The Only Absolute Truth in Mathematics is

The Myth of Mathematics as Universal

M. Joanne Kantner

Northern Illinois University

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Abstract

Culture and national origin can affect thinking about mathematics and mathematics learning. The myth that mathematics is objective and culture free becomes a barrier to adults learning mathematics. Adult educators must reflect upon culture's influence on learning and recognize the implications of universality myths on students' learning in mathematics classes.

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Myth of Mathematics as Universal

An expanding global workplace is coercing adults back into formal mathematics classrooms to improve current job situations and to gain education for career advancements (McCabe & Day, 1998). Adult mathematics classrooms in the United States have students diverse in cultural and national origins. Mathematics is thought to be an abstract, generalizable, absolute, universal language. But something thought of as universal is only universal to those sharing the same cultural and historical background (Secada, 1983). The myth that mathematics is an objective and culture free discipline can become a barrier to students constructing mathematical knowledge.

The concept of culture is a broad one and includes shared context, language, practical mathematics, and mathematics disposition. Each culture develops a mathematics based upon its own historical and present needs (D'Ambrosio, 2004). Educators are surprised to find that common computational procedures differ by culture and national origin. Cultural cognitive psychologists have shown conceptual differences in logic, spatial reasoning, and cognitive styles (Norenzayan, Jun Kim, & Nisbett, 2002). Linguists have identified the challenges to understanding new meanings of common words when they are used in mathematics. Learners bring different world-views, languages, and informal mathematical experiences into classrooms.

Research suggests connections exist between cultural symbols, representations, and cognitive imagery (Vergani, 1998). Cultures have different types of representational systems, which affect how students think about mathematics and mathematics learning. To make mathematics accessible to students, adult educators must reflect upon culture's influence on different forms of mathematics knowledge. and acknowledge the legitimacy and authority of what Foucault (1980) terms learners' "subjugated knowledge." Adult educators must recognize the marginalizing possible from universality myths concerning procedures, conceptualizations and native languages on student learning in mathematics classes.

Myth 1: Mathematical Procedures Are Cross-cultural

If mathematics is a language, algorithms are dialects of this language. An algorithm is a guaranteed series of steps to solve a problem. Algorithms are not universal across cultures and nations. Algorithms are created by people living within specific mathematics cultures to meet specific mathematical needs (D'Ambrosio, 2004; Orey, 1999). Every culture has variations in the processes, notations and symbols and reproduces these standards in their educational structures. For example, the North American long division sign can be interpreted as the square root symbol to students educated in the Russo-Soviet tradition. Also, when expressing answers, some cultural groups use the comma in place of the decimal point and others use periods instead of commas to separate multiples of hundreds.

Through the Algorithm Collection Project, Daniel Orey (1999) has identified four variations of the division algorithm which are grouped as North American, Franco-

Brazilian, Russo-Soviet, and Indo-Pakistani styles. Examples of different division algorithms are illustrated below (Figure 1).

USA-an	Russian	Brazilian
3.28	23 | 7	23 | 7
7 | 23	21 |	20 3,2
21	20 3,28	6
20	14	
14	60	
60	56	
56	4	
4		

Figure 1. Algorithm dividing 23 by 7

Besides differences in the notation and the step by step instructions, these examples illustrate different mathematical values derived from different cultural needs. First, cultures needing scientific research and applications value exactness and precision in answers. In contrast, cultures prioritizing counting and sorting needs recognize estimated answers as valuable. Second, cultures place different worth on mental mathematics. In many Asian cultures mental mathematics is symbolic of subject competency and algorithms facilitating mental mathematics are practiced (Nguyen, 2005). In the United States, instructors traditionally request students to “show all your work” which can confuse those students equating mathematics mastery with rapid mental calculations requiring little written detail.

Myth 2: The Universality of Mathematical Conceptualizations

Cognitive styles (the way individuals think, perceive and remember information) have been linked to differences in world-views between individualist and collectivist cultures (Merriam, 2007). Cognitive processes in individualist cultures are characterized by preferences for separating mathematics from its context, for using rules as predictors of behavior, for using formal logic, and for basing categories on necessary and sufficient features. Individualist cultures are connected to field independence which is associated with the ability to distinguish figures from their backgrounds.

The contrasting field dependence is attributed to collectivist cultures which view experiences holistically, inseparable from the circumstances surrounding the happening, show preferences for resolving conflicting views and for intuitive reasoning. The Indian and Chinese collective cultures believe a result in mathematics can be validated by any method, including visual demonstration while the individualist culture of Western-Europeans requires a formal step by step argument built from self-evident statements (Bishop, 1988). What is logical and important in one culture may seem irrational and unimportant to another culture. In classroom practices these differences must be respected remembering some cultures analyze and synthesize better silently than through discussion.

Myth 3: Mathematics Learning is Independent of Linguistic Differences

In United States adult education classes, many non-native students have difficulties building on their mathematics foundations because English is not their primary language. The textbooks, instruction, and assessments are written for what Eco (1994) terms the “model student”. The profile of a “model student” is a compilation of assumed backgrounds, prior knowledge, and connections of mathematics in real life. Often these textbook presentations are disconnected from the environment and experiences of actual non-native learners.

Language barriers occur with the discourses created by mathematics instruction. To make mathematical meaning students must not only learn new content-specific vocabulary (sum, quotient, decimal) but comprehend mathematics-specific meanings for common English words. Mathematical operations are associated with many different words. Prepositions used in word problems, such as “of” and “per”, have unique mathematical meanings unrelated to their spoken usage. Additional confusion comes from knowing the meanings of complex phrases such as “least common multiple” because phrases are not found in many bilingual dictionaries. Finally, many imperatives are phrased in a passive voice not present in some languages. Instructions to divide can be phrased as:

- twelve is divided by two
- the number of times two goes into twelve
- the number of times two can be repeatedly subtracted from twelve.

These variations can make the mathematics less transparent to learners.

Ethnomathematics is a branch of mathematics acknowledging the fundamental differences in mathematics content, mathematics understanding, and mathematics application which links culture and mathematics (D’Ambrosio, 2001). Instructors need to bridge the gap between mathematics and the everyday lives of adult education learners. Instructors can use concept maps, investigatory problems and guiding questions to uncover learners’ a priori knowledge about a topic before presenting formal mathematics experiences. In addition to the formal mathematics structures, adult educators using multiple representations of concepts (charts, graphs, diagrams and concept maps) while incorporating listening, speaking, reading and writing in the classroom, become cultural interpreters for learners to the culture of formal mathematics.

Closing

Differences in culture affect systematic ways of representing mathematical relationships and constructing mathematical knowledge. Without integrating content familiar to a variety of cultures, under-represented groups in adult education see little relevancy, meaning, or value in formal mathematics. Culture is not a problem to be solved in mathematics classrooms but can be a resource for problem-solving. As Paulo Freire stated at Boston College in 1982 (as cited in Frankenstein, 1998):

> Our task is not to teach students to think -- they can already think;
> but to exchange our ways of thinking with each other and look
> together for better ways of approaching the decodification of an object.

References

Bishop, A. (1989). *Mathematical enculturation: A cultural perspective on mathematics education*, Dordrecht, The Netherlands: Kluwer Academic Publisher.

D'Ambrosio, U. (2004). Ethnomathematics and its place in the history and pedagogy of mathematics. In T. Carpenter, J. Dossey, & J. Koehler, (Eds.). *Classics in mathematics education research* (pp.194-199), Reston, VA: National Council of Teachers of Mathematics.

D'Ambrosio, U. (2001). What is ethnomathematics and how can it help children in schools? *Teaching children mathematics*, 7, 308–10.

Eco, U. (1994). *Six walks in the fictional woods*. Cambridge, MA: Harvard University Press.

Foucault, M. (1980). *Power-knowledge*. London: Harvester Wheatssheaf.

Frankenstein, M. (1998). Reading the world with maths: Goals for a critical mathematical literacy curriculum. *Proceedings of the Mathematics Education and Society Conference,* Nottingham, England, 1.

McCabe, R. & Day, P. (Eds.). (1998). *Developmental education: A twenty-first century social and economic imperative*. Mission Viejo, CA: League for Innovation in the Community College.

Merriam, S. (Ed.) (2007). *Non-western perspectives on learning and knowing*. Melbourne, FL: Krieger Publishing.

Nguyen, T. (2005). *Learning to teach realistic mathematics in Vietnam* [doctoral dissertation]. Amsterdam: University of Amsterdam.

Norenzayan, A, Smith, E. E., Jun Kim, B., & Nisbett, R. E. (2002). Cultural preferences for formal versus intuitive reasoning. *Cognitive Science*, 25, 653-684.

Orey, D. (1999). *The Algorithm Collection Project*, Sacramento, CA: California State University.

Secada, W. G. (1983). *The educational background of limited English proficient students: Implications for the arithmetic classroom*. Washington, DC: Office of Bilingual Education and Minority Languages Affairs. (ERIC Document Reproduction Service No. ED 237 318).

Sowa, J. (2000) *Knowledge representation: Logical, philosophical, and computational foundations*. Pacific Grove, CA: Brooks & Cole.

Vergani, T. (1998). *Ethnomathematics and symbolic thought*. Paper presented at the First international conference in ethnomathematics, University of Granada, Spain.