How does language affect ESL/ELL students in the understanding of mathematics?

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When the English as a second language learner (ESL) or the English language learner (ELL) students have achieved English proficiency, it helps students to develop their understanding of mathematics. Students then effectively use mathematical tools, charts, patterns and other strategies, as well as their prior learning experiences to make connections to solve related problems. The majority are able to transfer their manipulative exploration to solving problems with pencil and paper. Students use multiple solutions and strategies when they solve problems. They express their mathematical thinking through drawing, writing, and speaking. Students socialize their intelligence through playing games and taking part in opportunities for team or pair work, when they explain their thinking. Upper grade students often find it difficult to discuss or write in mathematical terms, even after they have been given multiple opportunities to investigate.

In order to make schematic connections, instruction must be meaningful (in a language students can understand) and relevant (relating to students’ prior knowledge). Meaningful contains native language or sheltered English. Relevant contains culturally and/or experientially familiar. English language development that is integrated with developing knowledge about, for example, American school life and procedures, is usually a more effective way of proceeding than simply focusing on English language (Duff, 2001). The activities, tasks, and problems that students encounter should be accessible to students with a wide range of knowledge and skills. That is, students with diverse backgrounds should be able to understand what is required, make meaningful attempts to do the activities, and understand some of the simpler strategies that other students may use. They need to understand all the strategies because strategies help
students make meaning. The myth is until students learn English, there’s no point in trying to teach them content-area subjects. In reality, it is not necessary (or desirable) to wait until students are fluent in English before teaching them subject matter content (Carpenter, 1995). In fact, one effective way of learning a non-native language is to study content area subject matter through the media of the non-native language (McKeon & Samway, 1999).

From my own experience, many ESL/ELL students gravitate towards mathematics and towards fields where mathematics is essential such as physics, economics, engineering, etc. They assume that their language deficiencies will not handicap them as much as they would in other fields. They believe that the necessary level of English proficiency is lower in the study of mathematics because of the symbolic nature of the subject. Although learning English is essential for school success for all language minority students, the acquisition of English alone in no way guarantees that ESL/ELL students will succeed academically. Since understanding develops out of what people already know, teachers who teach for understanding constantly try to connect new problems to their students’ prior mathematical knowledge and backgrounds.

ESL/ELL Students’ Academic Advantages & Challenges

ESL/ELL students have knowledge gained in their country of origin, and this knowledge can be a useful part of their overall learning. Sometimes ESL learners have had experiences that make them particularly determined to succeed. Even if minority students have different ways to solve problems, they still get the same results. In fact, ESL students are often more creative in their approach to mathematics. Minority students
have the power of viewing a problem from different perspectives. They demonstrate their knowledge in many different ways.

However, the ESL/ELL students need to have skills and knowledge in the content area as well as the ability to clearly communicate their understanding in English. In mathematics for instance, they need to be able to do the mathematical calculations and they also need to explain their mathematical thinking by writing reports (http://www.sofweb.vic.edu.au/lem/esl/evce.html). Therefore, a mathematics teacher must teach students to communicate like mathematicians. Minority students often believe that mathematics does not require language proficiency because math involves logics and techniques to solving problems. However, five major categories of writing apply to the instruction of mathematics: direct use of language, whereby students record and copy information; linguistic translation, whereby mathematical equations are translated into English; summarization, which helps the student clarify the mathematical process in his/her mind and to reflect upon the process; applied use of language encourages the student to apply the concepts to a real-world and analyze problem-solving strategies; and creative use of language, which enables students to integrate writing and math skills (Seceda).

According to Herrrera & Murry, students can apply their knowledge in the first two years, but are limited when new material surpasses their mathematic skills from their prior knowledge. After a certain number of years or after they have used all their prior knowledge to move up to higher levels of thinking, they will be faced with struggles in understanding mathematics and language. Developing language proficiency is very important for understanding mathematics, language, reading, science, and social studies.
In attempting to do everything at once, however, academic performance slows down. ESL students need to have time to reflect on the knowledge available for them to transfer from their native language to another language.

Perhaps, students often believe that if they understand and are able to communicate in English, then they would not have problems in understanding the content. As many researchers proved, understanding the language does not mean students can understand the content areas (Carpenter, 1995). Language used in daily life, but the content material is used only in certain circumstances and requires specific/technical knowledge. I can translate all the mathematics problems from English to my native language, but it does not mean that I understand the problem.

Students might be able to do well in school during the first three years after their arrival to the United States but at a certain knowledge level, they will get stuck and will not be able to transform their prior knowledge into new knowledge. Teachers should encourage students to keep working on the language development as well as developing content areas; students will succeed in understanding mathematics if and only if they can interpret the concepts in mathematics. They need to acquire cognitive academic language proficiencies necessary to construct meaning in second language.

What math struggles do ESL students face?

One reason of ESL students’ struggles may be the perception that mathematics is a universal language, transcending language concerns (Lass, 1988). Recently, researchers in bilingual education have begun to address such issues as the complexity of the interplay between language and mathematics skills for bilingual students.
Linguistic factors must be considered, because mathematical pie/pi vocabulary is precise but not always familiar. Example: mass, product, table, sum/some all have specific meanings in math that are often different from students’ prior experiences with the words. Cuevas and Beech (1983) noted the importance of considering issues of language comprehension, knowledge of syntax and vocabulary, and understanding of relational terms as they apply to mathematics. Students may experience difficulty distinguishing differences and making comparisons in relationships that pertain to size, speed, space, and time.

Cultural differences define our values and what may be perceived as a real problem by one group but may be unfamiliar or unimportant to another group (Fellows, Koblitz, & Koblitz, 1994).

Another difficulty that may arise with language-minority students is that of differences in algorithms. An algorithm is the procedure used for finding the solution to a mathematical problem. Most Americans learn to calculate using set algorithms taught in the schools. Students from South American or Asian countries learn algorithms that are different in sequence. The position of numbers on the written page often does not match the algorithms typically used in American schools. Therefore, when students are asked to calculate something, a difference in the algorithm may be misinterpreted as lack of math ability. For language-minority students, it is more important to determine if the student knows how to obtain the correct answer and if they can explain the procedure, rather than how well the student's algorithms match those used in our schools (Raborn, 1995).

Individual needs and strengths vary among all students, including ESL/LEP students. Bilingual students may have excellent abilities in math and yet not be able to communicate that ability, due to lack of English proficiency or lack of communication skills in either language. Therefore, it is critical that mathematical ability be appraised on the basis of cognitive ability and not assumed on the basis of the student’s proficiency in English, or because of a disability that affects communication skills.
Five major categories of writing apply to the instruction of mathematics: direct use of language, whereby students record and copy information; linguistic translation, whereby mathematical equations are translated into English; summarization, which helps the student to clarify the mathematic process in his/her mind and to reflect upon the process; applied use of language, which encourages the student to apply the concepts to a real world and analyze problem-solving strategies; and creative use of language, which enables students to integrate writing and math skills (Seceda).

**List of challenges & accommodations for ESL/ELL students in the classroom**

- Homophones (e.g. sum/some)
- Technical terms (e.g. exponent, quotient)
- Common terms used in new ways (i.e. mean, product)
- Symbols
- Multiple words or phrases indicate the same mathematical operation
- Passive voice for questions and statements
- Typical syntax is often reversed
- Comparatives
- Superlatives

(Herrera & Murry, in press)

**Recommendations for promoting ESL/ELL student success**

One technique to encourage the students is to use practical application problems to help beginning ESL/ELL students acquire computation skills. The teacher could also incorporate explicit teaching of metacognitive strategies (i.e. self-monitoring, self-evaluation, planning how to solve various types of problems) into their teaching style as
well as instruct students on the sequence of steps that should be used to solve problems (Herrera & Murry, in press). The teacher could also use authentic problems that apply to real-life situations (avoid those that accentuate class distinctions). Another method is to incorporate explicit instruction of the mathematical language related to the concepts that they cover and have students use journals to clarify ideas, justify rationales, summarize ideas, connect concepts, review material, and express frustrations, accomplishments, and discoveries (Duff, 2001). The teacher should also try to engage students by using a variety of methods such as cooperative learning, modeling, computer-assisted learning, and guided discovery. In addition, the teacher could connect concepts to the background knowledge of their students by asking them to write their own word problems as well as find out how their students mentally manipulate and organize content information by encouraging them to explain their problem-solving process. In order to develop students’ cognitive academic language proficiencies, speaking and writing deepen understanding by helping students make schematic connections.

An example of promoting student success could be about ESL/ELL students, who would show their proofs by using two columns rather than summarizing in paragraph form. If teachers wanted to evaluate the students’ cognitive ability, then they might want to ask the students to come to their office before the students present their proofs in class. Also, students can verbally explain how they achieved their results and what makes them think their proofs are correct. In this case, teachers have to decide how teachers want to evaluate the student performance; that is they might give them partial credit for trying. For special cases, if a student lacks language proficiency, teachers should allow them to write their explanation in their native language. Teachers then find someone in the
department to translate what the student wrote. That is another option to determine what
and how students understand the concepts.

The two-column proof method is a practical strategy, which uses practical
application problems to help beginning ESL/ELL students acquire computational skills.
Teachers will use their professional judgment in deciding which instructional method will
best foster the learning process described above. Teachers will base their decisions on
the needs of the students, taking into consideration the student’s abilities, backgrounds,
interests, and learning styles when planning curriculum activities.

Students in a mathematics class typically demonstrate diversity in the way they
know best, which is the way they were taught in their native country. It is important that
the students have the opportunity to learn a variety of learning strategies – individually or
cooperatively, independently or with the teacher’s direction, through hands-on experience
or through less tangible methods. Students develop initial understanding of properties by
collecting, interpreting, and creating algebraic models for data drawn from a variety of
real situations. These initial experiences are then extended for linear relations into the
abstract realm of equations and formulas.

There is no single correct way to teach or to learn mathematics. Rather, a
balanced blend of strategies for learning is desirable. Furthermore, neither skills without
process, nor process without skills is a meaningful or powerful thing to have. Learning,
especially new learning, should be embedded in a context. Well chosen context for
learning are broad enough to allow for student exploration and development of relevant
supporting skills, and to gain experience with interesting applications of the new
knowledge.
Math can be used for connecting the language of concrete experiences to the development of abstract concepts. It is important to begin the development of concepts with concrete materials (Raborn, 1995). Manipulation of concrete materials is then supported and extended through the use of language. ESL/ELL students have difficulty learning mathematics when it is taught solely through language. For students with visual strengths, non-verbal routes to understanding can reduce the role of language. For example, the student is learning the concept of borrowing with hundreds, tens, and ones blocks. This is a great way to conceptualize language use to develop necessary vocabulary. In the first stage, the student learns to trade hundreds for tens and tens for ones, and learns to use language in describing the process. Language use may be the most difficult aspect of initial stage of verbal labeling. Words may be unfamiliar and precision of the statement used to describe the process may be awkward. In the second stage, the student forms an internal model by describing the idea or process without the use of manipulative or visual cues. In verbal labeling, drills are used as a tool to make connections and strengthen understanding of math in a meaningful context.

**How do teachers target understanding?**

Teachers often ask students to explain and/or elaborate their reasoning. Children explain their reasoning when they say how they had figured something out or why something was right or wrong. This needs to be a deeply embedded part of the class culture with regard to how things are done.

Teachers who teach for understanding often ask if anyone has solved a problem in a different way or can give a new way of justifying an idea. Such teachers attend to these and many other cues to determine how well their students understand the mathematical
content that is the subject of the lesson. They base their instructional decisions more than just on whether answers are right or wrong or whether they need to cover a certain amount of material (Duff, 2001). Although these may be considerations, the primary concern is to ensure that all students actually understand something of what is being taught and discussed.

Problems and activities should be interesting to students. The term interesting (not fun) is used purposefully to convey the intellectual quality of a problem that is engaging and can require hard intellectual work. While fun activities might also be interesting, the overlap is far from perfect; too many fun activities are mindless and contain little mathematical substance. English Language Learners (ELL) may come to school having learned different algorithms for the number operations than are commonly taught in the United States; teachers need to be alert to how these students think about computations (Seceda).

**Case Study:**

I came to the United State when I was 14 years old and was about to study at the 9th grade level before leaving Vietnam. I did not speak English; therefore, the school district decided to place me in the 7th grade. Obviously, I was handicapped in language proficiency, but my mathematics skills were very high. My mathematic knowledge was as high as College Algebra. I did not have experiences in Calculus or proofs. I assumed that math would be the only subject I could major in. After I took higher level courses in mathematics, I realized that language difficulties also affect one’s ability to succeed in math. I could only apply the prior knowledge that I had learned in Vietnam. My level of
thinking was not as proficient or as creative when I used the mathematics I had learned in the United States.

Some similarities between understanding language and understanding mathematics are reading practice, interpreting, and applying. I learned English in school, and I speak English in my daily life. My language development improved because I learned from people surrounding me in my daily life. That is how I developed my understanding of language. In order to develop my understanding of mathematics, I have to practice and understand how to manipulate the problems. I first thought that ESL/ELL students should not have any problems in mathematics since it is not an English-dependent subject. Mathematics involves calculations and sets of steps to memorize that do not require written or verbal communication. What I learned from my courses was an obvious contradiction to this idea. Many Asian students were definitely faced with English becoming an obstacle in mathematics (Perkins, 1995). That’s why ELL students tend to get more emphasis on computation than conceptual development.

I believed that a lack of language skills would keep me from succeeding in mathematics. I lost my interest in learning mathematics because I could not explain the problems in English. My self-esteem decreased when I could not solve the proofs. The language directly affected my physical and mental abilities to succeed in math courses. My language proficiency has improved, but my understanding of mathematics is slowly developing. Most of my courses require English, except mathematics requires higher cognitive skills in mathematical language and English. I must focus on both language development and mathematical content to understand the concept in mathematic skills.
Effective teaching practices

ESL/ELL students who lack receptive or expressive language skills profit from learning the language of math as they develop precise vocabulary, sequence, and comprehension skills in their native language. They need time to pose their own questions and to explore ways of answering them. It is important to give students the opportunity to talk with peers and adults in native language so that they can experiment with and validate their own ideas. For example, in Math 791, I liked having the topic discussions. When we discussed about the “schema,” I did not understanding the meaning of the word. The reading assignments, which defined “schema,” and class discussions, helped me to develop my vocabulary and improve my understanding of mathematics.

Conclusion

Mathematics teaches predictable patterns and can foster a natural acquisition of social and academic language proficiency. While educators may consider math to be universal, there are factors related to language, culture, and cognition that must be considered in math education. With careful assessment, planning, and implementation, student with diverse learning characteristics can be successful in math.

Understanding mathematics also depends on students learning styles, which are the different ways in which people take in, process, store, retrieve, and express information (Carpenter, 1995). I realize that knowing how the student learns best will be an important factor in addressing the student’s learning problems, especially ESL/ELL students. I will also need to assess a student’s background information when the student is experiencing difficulty making progress. As a future educator, I will search for
effective teaching techniques to help students develop their understanding. I will also provide students with an opportunity to develop their cognitive academic language proficiency.
Work Cited


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