Approaches to Scaffolding in Teaching Mathematics in English with Primary School Students in Colombia

Enfoques para el "Scaffolding" in la enseñanza de la matemática en inglés con estudiantes de primaria en Colombia

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Abstract
Teaching mathematics in a second-language (L2) environment requires teachers to understand both relevant mathematics concepts and the L2. Teachers must be aware that the explanations, clarifications, and development of mathematical language require that students have sufficient competence in the L2 to understand what is being taught. This implies teaching language to students in three specific ways, as suggested by Coyle, Hood, and Marsh (2010): language of learning, language for learning, and language through learning. Teaching mathematics also requires teachers to apply different types of scaffolding. This study seeks to identify the types of scaffolding and instructions used by the mathematics teacher at a bilingual school in Santa Marta, Colombia teaching first-grade students in English. Classroom observations, as well as interviews and classroom observation checklists, were carried out to determine what the mathematics teacher was already doing in the classroom in terms of scaffolding. The resultant data suggests that a range of visual aids and careful use of the L1 can play significant role in supporting the simultaneous development of content and linguistics competences.
Key Words: mathematics; scaffolding; teaching; second language learning, CLIL.

Resumen
La enseñanza de las matemáticas a través de una segunda lengua (L2) exige que los docentes tengan conocimiento de ciertos conceptos específicos del área así como también de la segunda lengua. Los docentes deben ser conscientes de que las explicaciones, aclaraciones, y el desarrollo del lenguaje matemático requieren que los estudiantes tengan competencia en la L2 suficiente para entender lo que se enseña. Esto implica que la enseñanza de L2 debe abordarse de tres formas específicas, como sugieren Coyle, Hood, y Marsh (2010): el lenguaje del aprendizaje, el lenguaje para el aprendizaje, y el lenguaje a través del aprendizaje. La enseñanza de las matemáticas también requiere que los maestros apliquen los diferentes tipos de andamiaje para el aprendizaje. Esta investigación busca identificar los tipos de andamiaje y las instrucciones utilizadas por un docente de primer grado que imparte su asignatura en inglés en una escuela bilingüe en Santa Marta, Colombia. Para determinar los avances del profesor en esta área, se llevaron a cabo observaciones de clase, entrevistas y se desarrollaron listas de observación en el aula. Los datos resultantes sugieren que una serie de ayudas visuales y el uso cuidadoso de la L1 pueden jugar papeles importantes en el apoyo del desarrollo simultáneo las competencias lingüísticas y de los contenidos.
Palabras Claves: matemáticas, andamiaje para el aprendizaje, docencia, aprendizaje de una segunda lengua, AICLE.

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INTRODUCTION

Most students immersed in a bilingual education program learn through instruction that integrates content and language. In such cases, language is typically used as a medium to teach academic subjects such as mathematics, science, or social studies. However, just as teaching either content or language require particular training, teaching both at once demands even more from the teacher—and teaching mathematics in a second-language (L2) environment is no exception. Mathematics teachers in L2 environments are responsible for teaching not only mathematical concepts of Math, but also the L2 itself (at least with relation to the field of mathematics).

There is a danger, in such an environment— perhaps especially if students are exposed every day to a second language as a part of their education—that it would be taken for granted that students will understand mathematical concepts introduced in the classroom; that is, the teacher might assume that, as the students are already learning English, they should then clearly understand the language of mathematics as expressed in English. However, when teaching mathematical in English, teachers must know what sort of content-oriented language in the L2 (especially in terms of explanations and clarifications) the students require in order to understand the subject matter.

This study examines the situation of primary-level mathematics teachers, teaching in English, at the Bureche School, a bilingual school in Santa Marta, Colombia, who faced frustrations when students had difficulty understanding their English-language mathematics instruction.

LITERATURE REVIEW

Bilingulism

Definitions of bilingualism range from describing a minimal proficiency in two languages to an advanced level of proficiency which allows the speaker to function and appear as a native-like speaker of two languages. Some authors in the field of bilingualism, such as Bhatia and Ritchie (2004) have defined bilingualism as "a complex psychological and socio-cultural linguistic behavior that has multidimensional aspects" (p. 114). Such aspects that can be seen through different points of view, and the structural function of bilingualism can vary according to the context in which is seen. Haugen (1953) defined bilingualism as "the point where a speaker can first produce "complete meaningful utterances in the other language" (p. 7). It may be inferred that we should conceive of a range or scale of bilingual functions that change as learner abilities develop.

Children in bilingual contexts can be expected to go through periods in which they mix the two languages and borrow vocabulary across languages (code-switching) to express their ideas, sometimes within the same sentence. This occurs because particular vocabulary may exist in one language but not the other, or because the speaker knows the vocabulary in one languages but not the other, or words from one language may convey a message that is not easily translated to the other language. Separation of the two languages occurs gradually.

Children in bilingual contexts may also experiment with their two languages to create special effects, or to express themselves in specific settings. For example, one language may be identified as less formal and used for information about events related to home and family; the other language may be identified as more formal and used for activities outside the home. There

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may also be periods when one language is used more than the other. Children may not be equally skilled in both languages. It is common for there to be greater understanding than actual use of one language. Less confusion will occur if children learn to associate the two languages differently; for example, what is heard at school and what is heard at home. As Ching (2007) points out, "some types of behavior are likely to influence the child's attitudes towards the two languages in either negative or positive ways" (p. 40). As a result, differences between the distinct settings in which the child is learning the two languages—for example, school and home—may (or may not) influence how successful a child is in becoming bilingual.

Learning Mathematics in English

Betne and Stanchina (2005) highlight the following parallels between learning mathematics and learning a second language:

> Language learning and mathematics learning are both cognitive processes. They can be understood through a constructivist model in which meaning is derived through the interaction between one's own background knowledge and experience (top-down processing) and one's ability to process the given task or decode text (bottom-up processing). These two processing modes are complementary; one can be used to compensate for weakness in the other, but each alone is insufficient in terms of successful learning and performance. They both develop through feedback. (p. 2)

A fundamental concern in mathematics education is understanding the connections between the mathematical concepts themselves and the students who are trying to learn those concepts. Even under ordinary conditions, it may be difficult for teachers to fully understand the challenges that their students face. An additional challenge for the L2 mathematics teacher is to understand—and make use of—the linguistic strengths and experiences that students bring to the classroom. Mathematics has its own specialized language, grammatical patterns, and rules. While students are learning English, they must also learn the unique meanings that some English words have in a mathematical context. In order to understand mathematics, among other things, students must:

- learn many content-specific vocabulary words (for example, *quotient*, *equivalent*, and *divisor*).
- know the meaning of many complex phrases (for example, *least common multiple* and *greatest common factor*).
- Understand that many common English words have specialized meanings in mathematics (for example, *face*, *plane*, *cone*, *square*, *triangle*, *place*, *positive*, *negative*).
- Know that mathematical operations are associated with many different words.

Socio-cultural Theory

Although socio-cultural theory remains poorly defined in many respects, some authors, such as Lantolf (2000) or Chen, and McNamee (2008), have related to the concept of the zone of proximal development (ZPD) as elaborated by Vigotsky (1978) and drawn connections between social interaction and second language learning. A socio-cultural theory approach emphasizes the importance of interaction in shaping the situation of a child's development and learning and points to the crucial role played by parents, teachers, peers, and the community in defining the types of interaction occurring between children and their environments.

Socio-cultural theory is the major theme in Vygotsky's theoretical framework, which points out that social interaction plays a fundamental role in the development of cognition, since a child's development cannot be understood solely by a study of the individual. It is also

necessary to examine the external social world in which that individual's life has developed through participation in activities that require cognitive and communicative functions. The belief that social exposure to various cultures expands a child's pool of knowledge seems inherently reasonable; the more experiences that a child has, the richer their world becomes. Developmental advancements, dependent upon the people and the cultural tools provided to the child, will help him to form his perceptions of the world. Vygotsky's theory suggests that there are three ways in which learning is passed along to an individual:

- imitative learning, in which a child simply copies another person.
- instructed learning, in which a child recalls direction given by a teacher and then puts it into play
- collaborative learning.

Children, especially toddlers and preschoolers, often speak aloud to themselves as they are trying to understand something. This self-talk helps them to work things out in their own minds. Vygotsky believed that this "private speech" lessens with age until it becomes all but non-existent. It is not that older children (and adults) have no need to think things through, but Vygotsky felt that they do this on an internal level, as thinking, but without necessarily voicing their thought processes.

Scaffolding

Scaffolding integrates multiple aspects of a task into manageable chunks and permits students to see how these interrelate. From the beginning, the metaphor of "scaffolding" in education has been related to what students are able to do if just the right amount of help is provided to enable them complete a task. The first definition of scaffolding was made by Wood, Bruner, and Ross (1976), who described it as the "process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts" (p. 90); this has been retained here, with the understanding that scaffolding in child education is a process that requires direct teaching and monitoring by an adult. Similarly, Coggins, Kravin, Dreux Carrol, and Dávila, (2007) observe the concept of scaffolding "refers to a specific type of coaching in which a teacher or other knowledgeable guide gives initial support for learning, with the goal of the development of students' independent learning skills" (p. 36). What makes scaffolding so effective, from this point of view, is that it enables a teacher to maintain a holistic view of a given task while students learn to understand and manage the task's constituent parts, thereby presenting the learner with just the right challenge.

This understanding of scaffolding is related to Vygotsky's concept of the zone of proximal development in that it includes constant support from the teacher and an approach to the content such that every student has the chance to learn and understood what is being said in the second language. When students are learning subject content in a second language, they are given more assistance. As they begin to demonstrate task mastery of language and content, the assistance or support is decreased gradually in order to shift the responsibility for learning from the teacher to the students. Scaffolding is gradually withdrawn as students become more independent and proficient; as the students assume more responsibility for their learning, the teacher provides less support.

METHODOLOGY

This investigation took an ethnographic approach, in that it was based on observation of people in their natural environment (Johnson, 2002). Information was collected through the application of various ethnographic instruments, such as classroom observations and teacher interviews. Data was analysed through triangulation in order to identify the various kinds of interpersonal interaction involving the teacher, instructional aides (if any), and students (including student-student interaction within the classroom) that occurred during instruction in mathematics content in the L2 (English). The essential purpose was to assist the teacher-observer in later work as a student teacher and a career teacher by improving accurate understanding of what classroom dynamics exist and how to impact them in the interest of high-quality instruction and scaffolding.

The study was carried out with 24 first-grade L1 Spanish-speaking students (aged 6-7) and one homeroom teacher at the Bureche School, a private bilingual school in Santa Marta, Colombia. Primary-level teachers at the school, some of whom are native speakers in the L2 (English), provide the first stages of instruction in the L2.

The study focused on the question of what is done by the mathematics teacher within a lesson to help students with their abilities in performing a mathematics class that is taught in English as a second language, as well as the particular characteristics of mathematics teaching in early grades at the institution, with the objective of identifying the general characteristics of an L2 mathematics lesion that help students successfully understand the mathematical content in the L2. Specifically, this study sought to:

- identify and analyze the types of instructions students receive in a mathematics class.
- identify and analyze the types of scaffolding used by teacher.
- analyze how the type of instruction and scaffolding help students to develop mathematical language and concepts through the L2.

RESULTS

A categorization process was used to group data into the categories identified in **Error! Reference source not found.**, adapted from the *Third Grade Texas Online Teacher Reading Academy (3OTRA) Study Guide* (University of Texas System/Texas Education Agency, 2006).

Table 1. Table of categories related to scaffolding.

Moment to moment verbal scaffolding	Instructional frameworks	Instructional procedures
Activate and build students' background knowledge.	Model procedures and/or "think aloud".	Present material in small steps
Check for understanding.	Review previously taught knowledge/skills.	Include opportunities for extensive practice.
Provide appropriate feedback.	Re-teaching as necessary	Interaction and evaluation.

It was found that, in some classroom observations, the teacher sometimes did not always exploit the students presumed background knowledge. However, the teacher generally did provide students with meaningful explanations that helped them master the topic of the lesson; particularly valuable was the use of context clues to clarify concepts. Scaffolding was also

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represented in the support and assistance provided through drawing graphs, mimics, and student interaction in support of information written on the board. Additionally, the teacher created opportunities for students to express what they learned orally.

The teacher showed awareness of the students' linguistics strengths and experience, and in this sense it was found that, code-switching, or a change of register, could be used as needed by both teacher and students as an aid to understand lesson content. In this way, the teacher would elicit students' knowledge by allowing them to build their own meaning of the lesson: "We can count faster …. *Volándonos un número* …". The teacher would not necessarily praise or criticize what students answered, but rather accepted their ideas, continuing by formulating additional questions based on their initial responses. In other words, through use of "mother tongue", ideas were made understandable, and thus helped construct the overall context for the topic under discussion. Even though most of the students had been involved in a second-language education setting throughout their primary school experience, their first language of instruction and daily interaction remains Spanish. Thus, in building of a model drawing on different methodologies, the use of code-switching or change of register formed an significant element of the daily lessons, especially in terms of developing connections between the content and the students as they learn the concepts associated with the content in a second language.

Generally, the teacher used a set of instructions based on the given lesson that permitted the construction of classroom experience that scaffolded achievement of the students' learning objectives, moving from a set of basic explanations on to performance of the topic at hand. The situation is captured in a teacher statement drawn from an interview: "Reaching all levels of understanding is an important part of everyday methodology; this allows students to work at the same time, performing different activities that reach the same goal."

Ultimately, the use of such a pattern of instructional procedures, along with moment-to-moment verbal scaffolding, as evidence from classroom observations were the most frequent elements within the categories considered in this study.

DISCUSSION

It is important to distinguish between the ways students learn English as a subject (as a second or foreign language) and/or the ways they learn subject content through/while learning English; recognizing such a distinction is critical in the development of an accurate framework based on theory and practice.

Working with children is very challenging. Their eager curiosity can sidetrack an observer from the purpose of observing how a particular class or lesson is developed. It is important to be prepared to interview child participants or to implement a kind of journal that could capture their perceptions. It is all too easy, in such situations, for the observer to become the observed. Children tend to ask the observer what they are doing in their class, no matter how familiar the presence of the observer might have been expected to become. Moreover, in a mixed level class, it is important to take notes not only about what the teacher does but also how they do it. Having copies a lesson plan or the activities to be performed by the children gives the observer a wider view of the methodology and strategies used by the teacher. In general, the teacher's classroom performance is informed by theory at some level. When developing a framework for research, as well as in triangulating the resultant data, it is very important to describe how the teacher's theoretical approach is developed within the class, as well as how suitable this approach may be.

For some students, mathematics seems itself to be a foreign language, consisting of words and concepts that do not mesh with their everyday experiences. For such students, successful teachers must find ways to make math understandable, relevant, and familiar. In a sense, the successful learning experience can be all about finding a common language, a process in which the instructor mediates between the students existing subject, linguistic, and everyday background knowledge and the new knowledge, competences, and abilities that they have yet to learn.

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BIODATA

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