cultural issues are more closely related with the traditional Erasmus.

- Pre-Erasmus:
  - Information about the University and the studies are not available beforehand
  - Students often disregard the preparation of their Erasmus, and do not read information about their studies
  - Basic knowledge about the local language
  - Virtual systems can facilitate in this process
- Post-Erasmus:
  - Difficulty in getting your courses recognized at your home University

Follow-up evaluation and helping new Erasmus students taking advantage of previous Erasmus students' experience

- Course structure and different educational systems:

- Different assessment types
- Theoretical vs Practical hours vary from country to country
- Systems have to be different, but comparable
- Social Issues, cultural issues:
  - Different study and learning habits
  - Can be a problem for group work
  - Relation between students and teachers varies from north (more informal) to south (more formal)
- Technical issues related with ICTs:
  - Hardware is still not widely available in many countries
  - Delivery of Virtual courses should have a centralised webpage showing all the possible courses in Europe.
  - Such website should contain some basic information and be structured like this:
    - Requirements
    - Prerequisites
    - Contents
    - Structure
    - Literature and Links

### **Time and schedule issues**

The localisation issues in this category can be split into the following:

- Day schedule issues
  - Time zones
  - Habits
  - Decision making
- Long term schedule issues
  - Holidays
    - Religious
    - National
  - Political issues
    - Strikes
    - Wars

- Student issues
  - Parties
  - Exams
- University issues
  - Year calendar
  - Clubs
- Other issues
  - Technical problems
  - Motivation issues

Solutions:

- Video recording
  - Archive or recorded video sessions
  - Timeline
- Flash conferences ( via tools such as Flash meeting )
- Emails
- Teacher training
- Schedule optimization

## Conclusions

The students created a checklist of time and schedule issues, technical issues and language aspects according to their concerns about the localization issue hading into consideration that these aspects could be used as tool for teachers and courses developers to understand and detect problems regarding the "locality".

They mainly focused their input on the issue regarding the fact that they are students. Hading in mind that they were contributing with their input for tool that could be used as a guiding tool that will ensure that the offered courses will meet their expectations and help a student to understand if he will adapt or not to a certain course.

They focused positive and negatives points about implanting a virtual course focusing on topic in discussion. They pointed out three aspects regarding their worries discussing in groups and providing solutions for the issue.

## Conclusion

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In previous events discussing educational issues together with the most involved stakeholders, students and professors, much attention has been given to teaching methods. Time has come to focus also on the learning process and to start having students make use of Active Learning (AL). As our discussion has showed, AL has still to spread in Europe, but it has a very good potential to become common for the future generations of students.

## Credits

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