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CLIL METHOD IN MATHEMATICS TEACHING AT UNIVERSITY LEVEL

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Abstract

In this article I intend to present implementation of the CLIL method at the International Faculty of Engineering of Lodz University of Technology and share my experience I have gained while working as an academic teacher there. I will point out challenges facing lecturers who teach in a foreign language as well as satisfaction this work brings.

1. Introduction

Studying in Poland in a foreign language has become very common, so gradually a larger percentage of lecturers are involved in giving courses whose language of instruction is not Polish. Within the framework of *Study in Poland* project, initiated in 2005, Polish universities have already offered over 400 study programmes in English. The CLIL method has also been introduced at secondary schools as part of mainstream education. According to a Eurydice Network report ([2]) during the 2003/04 school year there were 94 lower and upper secondary schools offering CLIL type classes (40 of them had English as the second language of instruction).

Young people has often acquired education in languages different from their native ones. This phenomenon has a long history. It is worth mentioning that studying in a foreign language was not always a result of voluntary decision but was due to various complicated, historical circumstances. Nowadays, it is usually caused by students' ambition to develop comprehensively and gain internationally recognized qualifications.

The concept of Content and Language Integrated Learning (CLIL) was introduced by David Marsh and Anne Maljers in 1994. International Faculty of Engineering (IFE) was established as a unit of Lodz University of Technology in 1993. BSc and MSc courses are taught completely in English or in French and are free of charge for all students from EU countries. There are nine first degree study programmes in English and one in French. They

are offered in cooperation with six faculties of the university. There are also second degree studies available at IFE. At present the unit has nearly 1400 students and a quarter of them are foreign students.

I have been teaching IFE students for over twenty years. While giving various mathematics courses in English I have had opportunity to put the CLIL method into practice. I could also observe how students adapt to studying in a foreign language and monitor their development during several mathematics courses they were attending. Depending on their study programme such courses lasted up to four semesters.

2. Challenges facing university students

All candidates who wish to study at the International Faculty of Engineering should prove they have sufficient knowledge of the language they need for their studies. If foreigners wish to study at IFE they should hold an appropriate language certificate (detailed information can be found on the university website). As for candidates from Poland they should gain at least 30% for matura exam at advanced level. Meeting these requirements combined with having good knowledge of secondary school mathematics and physics are considered sufficient to undertake studies at the technical university.

Based on my experience I may confirm that knowledge of English at the level described above enables students to acquire new mathematical skills and study areas of mathematics they did not know before. After a short (2-3 weeks long) adaptation period students actively participate in classes, ask questions and present their ideas clearly. Later if they turn out to have some problems to pass tests and exams it is not caused by insufficient knowledge of English but rather of mathematics as such.

Among IFE students there are many whose knowledge of English is better than requirements presented above. I noticed however that a well prepared lecture may be understood by a group of people who are not proficient in English. I have taken part in numerous projects targeted at prospective students of Lodz University of Technology, during which I have taught mathematics in English. The lesson topics have usually referred to areas which secondary school pupils had not studied at school such as mathematical logic, matrices and their applications, complex numbers and even elements of differential equations. The participants were able to learn new concepts and skills. Majority of them were pleasantly surprised that despite earlier concerns they could follow a lecture in a foreign language.

It follows from my observations that even when a foreign language is introduced only as "entertainment", students show more motivation and

concentrate harder than during traditional maths lessons (see also [3]). It is our, lecturers', job to take advantage of this positive attitude.

3. Challenges facing lecturers

Lecturers who take up teaching using the CLIL method are usually aware of difficulties and expectations they will face. Our teaching in a foreign language must not restrict us. We recognize importance of speaking English fluently using both general and specialized vocabulary. We must admit we happen to make mistakes while speaking a foreign language but making them should never obscure problems we explain.

Knowledge of general English is as important as being familiar with specialized vocabulary. When a new concept is introduced, we explain it using examples which often refer to everyday life or present it in relation to other branches of science. We have to be prepared to justify importance of problems we deal with and encourage students to take part in classroom discussions. We should motivate them, point out their mistakes, praise them for good ideas, boost their self-esteem not to mention maintain classroom discipline at the same time. Summing up, we have to do everything to teach efficiently and communicate with students well.

As for specialized vocabulary I have noticed and experienced myself a few difficulties. Usage of advanced vocabulary usually does not cause problems as we regularly browse mathematical journals while doing research. It is mathematical vocabulary at elementary level that we find much more trying. What I mean are phrases needed to pronounce mathematical formulae as well as these used to describe basic algebraic transformations. Formulae and symbols without a doubt constitute a universal language. We should be able to read them aloud and explain their meaning when we write them on the board.

I will present here pronunciation of some mathematical symbols. Because of their being simple we may underestimate importance of learning specific vocabulary required to read them correctly. I will begin with just a few examples referring to basic algebraic transformations whose pronunciation is not obvious:

- we combine like terms
$$3x^2y + xy - 7xy = 3x^2y - 6xy,$$
- we cancel x from the numerator and denominator
$$\frac{2\not{x}y}{3x^{\not{4}3}} = \frac{2y}{3x^3},$$

- we take out the common factor

$$2x^2 - 3xy = x(2x - 3y),$$

- we cross-multiply

$$\frac{a}{b} = \frac{c}{d} \Rightarrow ad = bc,$$

- we rationalize the denominator

$$\frac{1}{\sqrt{a} - \sqrt{b}} = \frac{\sqrt{a} + \sqrt{b}}{a - b}.$$

Even when we teach maths at university level, it may be necessary to remind students some basic things, such as precedence of operations: brackets, exponentials, multiplications and divisions, additions and subtractions.

We also regularly use more advanced mathematical symbols whose pronunciation has to be learned, e.g.

- $\lim_{x \to a^-} f(x)$ - limit of f at a from below or left-hand limit of f at a or limit of f at a from the left,
- $\log_a b$ - logarithm of b to base a,
- $g \circ f$ - g circle f for composition of functions,
- $\binom{n}{k}$ - "n-cee-k" for binomial coefficient.

The more we learn foreign language vocabulary, the more we are aware of its countless subtleties. Among many others there are so-called *false friends*, i.e. phrases used in two languages which look or sound similar but have got significantly different meaning. Let me mention a few appearing in English and Polish vocabulary. My purpose is to show examples coming from different branches of mathematics.

The English words *billion* and *trillion* are translated into Polish as *miliard* and *bilion*, respectively. There is also the word *trylion* in Polish translated into English as *quintillion*.

When we teach number series we usually examine properties of $\sum_{n=1}^{\infty} \frac{1}{n^p}$. Such series are called *p-series* in English and *szeregi harmoniczne* in Polish. In English however, the term *harmonic series* is reserved for the series $\sum_{n=1}^{\infty} \frac{1}{n}$, i.e. the p-series with $p = 1$ ([5]).

And another example of a phrase that may be incorrectly translated if we are not careful. It is taken from probability theory. When we present basic types of random variables we usually talk about *binomial experiment* and associated with it *binomial probability distribution*. These refer to the number of successes in n independent trials each of them resulting in one of two possible outcomes called success and failure. In Polish this probability distribution is called *Bernoulli*. What in English is *Bernoulli probability*

distribution is defined to be the binomial probability distribution with $n = 1$ trial ([4]).

Apart from many *false friends* and mathematical terminology that we have to learn, we also find that solutions to some typical problems are constructed in different ways in Polish and English coursebooks. Let us consider for example integration techniques used to calculate indefinite integrals involving $\sqrt{ax^2 + bx + c}$. In coursebooks written in English usually trigonometric substitutions are used ([5]) while in Polish ones we use Euler's substitutions instead. And another example this time referring to constructive methods applied to solve a linear differential equation of the first order. In English coursebooks the solution is obtained by means of an integrating factor ([1]). In Polish ones we usually solve such problems taking advantage of representation of the solution in terms of solutions of the homogeneous and nonhomogeneous linear equations. It is clear that teaching mathematics in a foreign language, apart from other advantages, gives us also opportunity to learn new mathematical skills. It is something I appreciate a lot even if these new methods are used to solve not very demanding problems.

What can we do to improve our language skills and other qualifications which we need to do our work well? Taking part in any project involving teachers' exchange (Erasmus+ or any bilateral agreement between universities) is a valuable opportunity. One cannot overestimate advantages gained by teaching abroad and sharing experience with members of staff of a partner university. Apart from improving language skills we may also take part in their everyday work, observe how it is organized and, if it is possible, implement some procedures at our home university. There are also things we may do on a regular basis such as studying coursebooks and numerous internet resources. A lot of highly respected academic institutions share their didactic materials on the net, e.g. Massachusetts Institute of Technology has its OpenCourseWare (ocw.mit.edu). Materials presented there are organized in a clear way and refer to various topics. Majority of websites presenting specific mathematics courses taught at MIT contain sets of lecture notes and video lectures with subtitles available as well. They are completed with problem sheets and samples of exam papers and are a valuable source of information about English vocabulary and about mathematics as such. I would especially recommend *Linear Algebra* and *Calculus* courses by Professor Gilbert Strang. His lectures and coursebooks are beautifully told stories about mathematics while their variety of examples and applications show importance of each topic.

Other universities also publish their materials on the net so I am certain one can easily locate these considered as suitable and valuable. Personally

speaking, I just regret that such resources were not available over twenty years ago, when I was beginning my career.

4. Final remarks

My over twenty years long experience shows that a large group of secondary school graduates may aspire to study in a foreign language at a technical university provided their knowledge of mathematics and physics is considered sufficient. Such studies take a little more effort but in return give qualifications appreciated in our competitive labour market.

As far as we, lecturers, are concerned teaching in a foreign language poses lots of challenges. We are aware that mathematics is much more than working with formulae and symbols and teaching is not just spreading knowledge. When we share it with our students, explain complicated problems, we must not struggle with English vocabulary. We should be able to motivate, inspire and ask thought-provoking questions. We should be prepared to teach international students as well who may have been taught mathematics according to different standards. As a result of this there cannot be routine in our work.

Summing up, teaching mathematics using the CLIL method requires constant self-development and at the same time brings a lot of satisfaction. A reward for our efforts is building good relationships with students and watching amazement on their faces when they realize that it is actually possible to understand mathematics in English.

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