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Active Learning at Kaunas University of Technology*

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The effectiveness of engineering education depends upon the teaching style of an instructor and the learning style of a student. The methods of active learning can be applied in order to improve the balance between these styles. There are several teaching strategies that can be employed by an instructor, including problem solving, laboratory work, home assignment and group discussions. In this article, the author deals with contribution of active learning methods in achieving improvement and increasing student's motivation in engineering education at Kaunas University of Technology (KUT), Kaunas, Lithuania.

INTRODUCTION

Nowadays, changes in information technologies, electronics, telecommunications, material science and chemical technology approach a rate of 25% per year [1]. Graduates of a university have to be prepared for such a situation. This is a challenge for any technical university. In order to survive, a technical university has to be prepared for changes in engineering education.

One of the most important problems is the teaching and learning strategy at a university. In a typical classroom setting, students are involved in listening to the instructor, reading the textbook, observing the explanations or following the solving of problems. Such a passive involvement generally leads to a limited retention of knowledge by students, as indicated in the cone of learning, shown in Figure 1. However, according to the research of Edgar Dale, the levels of effectiveness in learning are directly related to the participation of students [2].

ACTIVE LEARNING

Active learning is defined as a strategy that involves students in doing things and thinking about the things that they are doing [3]. Active learning is anything that engages students in undertaking something besides listening to a lecture and taking notes to help them learn and apply course notes.

There are a few teaching strategies that can be employed in active learning by an instructor, including problem solving, laboratory work, home assignments and group discussions. Even in a lecture, short, active learning activities can be introduced. Furthermore, in the case of the engineering discipline, active learning methods may include projects with class participation and hands-on experiments, or even an experimental design.

Active learning is also known as *cooperative learning*, in which students work in small teams on problems or projects in order to improve their understanding of a subject. Each member of a team is responsible not only for his/her learning, but also for helping teammates to learn.

Cooperative learning should be distinguished from *collaborative learning*, which refers to those classroom strategies that involve an instructor, with students placed on an equal footing, working together in searching for understanding or solutions, or in the creation of a product [4]. Various active learning techniques could be implemented in almost any classroom learning activity, including lectures, tutorials, seminars and laboratory training [5].

During lectures, instructors can utilise the following active learning strategies:

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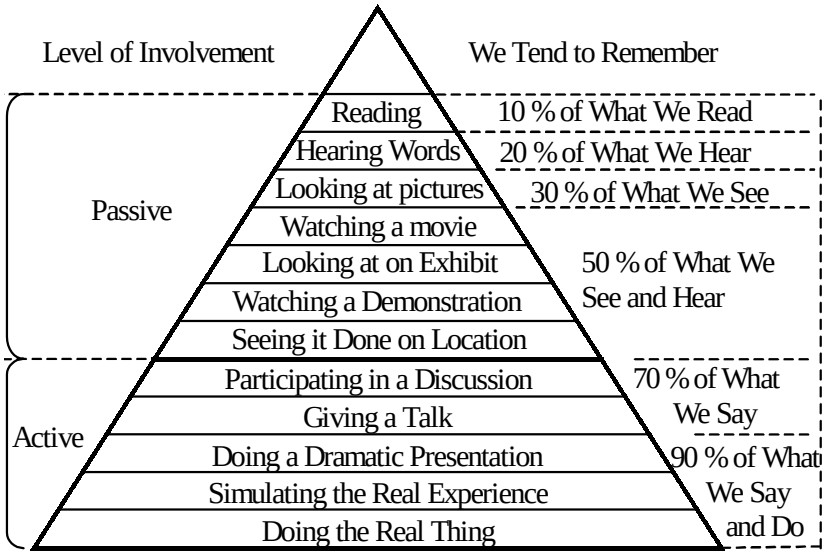

Figure 1: The cone of learning.

- The *pause procedure* to allow students to check course notes or to clarify the presented material;
- The *short write* or a *one-minute-paper* as a student's reaction to the main topic of the current lecture in the form of a small unevaluated writing assignment;
- The *think-pair-share* as answers to questions posed to the class;
- *Formative quizzes*, similar to those encountered in an examination;
- *Lecture summaries* presented by students [5].

All of these active learning techniques can be successfully implemented in tutorials and laboratory training. This is because these activities are normally based on group work in engineering classes.

THE STRUCTURE OF EDUCATION AT KAUNAS UNIVERSITY OF TECHNOLOGY

Kaunas University of Technology (KUT), Kaunas, Lithuania, awards bachelors, Masters and doctoral degrees. Undergraduate studies, covering four years, lead to a Bachelor of Science degree, with a Masters of Science degree after 1½-2 years of further study. The Doctor of Science degree, which corresponds to a PhD or some higher degree elsewhere, takes four years to acquire and is only awarded to those whose research provides a significant and original contribution in the student's selected field.

The academic year is divided into two semesters, each containing 16 weeks for teaching and four weeks for examinations.

The extent of a subject is measured according to a credit system. A KUT credit is equivalent to 1½ credits of the European Credit Transfer System (ECTS), and corresponds to the workload of 40 hours per semester, including contact hours in the classroom or laboratory, student's independent study and/or other assignments.

In the study programme, the hours per week are indicated separately for lectures (x), tutorials or seminars (y) and laboratory training (z) for any subject included. Furthermore, the total amount of contact hours per semester is presented in a different column, as shown in Table 1, which is taken from the study programme in electronics engineering from the Faculty of Telecommunications and Electronics at the KUT. Contact hours and number of subjects of professional qualifications for the same study programme are presented in Table 2.

It is obvious that contact hours are not limited to lectures, but include different pedagogical techniques that are more applicable for active learning than for lecturing.

DISCUSSION

Kaunas University of Technology applies active learning techniques that are not prescribed by institutional academic regulations, but teachers are nevertheless encouraged by the University's administration to incorporate interactive instructional techniques in the classroom. Therefore, the incorporation of active learning depends upon the teacher's viewpoint, plus his/her pedagogical experience and teaching style. Students' educational motivation, learning styles, aptitudes and intentions cannot be ignored either.

Lectures are the most common form of teaching engineering, but the length and degree of involvement in active learning is limited, because it is performed at the expense of the time allotted for lecturing. At any rate, the *pause procedures*, *think-pair-share* and

Table 1: An excerpt from the curriculum in electronics engineering in the Faculty of Telecommunication and Electronics at the KUT.

Study Modules	Credits	Contact hrs per semester	Semester	
			5	6
			xyz	xyz
Signals and Systems 1	4	80	311	
Applied Electromagnetics	2	48	201	
Discrete Time Electronics	4	80	302	
Analogue Devices	4	96	312	
Measurement and Metrology	4	80		302
Signals and Systems 2	4	80		311
Microprocessors	4	80		311

Table 2: Contact hours and number of main subjects of professional qualifications in the Faculty of Telecommunications and Electronics at the KUT for the electronics engineering study programme.

Contact hours				Number of subjects
Per week	Per semester (16 weeks)			
xyz	16x	16y	16z	
202	32	0	32	1
211	32	16	16	2
212	32	16	32	1
302	48	0	32	6
311	48	16	16	8
312	48	16	32	1
320	48	32	0	1

formative quizzes are utilised by instructors and appreciated by students in the classroom.

The effectiveness of active learning depends upon the class size. In a large class, it is difficult for a teacher to have the majority of students involved in these activities.

A quite different situation can be found at the tutorial or seminar level, where class size does not exceed 25 students. Small classes develop mutual interactions between students and between the instructor and students. Such interaction is favourable for active learning activities.

Among other active learning techniques, the *think-pair-share* strategy is easily adaptable in engineering classes, where problem-solving skills are of great importance. In this method, a problem is presented to the class and students are asked to identify solutions in small groups. A final solution is the result of students discussing the problem at hand. Any students who are wrong can correct their solution after class. The most important thing is that students learn by looking for their own way in order to solve the problem and discuss their reasoning with others.

Think-pair-share is adaptable and can be applied for tasks outside the classroom, when students' individual home assignments or projects have something common in solution but are different in outcomes. Unavoidable cooperation and discussions are beneficial for all students, if students are motivated enough to learn.

The ideal place for active learning is a laboratory. As a rule, students work in teams, usually consisting of two or three students. This situation provides the following opportunities:

- Learn in a *real world* environment;
- Function as team members;
- Discuss the planning of the experiment;
- Share ideas about analysis and interpretation of data.

However, this is sometimes not the case if some student team members are not active in the laboratory work. Therefore, a teacher's experience, attitude and support are highly desirable in the laboratory setting.

Teacher Education

Those who can, do, those who can't, teach. This widely known saying is attributed to the famous British playwright, George Bernard Shaw. Apparently, this saying has nothing to do with the teaching at the technical university or college, because it is a hard and versatile work.

A teacher, in order to be successful in his/her occupation and, maybe, provide education that is attractive to students, must be persistent and inventive. The teacher has to be prepared to use different approaches, various methods and techniques, including active learning.

As a matter of fact, active learning techniques do not make the teacher's job easier, but it *enhances* the

role of the teacher in the classroom. Therefore, the professional competence of the teacher is of great importance for the effectiveness of engineering education.

A teacher's professional development is a great concern for the Department, since the Department is responsible for the quality of education.

According to Richard M. Felder,

> *College teaching may be the only skilled profession for which systematic training is neither required nor provided – pizza delivery jobs come with more instruction* [6].

The majority of engineering teachers have never had a formal course in education. Instead, they learned something about teaching from their professors. However, this is not enough. This is why the University seeks to improve this situation. There is a special compulsory educational programme in pedagogy for young instructors and the possibility for further professional development for every teacher on a five-yearly basis. Furthermore, educational problems and techniques are often discussed at departmental meetings.

Paul Ramsden, in his book *Learning to Teach in Higher Education*, emphasised the following:

> *The purpose of education in teaching is the self development of the teacher. No one but a fool or a charlatan may presume to tell lecturers the right answer to the question of how to teach students better. There are no right answers: there are only methods that may work better or worse for each individual teacher, each department, and each group of students* [7].

Apparently, he is right.

Research Activities

There is an ambiguous situation at a university. The main occupation of an academic staff member is teaching, but any promotion to a higher position is based on his/her research activities!

Unfortunately, most research shows that there is almost no correlation between effective teaching and effective research [8]. Research is very important for professional development, but personal perfection in teaching should be taken into consideration as well.

CONCLUSION

Students sitting in a university class today are different from those students who had occupied those seats 15 or more years ago. Nowadays, these classrooms are filled with a generation of students who have been raised on television, video games and the Internet. Evidently, their attitude towards education in general, and to their university in particular, is different to those students who came before them.

Therefore, an active learning environment in the classroom could be beneficial for a university to accomplish its mission in this rapidly changing world.

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BIOGRAPHY

Romanas Vladas Krivickas is a professor of electronics and the Head of the Department of Signal Processing at Kaunas University of Technology, Kaunas, Lithuania. He graduated in engineering from Kaunas Polytechnic Institute in 1961 and received his doctorate from

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His research interests are in circuit theory, signals and systems, and digital signal processing. He is the author of two textbooks. He is currently in charge of curriculum development in electronics at Kaunas University of Technology.

On the international front, he is a Council Member of the European Association for Education in Electrical and Information Engineering (EAEEIE).

In 1997, he was awarded the UICEE's *Silver Badge of Honour* for his distinguished contribution to engineering education and to the achievements of the UICEE.

World Transactions on Engineering and Technology Education

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Current events have impacted upon the arena of international conferences and academic travel, impinging on the freedom of intellectual movement to conferences and the like that are so important for the advancement of engineering education internationally and regionally and, indeed, the development of humankind now and into the future. To this end, the UNESCO International Centre for Engineering Education (UICEE) has established the *World Transactions on Engineering and Technology Education* (WTE&TE), which is open to everyone around the world who is interested in the progression of engineering and technology education. The *World Transactions* offers a safer and cost-effective alternative to conference participation.

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Therefore, a call for papers is made for the next issue of the WTE&TE, **Vol.4, No.2**. The very nature of the *World Transactions* is open to every facet of engineering and technology education and is not confined to traditional views about science, engineering and technology. As such, there are no overriding engineering or technology themes, but rather the overarching principle of the globalised expansion of engineering and technology education that is not confined to borders or regions; instead the WTE&TE seeks to benefit all those involved in the engineering and technology through the wider dissemination of knowledge.

The deadline for this issue is **30 September 2005**. Authors should indicate their interest as soon as possible. Additional information can be found at the UICEE s homepage under *World Transactions* at http://www.eng.monash.edu.au/uicee/

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The electronic kit for authors, incorporating standard formatting details and submission forms, covering copyright, will be supplied on request. Potential authors should notify their intention of submitting a paper at their earliest convenience and earlier submissions than **30 September 2005** will be particularly welcome. Further correspondence via e-mail should be directed to Mr Marc Riemer on marc.riemer@eng.monash.edu.au