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Verbal Counting in Bilingual Contexts

Ana Donevska-Todorova

Abstract: Informal experiences in mathematics often include playful competitions among young children in counting numbers in as many as possible different languages. Can these enjoyable experiences result with excellence in the formal processes of education? This article discusses connections between mathematical achievements and natural languages within the CLIL (Content and Language Integrated Learning) theoretical framework. The focus of the research study is set on learning counting and concepts of numbers in bilingual, German-Macedonian, context, in early primary school, taking into consideration students' previous language and immigrant backgrounds. In particular, developing number concepts is analyzed through children (un)awareness of the existence of a starting element in the set of natural numbers, a unique immediate successor and a unique immediate predecessor of any natural number (except for the first element) and the infinity of the natural numbers. The obtained results are discussed through two case studies on which the conclusions are derived.

Key words: CLIL, natural numbers, primary education, verbal counting, language

1. Introduction

This article consists of eight sections, beginning with an elaboration of the theoretical frameworks which incloses information about young children learning numbers and counting. It points out the CLIL theoretical framework which serves for stating the research question and the epistemological analysis of the results. The article focuses on impact of language proficiency on early mathematics achievement in bilingual contexts, and in particular in the German-Macedonian context. Therefore the next section discusses mathematics curriculum and language settings in Macedonia and Germany. The section four is a comparison between word number systems in English, German and Macedonian and identification of possible obstacles for learning. The research question, data collection, methodology and data analysis are stated in the following two sections. The article ends with a presentation of the results through case studies, conclusions and discussions.

2. Theoretical Framework

It is a well known fact that children in their early years of childhood (age two to five) learn counting as stating a sequence of words without deeply understanding the concept of numbers, similar as if they learn any other sequence of random words. Although memorizing is a cognitive process with a lower dimension according to Bloom's taxonomy, this capability plays an important role in learning at the beginning stages, i. e. when young children (above two) are firstly confronted with numbers and counting. Preschool period (age four to five) is identified as important for developments in counting (Sarama & Clements, 2009) due to curiosity about the structure of the number word systems themselves (Sarama & Clements, 2009; Griffin, 2004). As children meet this particular sequence more often in everyday life and later in school, they start to develop the concept more intensively. In this period, the necessity of language for verbal counting and forming systematic conception of numbers on a logical foundation comes into focus (Wiese, 2003). Children routes to number concepts from early beginnings through language acquisition and emergence of counting have been widely researched from different perspectives (Wiese, 2003; Mix, 2002; Fuson, 1988; Gelman, 1972; Dodwell, 1960). Counting sequences of natural languages play an important role in learning cardinal,

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ordinal and nominal numbers and precondition numerical cognition (Wiese, 2007). Verbal counting plays an important role in developing arithmetical methods: written standard, written informal and mental arithmetic (Selter, 2001).

Cross-cultural research verifies that learning of counting varies depending on the language of instruction in which it is learned (Sarama & Clements, 2009; Barwell, 2005). Learning number concepts depends on the language (Wiese, 2003) and vocabulary of counting words plays a crucial role in learning numerical concepts (Gelman, & Butterworth, 2005). Counting words are essential for concepts' leraning (Gelman, & Butterworth, 2005). Development of number concepts is inseparable from language, which facilitates the development, though it is not a unique underpinning for young children knowledge (Gelman, & Butterworth, 2005). The relevance of the mother-tongue for securing access to mathematics is emphasized by Clarkson (1992). What is the situation in Germany regarding the language of mathematics instruction? German is the official language of instruction in German mathematics classrooms although there may be students with up to seven different native languages learning together (Meyer & Prediger, 2011). There have been plenty of research studies accrediting the relevance of language in mathematical instruction addressing immigrant children in Germany (Prediger, Renk, Büchter, Gürsoy, & Benholz, 2013; Prediger, & Özdil, 2011; Werning, Löser, & Urban, 2008). Most of the research focus on the dominating minority group in Germany, the Turkish (Meyer & Prediger, 2011; Prediger & Wessel, 2011; Becker, Klein, & Biedinger, 2013; Kempert, Saalbach, & Hardy, 2011). These studies emphasize not only the language, but also the social and cultural dimensions of students' engagements in which learning occurs (Prediger, Renk, Büchter, Gürsoy, Benholz, 2013). This situation, however, substantially differs in the context of 'smaller' minority groups such as Macedonian. For example, there is no evidence on how well Macedonian immigrant children develop mathematics skills and understanding depending on the language or social and cultural circumstances in German-speaking countries. Scientific research on bilingual programs in Macedonia emphasize social, cultural and political perspectives (Baker, 2003; Tankersley, 2001; Бешка, Најчевска, Кениг, Балажи, Томовска, 2009; UNICEF, 2012), while research on their contribution in mathematics education in particular is vague. A document (Биро за развој на образованието, 2012) contains deficient information about mathematics education of Macedonian immigrant children. Therefore, this article may contribute in research about the extent of impact of language proficiency on early mathematics achievements in bilingual contexts of German and Macedonian, by detecting, classifying and explaining students' difficulties in practice and framing them within existing theories.

CLIL Theoretical Frameworks

Educational processes carried out from early childhood to higher education which aim gaining different content knowledge through a foreign language are often called CLIC (Content and Language Integrated Learning) (Jäppinen, 2005). Forms in which CLIC appears are broad, varying among cultural, environmental, social, psychological, subject and language appearance. These diversities are addressed in research (Jäppinen, 2005; Dalton-Puffer, 2008) and also in the European CLIL (European Commission, 2000, 2001) framework. Using the CLIC theories this research study investigates how could first grade pupils develop number concepts through verbal counting in different language contexts. More preciously, the four 4Cs (Coyle, 1999) in this research study are envisioned in the following way.

(C1) Content. Mathematical content which is in the focus of the research is simple verbal counting from 1 to 100. Simple counting is citing the number word sequence to some numeral and advanced counting is getting the successor of any numeral (Rips, Bloomfield, & Asmuth, 2008, p.624).

(C2) Communication. Students learn number concepts and counting in two languages, German and Macedonian.

(C3) Cognition. Tracking how children overcome remembering numbers as a particular sequence of words and achieve higher dimension in cognition by developing number concepts (for example, getting a sense of the existence of a starting element in the set of natural numbers, getting a sense of a unique immediate successor and a unique immediate predecessor of any natural number (except for

the first element), getting a sense of the importance of digits' positions in numbers or detecting and applying patterns in a word number system).

(C4) Culture. Children from the Macedonian community in Berlin are integrated into the formal German educational system, thus study in public (comprehensive) primary schools.

Such identified 4Cs of the CLIL theoretical framework are used for shaping the research question in the section 5 and the analysis of the outcomes of this study in the section 7. They may also be used for "integrated planning" of the teaching processes at primary schools in Macedonia (Mirascieva, 2010), because they integrate mathematical content, language and social environment.

3. Mathematics Curriculum and Language Settings

Mathematics Curriculum Settings in Macedonia and Germany

Regulations (Закон за заштита на децата, 2010, IV. Детска градинка) about pre-school (kindergarten) education in Macedonia address: educators who must be bachelor-degree holders, teaching and learning materials for language, mathematics and organization of groups of 20 to 25 children at the age between 5 and 6 in the last year of kindergarten (besides other issues regarding this educational institutions). This last year in the Macedonian kindergartens includes verbal counting from 1 to 10 as an important part of the mathematics pre-school education. Curriculum for the first grade mathematics in Macedonian primary schools (children at age 6 to 7) includes comparison of numbers, addition and subtraction with 1 also or the numbers from 1 to 10, but now including writing of the numerals (Биро за развој на образование, 2007a). Counting and number operations with numbers up to 20 are part of the curriculum for the second grade (Биро за развој на образование, 2007b). Having in mind these explanations, it seems that transition from pre-school to primary school mathematics is smooth. In comparison, regulations about pre-school education differ between the 16 German federal states (Brandt, 2013). Though most of them include explicit curricula for mathematics, for example the curriculum of Hesse (Hessisches Sozialministerium & Hessisches Kulturministerium, 2012) other states insist on increase of the on-going debate. Thus, the transition from pre-school to primary school mathematics seems more noticeable in the sense of all necessary cognitive and emotional requirements from children who have to learn numbers from 1 to 20 by the end of the first grade German primary school (sometimes without previous adequate kindergarten preparation).

According to the mathematics curriculum for the first grade primary school in Berlin, students have to learn numbers from 1 to 20. This includes counting and operations addition and subtraction. The second grade curriculum covers counting and number operations: addition, subtraction, multiplication and division until 100 (besides other topics such as geometry). Cultural circumstances in schools in Berlin and in Macedonia favor verbal and object counting in comparison to finger counting, although finger counting "may provide the missing tool to apprehend numbers in the physical world" and "may critically contribute in understanding natural numbers" (Andres, Di Luca & Pesenti, 2008, p. 642, 643). Finger counting, in our experience, has a bigger role to play in simple arithmetic then in either simple of advanced counting.

Traditional way in introduction to number space 1 to 20 in the first grade German primary schools is trough four phases (Wittmann, 2001, p. 10). Namely, in the first quarter of the school year students learn the numbers from 1 to 6, in the second quarter, the numbers from 1 to 10, in the third quarter, the numbers from 1 to 20, but without sums greater than 10, which are planned for the fourth phase of the school year, according the curricula. Exemplary textbooks and learning materials are from Bauer, R. und Maurach, J. (2010). Another approach for introduction in arithmetic to 20 in the first grade has been proposed as one whole, without any 'boundaries' (Wittmann and Müller, 1990).

In Macedonia introduction to arithmetic in the first grade is only for the number system 1 to 10 through adding and subtracting the number 1 (for example, textbooks and learning materials with didactically recommendations Крстеска, et al., 2008a). Arithmetic 1 to 20 is in the second grade. Exemplary textbooks and learning materials with didactically recommendations are from Крстеска, et al. (2008b). These goals stated in the curricula for the first and second grade primary schools in Macedonia are criticized as weak and need actualization (Роде, и Вилмот, 2008).

Language Settings

Language differences are large having in mind the fact that Macedonian language, as a Slavic language (belonging to the South Slavic branch), uses the Cyrillic alphabet. Yet, since Slavic languages form a coherent group in the Indo-European family of languages, to which the German (and the English) language belongs, similarities cannot also be denied[1]. In order the reader to get more familiar with these language differences and similarities, and easily understand the research problem, the following Table 1 was constructed. It shows that although the base-ten number system uses standardized Arabic numerals, cardinal numbers sound differently across the corresponding languages as English, German and Macedonian.

Portion		English	Deutsch (German)	Македонски (Macedonian)
First portion	1	one	eins	еден (eden)
	2	two	zwei	два (dva)
	3	three	drei	три (tri)
	4	four	vier	четири (chetiri)
	5	five	fünf	пет (pet)
	6	six	sechs	шест (shest)
	7	seven	sieben	седум (sedum)
	8	eight	acht	осум (osum)
	9	nine	neun	девет (devet)
	10	ten	zehn	десет (deset)
Second portion	11	eleven	elf	единаесет (edinaeset)
	12	twelve	zwölf	дванаесет (dvanaeset)
	13	thirteen	dreizehn	тринаесет (trinaeset)
	14	fourteen	vierzehn	четиринаесет (chetirinaeset)
	15	fifteen	fünfzehn	петнаесет (petnaeset)
	16	sixteen	sechzehn	шеснаесет (shesnaeset)
	17	seventeen	siebzehn	седумнаесет (sedumnaeset)
	18	eighteen	achtzehn	осумнаесет (osumnaeset)
	19	nineteen	neunzehn	деветнаесет (devetnaeset)
Third portion	20	twenty	zwanzig	дваесет (dvaeset)
	21	twenty one	einundzwanzig	дваесет и еден (dvaeset i eden)
	22	twenty two	zweiundzwanzig	дваесет и два (dvaeset i dva
	23	twenty three	dreiundzwanzig	дваесет и три (dvaeset i tri)
	24	twenty four	vierundzwanzig	дваесет и четири (dvaeset i chetiri)
	25	twenty five	fünfundzwanzig	дваесет и пет (dvaeset i pet)
	26	twenty six	sechsundzwanzig	дваесет и шест (dvaeset i shest)
	27	twenty seven	siebenundzwanzig	дваесет и седум (dvaeset i sedum)
	28	twenty eight	achtundzwanzig	дваесет и осум (dvaeset i osum)
	29	twenty nine	neunundzwanzig	дваесет и девет (dvaeset i devet)
	30	thirty	dreißig	триесет (trieset)
	31	thirty one	einunddreißig	триесет и еден (trieset i eden)
	...			
	100	hundred	hundert	сто (sto)

Table 1. *Tree Portions of Numbers from 1 to 100 in English, German and Macedonian*

The portions of verbal representatives of numbers from 1 to 100 presented in the Table 1 in English, German and Macedonian are analyzed in the next section 5.

[1] In this sense, this article may also contribute in comparative studies in linguistics (Comrie & Corbett, 2003). For additional reading, see (Gvozdanovic, 1997).

4. Comparison between Word Number Systems in English, German and Macedonian and Identification of Possible Obstacles for Learning

Natural numbers (or positive whole numbers: 1, 2, 3, …) clearly have a foundational value for learning more complex number sets as: the set of integers, the set of rational, the set of real and the set of complex numbers in the later stages of mathematics education. The set of natural numbers is infinite and countable, but in comparison with the set of integers it has a unique initial element. Every element in the set of natural numbers has a unique immediate successor and a unique immediate predecessor (except for the first element). Finally, natural numbers have the inductive property. These characteristics of the natural numbers are acctually the Peano's axioms. Thus, it is absolutely not irrelevant in which way children are first introduced to the set of natural numbers, by verbal counting based on natural language.

Research distinguishes between four potions of verbal counting of numbers from 1 to 1000, namely, from 1 to 10, from 11 to 19, from 20 to 29 and from 100 to 999 (Ng, & Rao, 2010; Miller & Paredes, 1996; Miller, Smith, Zhu, & Zhang, 1995; Miller & Zhu, 1991). The first three of these four portions of verbal representatives of numbers are of interest for the study and are therefore shown in the above Table 1.

The *first portion* forms one block of pattern in all three languages. This block of pattern appears as analog in the *second portion* in complete only in Macedonian, while it occurs as a block of pattern only for seven numbers, namely for the numbers from 13 to 19, in English and German. In other words, the second portion of word numbers from 11 to 19 in Macedonian is obtained by adding the expression “naeset” at the end of each verbal representation of the numbers from 1 to 9 (the last column in Table 1). Simultaneously, the “teen” pattern in English and the “zehn” pattern in German work only for the numbers from 13 to 19[2]. Thus, the numbers 11 and 12 are exceptions from the pattern in both English and German. This is a potential obstacle for learning of bilingual children Macedonian-German or Macedonian-English and reserves a lot of attention. The boundary between 10 and 11, and the problem of “teen” numbers are particularly relevant when one considers the language used to denote numbers 11 to 19 (Ng, & Rao, 2010). Difficulties with the “teen” numbers in the English language compared with the Japanese language are also discussed in a Macedonian study (Род, Кнапмилер, & Туре, 2008, p. 58-59), but no comparison is offered regarding these numbers in the Macedonian language. Still, according the above analysis, it seems that the Macedonian number naming system promotes acquisition of these particular numbers: 11 and 12 besides the “teen” numbers.

The *third portion* of verbal representatives of numbers starts with the number 20 in all three languages. The block of consistent pattern, for the numbers from 20 to 29, overlaps with the third portion of verbal representatives of these numbers in the three languages. A significant difference appears in German, in which the number of ones is read prior the number of tens as opposite of English and Macedonian. Therefore this is one more potential obstacle for bilingual Macedonian-German children when learning verbal counting.

Shortly summarized, the comparison of the word number systems in English, German and Macedonian points out three main possible obstacles: *first obstacle*, boundaries between 10 and 11 (analogically between 20 and 21 and 30 and 31 etc.); *second obstacle*, “teen” numbers; and *third obstacle*, reading the number of ones prior the number of tens in the German language.

[2] The first block of pattern can be viewed as an equal set with the first portion of numbers. The second block of pattern can be viewed as an equal set with the first portion of numbers in Macedonian, whereas only as a proper subset of the second portion of numbers for the English and the German language.

5. Research Question

One research question often pointed out in current and future trends in cognitive sciences is “how do varieties of languages, especially varieties of number-naming systems, promote or inhibit acquisition of basic numerical concepts” (Gelman, & Butterworth, 2005, p. 9). This study may contribute in research in the mentioned direction by posing the following research question.

> How does verbal counting in two (or more) languages, thus the communication (C2) and culture (C4) influence development of mathematical content (C1) and cognition of number concepts (C3) in early primary school?

The posed research question is not a trivial question. Namely, findings obtained by verbal counting in one language may not coincide with findings gained by verbal counting in another language. They even differ in most of the cases. Therefore the research question could be analyzed in two directions as: (a) how does the mother tongue (Macedonian) influence learning counting and number concepts in the German language of instruction in early primary school; and vice versa (b) how does the German language of instruction affect learning counting and number concepts in the Macedonian language in early primary school?

6. Data Collection, Methodology and Data Analysis

Participants in the research study are primary school students from a Macedonian school[3] in Berlin where they meet once a week, primarily to develop their speaking and writing competences in the Macedonian language. Two students from a class in this school were selected in collaboration with the instructor and parents to voluntary participate in the case studies. Students have different backgrounds as is elaborated below, in the subsection *Preliminary Data*. Collected data during the research include transcripts of video recordings of working sessions. Excerpts of the transcripts, their translations and their interpretations are given in the section 8 of this article.

Teaching method applied during the research was inspired by the organizational and teaching concept in German “Grundschulen“ according to which students in the first and second, and sometimes also third grade, learn together as partners in one classroom. Research distinguishes between multi-grade classes which are formed out of necessity and multi-age classes which are formed deliberately (Veenman, 1995). Still, both forms highlight collaborative work among students. Organization in multi-grade classes in the Macedonian school is due to the relatively small number of students and is regulated according to instruction in the document (Биро за развој на образованието, 2012). Such education substantially differs from the standard primary school programs which are designed to respond the needs of students in a single grade (students at same age) separately from the rest. For the purpose of this study, a pair of the multi-grade class, one student from the first and one from the second grade, was chosen to undergo the qualitative analysis. Each student's work aims answering the corresponding research question (the first grade student to research question (a) and the second grade student to research question (b)). Design of the teaching intervention was made in order to strengthen students team works in which students learn one from another (not necessarily the younger from the older, but in collaboration depending on the language proficiency). Students are allowed to communicate in any of the two languages. The instructor, a language teacher previously prepared for the research (one of the challenges in CLIL, p.6), is in the role of a coordinator. During the instruction, the instructor switches between the German and the Macedonian language only when necessary. The researcher is in the role of an observer and takes notes. After each working session, the instructor and the researcher meet to discuss and analyze collected data, so they work in tandem, with accordance to the Model B5 Specific-domain vocational CLIL (Coyle et al., 2010, p. 22).

[3] Educational processes in the Macedonian school in Berlin are organized as after school activities (after the lectures in the comprehensive German primary schools) due to the drastically reduced number of enrolled students during its historical existence.

Preliminary Data

Students' backgrounds regarding previous formal pre-school (kindergarten) education and language are the following.

Case 1: The Case of Jovana

Jovana is a five and a half year old student in the *first* grade primary school in Berlin[4]. Prior the study took place she was enrolled in a Macedonian kindergarten for three and a half years and another six months in a German kindergarten. Her mother tongue language is Macedonian. She is the youngest member in the observed multi-grade class.

Case 2: The Case of Melanie

Melanie is a seven years old student in the second grade primary school in Berlin. She has attended German kindergarten and has no previous formal education in the Macedonian language. She belongs to the third generation of students with Macedonian origin in Berlin.

These preliminary data are in connection to the (C4) CLIL theoretical framework, because the mother tongue, family circumstances and early education may influence students' achievements in mathematics, especially on the beginning of primary school. Family immigrant background and socioeconomic background in the general educational system in Germany is analyzed in many studies, for example, (Prediger, Renk, Büchter, Gürsoy, & Benholz, 2013) and (Werning, Löser, & Urban, 2008).

7. Results of the Research Study

Case 1: The Case of Jovana

During the research study Jovana is at a stage when she notices numbers on the buildings as she walks along a street and she happily reports that a particular building is numbered thirteenth and the next one fifteenth, and then seventeenth by looking at the notations 13, 15 and 17 (a statement derived from the meetings between the research team and parents). However, for the notation 21, for example, she says "twelfth". What we could claim at the moment is that she definitely recognizes both numeric representations: 2 for "two" and 1 for "one", but is her mistake due to unawareness of the importance of digits' positions in numbers or to the German language? This dilemma is an illustration for the motivation of the study and it initiated further investigations presented in this article through several questions of the interviews.

Transcript 1. Verbal Counting from 1 to 20

> Instructor: *Could you please count from one to twenty?* [in the German language]
>
> Jovana: *eins, zwei, drei, vier, fünf, sechs, sieben, acht, neun, zehn, einundeinzig, zweiundeinzig, dreizehn, vierzehn, fünfzehn, sechzehn, siebzehn, achtzehn, neunzehn, zwanzig.*
>
> Translation: *one, two, three, four, five, six, seven, eight, nine, ten, ?, ??, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty.*

She counts from 1 to 10 without a mistake, but when she riches eleven she says: "einundeinzig" which is a non-existing German word, but could be 'translated' as "one and one tenth". Similarly for twelve she says "*zweiundeinzig*" ("two and one tenth") and then continues to count correctly. Afterward, for deeper investigation of the research question in both directions, she is asked to count in the Macedonian language. She does that without a mistake. This fact suggests that she connects verbal counting in German with verbal counting in her mother tongue language, because "eleven" in the Macedonian language is formed from the words "one" and "ten" (edinaeset) and "twelve" is formed from the words "two" and "ten" (dvanaeset), as also presented in Table 1. Grammatical rule which is

[4] She is enrolled in the first grade earlier than usual (children with 6 or more years).

used for forming the numbers from “thirteen” to “nineteen” in the German language (and also in the English language) is the same with the rule in the Macedonian language, and moreover the numbers “eleven” and “twelve” also follow the same rule in Macedonian (as was previously shown in Table 1 and explained in section 5). In other words, she follows the pattern for the number words in the second tenth according rules in the Macedonian language, so starting with eleven. The same pattern in German and in English starts with the number thirteen. This fact gives us indication to assume that Jovana builds her knowledge on verbal counting based on the mother tongue language, thus developing mathematical content (C1) and cognition (C3) depend on the way she communicates, i.e. (C2). She has found a personal mechanism for practically overcoming the previously theory driven and identified first and second obstacle (in section 5 of this article). This excerpt of the interview also confirms that she is no longer in the stage of repeating a particular sequence of words, but she made progress in conceptual understanding, thus in cognition (C3) by reasonably applying her previous knowledge in the mother tongue language into learning counting in the second language (by inventing new words analogical to existing words in her mother-tongue language). Thus, she efficiently uses her mother tongue language to learn mathematical content in German and the capability to think in different languages even to a small extent, results with positive effects in content learning (Marsh, 2009).

Is children capability for verbal counting of numbers until a fixed number (20 in the above Transcript 1) enough evidence for their awareness of the existence of the unique first number in the natural number's system? They learn simple counting *starting from 1* without very big problems even in non-native languages, whereas verbal counting *starting from any other number than 1,* which may be considered as advanced counting, seems more difficult in most of the cases even in the native language. This was also tested with Jovana and she refused to count starting from 5. Is this a sufficient proof for an affirmative answer on the stated question? One important remark is that, it is even not necessary young children to be conscious about the first principle of the set of natural numbers (that it has a first element) in order its acquisition (Rips, Bloomfield, & Asmuth, 2008, p.638). Second remark is that the previous statement can be considered as an example that advanced counting emerges later. Third remark is the following. Jovana knows that there are exactly two 'missing' numbers (11 and 12) and invents exactly two own words for them. Furthermore, the invented non-existing words for the first two numbers in the second portion (Table 1) have an ordinary character (paraphrased: 'one and something' and 'two and something'). Is this a sign that she has a sense of the generative rules of the number sequences? Such generative rules have implications in understanding infinity of numbers. Finally, a fourth remark is that, she places them in the correct place in the sequence. Is all of that a sign for her sense of the successor function which is one-to-one? The transcripted interview suggests that even simple verbal counting up to 20 may serve as a predictor whether understanding of the successor function at this age starts to emerge or not, although some resources claim that only advanced counting leads to natural numbers concepts (Rips, Bloomfield, & Asmuth, 2008, p.631 and p.639). Nevertheless, it may also be the case that she already is in the phase of advanced counting, because she is able to compare two given numbers with relations as “greater than” and “less than”, but her denial to count starting from a number different from 1 upward, gives indication to think that she does not master advanced counting yet. It would be difficult to imagine that advanced counting can emerge without simple counting. In this sense, the use of a foreign language (C2) for simple counting may serve as a tool for such discoveries, which cannot be detected by simple counting exclusively on the mother-tongue language.

Transcript 2. Backward verbal counting from 10 to 1

Backward counting is considered important for developing sense for the existence of a unique immediate predecessor (except for the first element) of any natural number. Furthermore, it is relevant for learning the relations “less than” and “greater than” and even more important for learning the operation subtraction of numbers. When Jovana is asked to count backward from 10 to 1 in the German language, she says:

Jovana: *zehn, neun, acht, sieben, fünf, sechs, vier, drei, zwei, eins.*

Translation: *ten, nine, eight, seven, five, six, four, three, two, one*

In order to detect whether the mistake is due to the conception or to the language, she is asked to count backward from 10 to 1 in her mother tongue language (language switching, according to Moschkovich, 2007). She counts:

> Jovana: *deset, devet, osum, sedum, pet, shest, chetiri, tri, dva, eden.*
>
> Translation: *ten, nine, eight, seven, five, six, four, three, two, one*

These excerpts of the transcript confirm our previous hypothesis that she bases her new mathematical knowledge (C1) in the German language on the foundations of her previous knowledge in her mother tongue language (which was also the language of instruction in her pre-school education), thus (C2) and (C4), because the same misconception, replacing six and five, occurs in both languages.

From the conceptual and cognition (C3) perspective, it seems that determination of the exact unique immediate predecessor causes more difficulties than determination of the exact unique immediate successor (there was no mistake in the counting sequence from four to seven in Transcript 1), but awareness for the “uniqueness” seems to be present to a certain extent (there is no additional element occurring in between six and five, and none of them is missing, they are only replaced).

Transcript 3. Verbal Counting from 20 to 100 in English.

Outside of the research settings, Jovana was detected enjoying counting in English. Her experiences with the English language started in the Macedonian kindergarten, a year before her experiences with the German language. She has not studied these numbers in formal school settings, thus these outcomes may be a consequence of older children influence during participation in collaborative games in a presence of an English-speaking educator in the kindergarten.

> Jovana: *...twenty-eight, twenty-nine, twenty- ten, twenty-eleven, twenty-twelve,...*

Such a mistake is done only by English-speaking children and not by Chinese children for example, is claimed in research (K. F. Miller at al., 2000; Ng, & Rao, 2010). Similarly as the first obstacle for the boundary between 10 and 11 (identified in section 4), the boundary between 30 and 31 appears as problematic, because of the need of a new word. Yet, Jovana's construction “twenty-eleven” instead of thirty-one or “twenty-twelve” instead of thirty-two, may show useful for learning addition of two-digit numbers in the later stage of cognition. Although English was not in the focus of the research, we considered this information as relevant to show that rich language competences (C2) may lead towards gaining knowledge in mathematics (C1) and it reserved a place in this report. In this case it was learning numbers in the third tenth from the number system of natural numbers due to child's curiosity much before her exposure to learning of these particular numbers in formal settings (part of the mathematics curriculum for second grade in Germany) in any of the three languages.

Lack of new words in a foreign language (“elf”, “zwölf” in German, in the Transcript 1, or “thirty” in English, in the Transcript 3.) results with Jovana's own word constructions as representatives of numbers, thus contributes to her conceptual thinking in mathematics besides developing working memory for number names.

In Transcripts 1 and 3 Jovana did not stop counting when she run out of corresponding words (for 11 and 12 in Transcript 1 and for 30, 31, 32 in Transcript 3). Although her verbal lists stop at 10, i.e. 30, she did not stop counting. On the contrary, she continued counting by inventing new number words, which suggests possible sense for the infinity of natural numbers or at least for the countability of natural numbers. Thus, she recognized the necessity for existence of number words, which provided enough indication to think that she only cannot figure out names matching the number concepts she already possesses.

All of the above excerpts of the transcripts show how mother tongue language (C2) facilitated learning mathematical content (C1) and cognition (C3) in a foreign language of instruction within the CLIL theoretical framework in accordance to the research question and (a).

Case 2: The Case of Melanie

The problem regarding digits' position in numbers seems even more important for the older children in the multi-grade classroom. According to the Berlin's curriculum for second grade, students learn numbers to 100 in the German language of instruction. The older student in the researched pair of students, Melanie, has no problems with verbal counting in German, but in writing notations of numbers when hearing them in the Macedonian language.

Transcript 4. Written Counting from 20 to 100

In comparison with previously discussed examples about verbal representatives of numbers, this example refers to writing numeric representations of numbers depending on the spoken language. Namely, for the numbers from 21 onwards in the Macedonian language Melanie first writes the number of ones and then the number of tens in front of it, although this ordering is not a characteristic of the Macedonian language (Table 1) (C2) and culture (C4).

This characteristic of the German (and the Dutch) language for reading the ones first, or before the tens is identified as more difficult even from the English language (and much more difficult from the Chinese language in which the number 21 for example, is pronounced two-tens and one) (Sarama & Clements, 2009, p. 54).

Since Melanie is in the second grade, she has already learned patterns and principals in the number system as coded in the German language, which is especially important for number words above twenty (Baroody, 1987; Fuson, 1992). The problem occurs when she has to translate into Macedonian language due to differences in building these patterns in each of the languages. This is a practical confirmation of the third theoretically driven obstacle in section 4 of this article. Exposure to the German language in both preschool and school settings and to the Macedonian language only in informal settings (Preliminary Data), thus both communication (C2) and culture (C4), partly preconditions the problem. In order to be able to switch the wording in number pronunciation she needs more time. It seems that collaboration with the other partner-child (more skilled in the Macedonian language) was helpful for overcoming the problem during the intervention.

The above discussion shows the following. A typical (expected) situation would be problematic writing of numbers above 20 in German. Yet, it seems not to be the only problem. As the example suggests, similar obstacle may occur in situations when German children, for example, learn written representations in English (as Macedonian and English have same patterns for the numbers from 20 to 99, reading the number of tens prior the number of ones, thus from left to right, presented in the Table 1.). These elaborations are related to the second specific research question (b) about how do students with mathematical background gained in the German language of instruction learn counting and writing numbers in the Macedonian language.

8. Discussions and Conclusions

The article does not argue that natural language is a sufficient tool for acquiring concepts of numbers, but how could the use of two (or more) languages (C2) may serve as an experimental technique for detecting and verifying possible obstacles or different degrees of their cognition (C3). It does not also mention other relevant aspects for development of number concepts, as for example: numbers as cardinality of sets, not because they are less important or ignored during this small-scale research study, but because the aim was investigating in language-mathematics (or word-number) dependences.

This research study exemplifies theoretically detected obstacles and their practical confirmation in one specific situation for learning verbal counting from 1 to 100 and concepts of numbers through different languages. It aimed to facilitate turning young children potentials in mathematics into reality, which often depends on family and community settings (Cross et al, 2009). It tried to provide working atmosphere for young immigrant children in a multi-grade classroom towards equity and excellence in mathematics achievements in early childhood. With its focus on having languages as a medium for learning mathematics, but also a dual focus of setting mathematics as content for learning vocabulary, CLIL contributed in students' progress in counting and understanding of existing patterns in number systems. Overall children not only improved their language skills (C2), because development of second language competences are inseparable part of CLIL approaches, but most of all made progress in cognition (C4) of word counting understanding that number words patterns differ among languages and attention of digits' positions in numbers (place value) significantly matters. Both CLIL learners in this study, benefited from their participation by gaining mathematical knowledge without particular guidance or use of special learning materials, but with help one from another which is the first, out of four, key characteristic of a CLIL environment (Jäppinen, 2005). As fellow learners they interacted through their spoken language, gesticulations and movements. Our opinion is that Macedonian immigrants' children benefited from this small-scale case study with CLIL approach, (which does not necessary have to stand for autochthonous children) as also emphasized by Van de Craen (2001, p. 218).

Conclusions on classroom level.

Jovana's reactions during the interview in Case 1 show that the word representations are not just numerals for her (C1), but they have the meaning (C3) of natural numbers (ordinality as exemplified on the beginning of the section 7, case 1; values and labels as explained through the transcripts). Her number word sequences have the structure of the natural numbers. In particular, Transcripts 1 and 3 show that Jovana is at level 5 (out of five) which means that she can autonomously state a long sequence of numbers from the beginning to the end, although she uses non-standardized names for the numbers (Род, Кнапмилер, Туре, 2008, p. 53). Transcript 2 for backward verbal counting shows that she is at level 4 because her produced sequence has correct beginning and ending, but an unstable middle. Both forward and backward simple verbal counting, in coherence one with another, contribute in students' grasp the idea of existence of a unique immediate successor and a unique immediate predecessor (except for the first element) of any natural number.

On standardized measures of mathematical achievements on a particular language some children may show weaker results not as a result of insufficient mathematical knowledge, but due to an ongoing process of development of language competences, as in the Case of Jovana, Transcripts 1 and 3; and in the Case of Melanie, Transcript 4. The interplay of two (or more) languages may enhance or distract bilingual students and teaching mathematics on a non-native language for them is a challenging task (Lim & Presmeg, 2011). For such reasons immigrant children achievements in mathematics substantially depend on instructional support (Howes et al., 2008). Determined obstacles in section 4 may also prove helpful for parents willing to engage in their children achievements in early mathematics (C1), because students' achievements in early mathematics mainly depend on language proficiency (C2) and not on the family background (C4) (Prediger, Renk, Büchter, Gürsoy, & Benholz, 2013). Germany, besides Switzerland, France, Netherlands and even Sweden in continental Europe, is pointed out as a country with imbalance in mathematical competences between native and immigrant children (Schnepf, 2007). Mathematics achievements of students with immigrant background in Germany are often measured as weaker compared to those of native students with cross-national data sets as Program for International Student Achievement [PISA] (Marks, 2005; Ammermueller, 2007; Jensen, & Rasmussen, 2011).

Implications for schooling and research suggestions

Creation of language-sensitive teaching/ learning strategies and materials (Thürmann, Vollmer, & Pieper, 2010) which would support *all* students, including those with language disparities seems to be highly important and challenging task (Prediger, Renk, Büchter, Gürsoy, & Benholz, 2013). Policies for equity among children, regardless on the national group they belong to, are hard for implementation in practice. Still, this study shows that sometimes development of special learning materials may not even be necessary. Allowing interactions between students with different backgrounds and organizing them in small working groups with minor instructor’s support may be sufficient for their progress in early mathematics. In this sense, certain changes of researchers' viewpoint may influence further debates. For example, instead of mainly considering language disadvantages of immigrant children, in the sense of (C2) and (C4), researchers could seek for ways of utilization of language differences as potential rich sources for learning (as for example Jovana's own word constructions which point out creative capabilities and mathematics maturity vs. language disadvantages) and promote inclusive education of heterogeneous groups of students with different language backgrounds in multi-grade (and/ or multi-age) mathematics classrooms. Next similar studies which may track how children absorb vocabulary and new mathematics concepts (arithmetic, properties of number operations) which lead to further developments in cognition (C3) of concepts of numbers could also address the above considerations.

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Authors

Ana Donevska-Todorova, Humboldt-Universität zu Berlin, Berlin (Germany). E-mail: todorova@math.hu-berlin.de