USING ORIGINAL TEXTBOOKS WHEN TEACHING MATHEMATICS IN A FOREIGN LANGUAGE

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Abstract[1]

The paper is a part of a longitudinal study focusing on qualitative aspects of learning in a foreign language in the development of cognitive processes in mathematics. In this contribution we are focusing on textbooks and teaching materials based obstacles to communication, originating in the process of vocabulary and grammar acquisition, within the sociocultural context. During the experiment, we worked with textbooks used in English speaking countries. Examples of activities to overcome obstacles influencing Czech students' perception of mathematics taught in English are presented.

Introduction

In the Czech Republic, Content and Language Integrated Learning (CLIL) is a newly introduced approach which refers to the teaching of a non-linguistic subject such as mathematics through a foreign language. CLIL suggests equilibrium between content and language learning. Both are developed simultaneously and gradually, depending on the age of students and other variables.

In (Hofmannová, Novotná, 2002) we studied the role of the teacher in the mainstream English-only mathematics classroom and we analysed how the teacher enacts supportive learning environment. All the students were Czech, acquiring English as a foreign language. The teachers used a variety of approaches to bypass the gaps due to the students' innocence of vocabulary, to make the English input more comprehensible, and to ensure the students' active participation in the lesson, thus enabling joint construction of knowledge.

This article is a contribution which should clarify the following question: How does the use of authentic, foreign textbooks and teaching materials influence Czech students´ learning of mathematics? It is by no means to be regarded as an exhaustive study in this area. The goal is rather to show a possible method for further research.

The article is a result of co-operation of three authors: a Czech teacher of English as a foreign language (EFL), a mathematics teacher educator and an English teacher educator. The reason for our co-operation is the joint experience of all three that covers the investigated area in the most complex manner and offers an opportunity to compare theory with school reality in the corresponding area.

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Theoretical Background

Language aspects of teaching mathematics and especially of mathematical problem solving have been dealt with in several papers. For our intentions, i.e. to show examples of textbooks based obstacles to communication, we selected the following ideas. (Alrø, Skovsmose, 1992) states that "*Mathematical cognition and competence are developed through communication.*" (Cummins, 1981) dealing with educational development of bilingual children holds that: "*There may be a threshold level of linguistic competence which bilingual children must attain both in order to avoid cognitive deficits and to allow the potential beneficial aspects of becoming bilingual to influence their cognitive growths*." (p. 229). Cummins does not define the threshold level in absolute terms since it is likely to vary depending on the bilingual's stage of cognitive development and on the academic demands of different stages of schooling.

Mestre (1988) argues that the language proficiency of the students mediates cognitive functioning and identifies four forms of language proficiency influencing problem solving in mathematics (p. 215): language proficiency in general, proficiency in the technical language of the domain, proficiency with the syntax and usage of language in the domain, and proficiency with the symbolic language of the domain[2]. Various ways in which the language of the textbook can influence problem solving are presented.

In (Adler, 1998) four dilemmas of mathematics teachers are expressed in connection with teaching in a multilingual mathematics classroom, from which mainly the *dilemma of mediation* (of validating students' meanings versus developing mathematical communicative competence) and the *dilemma of transparency* (of the visibility versus invisibility of language as a resource for learning) are of importance: "*Language, as a communication tool in a mathematics classroom, must be visible (so it is clearly identified) and simultaneously invisible (so it can be utilized when discussing mathematical meaning).*" (p. 32)

In (Gorgorió, Planas, 2002) it is stated that "*even if the mathematical language can be considered universal, i.e. shared by all those doing mathematics, then the language of 'doing mathematics within the classroom' is far from being universal*" (p. 30).

Whereas some papers focus on obstacles in communication and linguistic barriers, that is the impaired relation of images and thoughts and their linguistic representation (Hejn_, 1990), others Moschkovich (2002) claim that everyday meanings can be seen as resources for mathematical discussion. "*An accurate description of mathematical communication for bilingual students needs to include not only an analysis of the difficulties but the also the multiple resources students use to communicate mathematically.*" (p. 206)

[2] The second and fourth proficiencies are domain dependent.

Findings

When studying issues related to using authentic textbooks in teaching mathematics in English to Czech students (MEC) we used the following methods: analysis of the language of EFL textbooks and teaching materials used in Czech schools; study of TEFL curricula (Charles University in Prague, Faculty of Education); observation of the milieu of the classroom during EFL and MEC lessons, analysis of video recordings of MEC lessons, contrasting oral and written forms of the language; comparing linguistic barriers in MEC lessons at schools and in teacher training; the authors' accounts of their own classroom and teacher training experience.

The identified obstacles were classified into three main groups: *general vocabulary and realia*, *grammar items* and *mathematical terminology*. In the process of communication, the three groups are not separated, they overlap. However, this division enables to characterise the nature of the corresponding obstacles more clearly and to see possible ways of avoiding them.

In the following sections we give the list of main problems identified in our study and illustrate them by the concrete examples from foreign textbooks. The textbooks used were an American textbook for young learners *Addison-Wesley Mathematics* and Australian textbooks for upper-secondary students *Introductory Calculus* and *Discrete Mathematics.*

1. *General vocabulary and realia*

1a) Vocabulary taught in EFL lessons versus specialised vocabulary

Vocabulary presented to beginner and pre-intermediate students in EFL lessons covers mostly everyday life issues. Learners start with real objects that surround them. They learn to speak about their families, school, home, friends and hobbies. Words they are likely to know at relatively early stages are e.g. words connected to food, fruit and vegetables that they are likely to eat (i.e. food that they can buy in Czech shops), items of clothing, colours, school subjects taught in Czech schools, basic housework, time expressions, common household objects, means of transport, etc. It takes time before students get acquainted with realia of the target language culture. Unfortunately, and this was especially the problem of the textbook for young children, groups of words listed below are natural for young American children, but they cause problems for Czech learners. They are either too difficult or they have no counterpart in Czech culture. In the analysed textbooks in English we found the specialised vocabulary covering e.g.:

- Special parts of clothing (*regular tie, bow tie, ball glove, small bat* – Addison-Wesley Mathematics, p. 9).
- Special casing (*egg flats, mackerel cases, box of seal food* – Addison-Wesley Mathematics, p. 331, 332); beginner students will only know two words from this list: *egg, box*. N.B. If only the word *box* was used in the assignment, it would not change the mathematical content of the problem.

- Special types of banknotes (*dimes* – Addison-Wesley Mathematics, p. 40). Money is introduced to learners at a relatively early stage of their learning (e.g. New Hotline – Unit 1) as it is used for practising of saying numbers.
- Special units (*inch, mile, feet* – Addison-Wesley Mathematics, p. 247, 310, 365, *quart, gallon* – Addison-Wesley Mathematics, p. 374).
- Special products, objects used in English-speaking countries but not in the Czech Republic (*geoboard,* Addison-Wesley Mathematics, p. 229, 250, 100).
- Special food (*muffins, batch of bread, rye and wheat bread* - Addison-Wesley Mathematics, p. 87, 88, 100); EFL students will only know the basic terms such as bread, roll, cake but they will not be able to distinguish between special kinds of these.

1b) Vocabulary from other specialised domains

It is not rare that the context of word problems is connected with a specific scientific domain, e.g. biology, physics, geography with its specific terminology (e.g. *Douglas fir*, *bamboo, loblolly pine*, Addison-Wesley Mathematics, p. 96; *wingspan, gliders* - Addison-Wesley Mathematics, p. 123 etc.). This usually does not represent an obstacle for native speakers who have learned the terminology in the lessons of the corresponding school subjects but it represents a major obstacle for those who did not go through such courses.

The above presented obstacles are much more important with younger students who are not able to separate the reality from the mathematical structure. Students able to generalise are often not disturbed by the lack of understanding of the real meaning of the used context terms. They are able to replace them by general expressions or symbols. The importance of this group of obstacles diminishes with the age of students.

What can the teacher do to help the class? We see two main possibilities: to modify the context of problems presented in the textbooks to more comprehensible areas for Czech students, or to present and to use the necessary vocabulary items several times before presenting them in a mathematical context: either in the MEC lessons or in EFL (if such co-operation is enabled by the EFL teacher). New vocabulary or terminology could be presented in a text and practised through a game, competition, crossword etc. Illustrations accompanying the text will also be very helpful. In this case vocabulary should be revised before the students start solving mathematical problems.

1c) Realia

Problems with different ways of expressing basic things can be listed under this heading. For example a different way of recording the date in American English than in Czech language[3] or the differences in telling the time. In these instances it is not a

[3] The problem with recording dates either as dd.mm.yy common in the Czech Republic or yy.mm.dd common in the USA can represent an obstacle if not clearly explained to students and experienced enough with them.

problem of unknown vocabulary but a socio-cultural difference. Students are simply used to different standards of recording and saying things. We would like to point out some of the advantages and disadvantages of expressing time in English and in Czech. In Czech, the usual way of expressing e.g. "5.10 p.m." is "in 5 minutes a quarter to 6"; "5.35 p. m." is expressed as "five past half six"; "5.42 p.m." is expressed as "in 3 minutes three quarters to 6". It obviously requires much easier mathematical calculations as it never exceeds adding or subtracting 10. In English, on the other hand, children have to subtract and add up to twenty. Telling time can be therefore successfully used as the method of teaching children how to add and subtract. Czech students are taught the English way of telling the time relatively early in EFL lessons. It is presented as a cultural difference, and so the students regard it as something unnatural. Therefore it does not seem the best idea to use it in mathematics lessons as they would have to pay attention to two problems instead of fully focusing on adding and subtracting.

2. *Grammar*

This group of obstacles is undoubtedly also of utmost importance. The structure of English and Czech languages shows basic differences as Czech is an inflected language whereas English mostly analytical, not abounding in flections. That is why it has other means for expressing syntactic relations – e.g. functional words and word order. Grammatical structure is flectional in Czech, analytical in English, which is connected with a relatively free word order in Czech and fixed word order in English. English recognizes the same parts of speech (plus the determiner) as Czech and their classification depends also on morphological, lexical and syntactic signs as in Czech. However, these criteria are not proportioned in the same way. A Czech word belongs to a certain part of speech even out of sentence context; in English it is, due to the lesser degree of flexion, not so clear, conversion (one word used in several parts of speech) being common. English also knows various types of word formation, derivations, composites, very frequent is homonymy. Passive voice has different characteristics as well as the category of countability. Functional sentence perspective is achieved through different means. The key problem here is the fact that in the Czech language with its free word order, the mathematical problem can be presented in such a form that the relevant information is highlighted by its position in the sentence. In the English language, however, this possibility is greatly limited. This may lead to better understanding and mathematisation of word problem assigned in Czech than in English. There are also other problems, which may influence the understanding of word problems by Czech students.

Let us present some of the obstacles identified in the above mentioned textbooks. It is obvious that the influence of this type of obstacles diminishes with the developing language proficiency of the particular student. But some of them might influence even the high level mathematics doing.

- Word order: e.g. *What number times 2 equals 8?* or *7 times what number equals 14?* (Addison-Wesley Mathematics, p. 99) use word order utterly alien to native

Czech speakers who are used to the following two questions: How many times two equal six (the number we are looking for is at the beginning of the question) or Two times how much equals 6? The English question will, therefore, at first require the child's attention as it is not natural. Nevertheless, Czech students will get used to it quite easily as the question uses the expression *what number* and thus gives a better clue to what the pupil is asked to look for.

- Use of different expressions: e.g. *What is 66 divided by 8?* – Addison-Wesley Mathematics, p. 193; in Czech the question is expressed by *How much is 66 divided by 8?* the presence of the word *what* instead of the usual *how much* can be misinterpreted.
- *How many 30s are in 270?* – Addison-Wesley Mathematics, p. 99, p. 319; in Czech the plural is not formed by the ending –s, it has its own form (singular *tricítk**a***, plural *tricítk**y***) and in the written symbolic form in both cases only number *30* is written; *30s* can be either misunderstood or misinterpreted as an algebraic expression.
- There are typical forms of expressing the relationships in English, e.g. *three times as long as* – Addison-Wesley Mathematics, p. 170; in Czech this is expressed as *three times longer than*. This different way of expressing the same thing is often the source of misapprehension.

The obstacles of the above mentioned type can be overcome only by a longer practice with doing mathematics in English. The repeated attention paid to these difficulties helps students to understand the formulations naturally without being disturbed by the language differences. The suitable activities for giving students more practice in expressing and understanding the English formulations correctly are games. Examples of such games adapted from EFL teaching are presented e.g. in (Novotná, Hofmannová, Petrová, 2002).

3. *Mathematical terminology*

The language of mathematics is universal, but it is necessary to be aware of certain conceptual differences. Some terms are known only in a particular language (e.g. the Czech term *central symmetry* is not used in English, the English mathematical term *barrel* is not used in Czech for a special type of solid). When preparing a lesson it is necessary to make the concept analysis of the corresponding mathematical area.

3a) Meeting English words in the texts[4]

- Different meaning for the same word: for Czech students the first meaning of the word *times* is connected with the noun *time* and not with the adverb representing a multiplicative relationship. It represents an obstacle for understanding the structure of the problems assigned by words.

[4] Further examples are given in the section 2 dealing with grammar.

- Non-existing Czech translations for English terms: e.g. *barrel*.

3b) Presenting new vocabulary

Presentation of new vocabulary is a necessary activity in both mathematics taught in Czech and in English. When teaching mathematics in English, we often face the situation where students know the word in the Czech form from their previous experience but the word is not integrated into their English vocabulary register. The most common case is that

- the Czech translation has the meaning in the real life that supports students' understanding of the mathematical term, which is not the case for the English equivalent (the English term *perimeter* is not used in real life for describing something like a *boundary* enclosing an area, the Czech translation *obvod* has this property).

The above mentioned phenomenon cannot be seen as an obstacle only. It can also help overcome misunderstandings. In Addison-Wesley Mathematics, p. 263, e.g., we can find the distinction between *it is likely* in everyday language and *it is probable* in mathematical probability. In Czech the word *pravdepodobny* is used in both cases, which may, to some students, cause a conflict in the meaning. Similarly, the English use of the only term *digit* (also in the collocations like *2-digit number*) prevents confusions based on the two Czech official terms: *cifra* (used also in the adjective collocations: *2-cifern_*) and *číslice*.

Suitable activities helping students are the same as in the previous cases, mainly the use of games developing students' vocabulary. The presentation of new vocabulary should be based on several separate models of the terms and in no case can be done quickly without feedback. Frequent repetition is welcome. Interactive teaching strategies are more successful than the transmissive ones (Hofmannová, Novotná, 2003).

Concluding remarks

As already mentioned, the list of items influencing the comprehension of original English texts is not complete. Deliberately, well known facts like different writing of decimals and natural numbers in USA and many European countries were not highlighted.

It must be concluded from our analysis, that the higher and more difficult mathematics is used, the fewer language problems the students will have to face. Firstly, as they mature their language competence increases, but more importantly higher level mathematics uses much less everyday language and many more terms and formulas.[5]

[5] Both Australian upper secondary school textbooks (Byfield, 1990) represent further evidence for our findings.

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