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Mathematics-related beliefs of Ecuadorian students of grades 8–10

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1. Introduction

Over the past 25 years an increasing number of studies about learning and instruction in general and about mathematics education in particular have indicated that students' beliefs about subject-matter domains (e.g., mathematics) and about learning in those domains have an impact on different aspects of their learning, such as their motivation, learning approaches and strategies and achievement (De Corte, Op 't Eynde, & Verschaffel, 2002; Hofer & Pintrich, 1997). In relation to mathematics education Schoenfeld (1985) was the first scholar who pointed to the existence of a system of beliefs that influences students' mathematical problem-solving behavior:

> "Belief systems are one's mathematical world view, the perspective with which one approaches mathematics and mathematical tasks. One's beliefs about mathematics can determine how one chooses to approach a problem, which techniques will be used or avoided, how long and how hard one will work on it and so on. Beliefs establish the context within which resources, heuristics, and control operate." (p. 45)

Inspired by Schoenfeld's (1985) pioneering work and the initial findings that many students appear to hold a lot of naïve and incorrect beliefs about mathematics (e.g., Lampert, 1990), many researchers, especially in the USA and Europe, investigated students' beliefs aiming at identifying different kinds of beliefs that influence mathematical learning, and at understanding the processes through which they develop and determine learning (De Corte, Mason, Depaepe, & Verschaffel, 2011; De Corte, Op 't Eynde, Depaepe, & Verschaffel, 2010).

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The growing attention for the impact of beliefs in relation to mathematics learning is part of an important development over the past decades according to which – besides cognitive aspects – the important and determining role of conative (motivation and volition) and affective (self-confidence, positive emotions and availing beliefs) factors in students' mathematics learning is stressed (Op 't Eynde, De Corte, & Verschaffel, 2002). Furthermore, the current prevailing view among scholars in mathematics education is that the ultimate goal of mathematics learning and teaching is to acquire *adaptive competence*, i.e. the ability to apply meaningfully-learned knowledge and skills flexibly and creatively in different situations. This is opposed to *routine expertise*, i.e. being able to complete typical school tasks quickly and accurately but without understanding (Baroody & Dowker, 2003; De Corte et al., 2011; Hatano, 1988). As a result there is today a broad consensus that becoming adaptively competent in mathematics requires the integrated acquisition of five cognitive, affective and motivational components (De Corte et al., 2011; see also National Research Council, 2001; Schoenfeld, 1992):

1. A well-organised and flexibly accessible domain-specific knowledge base involving the facts, symbols, concepts, and rules that constitute the contents of a subject-matter field.
2. Heuristic methods, i.e. search strategies for problem analysis and transformation, which do not guarantee but significantly increase the probability of finding the correct solution through a systematic approach to the task; for instance, decomposing a problem into sub-goals, making a graphic representation of a problem.
3. Meta-knowledge involving knowledge about one's cognitive functioning or meta-cognitive knowledge (e.g., believing that one's cognitive potential can be developed through learning and effort), and also knowledge about one's motivation and emotions that can be actively used to improve learning (e.g., becoming aware of one's fear of failure in mathematics).
4. Self-regulatory skills, which embrace regulating one's cognitive processes/activities (meta-cognitive skills or cognitive self-regulation; e.g., planning and monitoring one's problem-solving processes), as well as skills regulating one's volitional processes/activities (motivational self-regulation; e.g. maintaining attention and motivation to solve a given problem).
5. Positive mathematics-related affects which includes positive emotions and attitudes toward mathematics and mathematics education, as well as mathematics-related beliefs that comprise the implicitly and explicitly held subjective views about mathematics and mathematics learning and teaching (epistemic beliefs about math), about the self as a learner of mathematics (motivational beliefs), and about the social context of the mathematics classroom.

Taking into account that mathematics-related beliefs can significantly influence students' mathematics learning, and considering that those beliefs have so far hardly been studied in Latin America, and certainly not in Ecuador, the investigation reported in this article aims at describing and analyzing the math-related beliefs of Ecuadorian students of grades 8–10 of "Educación General Básica" (EGB). Apart from the fact that it is in itself relevant to portray the beliefs of Ecuadorian students, such an investigation is of broader theoretical and intercultural significance. Indeed, it has been argued and shown by several authors that culture plays an important role in the development of people's beliefs about knowledge and learning (see e.g., Alexander, Murphy, Guan, & Murphy, 1998; Felbrich, Kaiser, & Schmotz, 2012). It is therefore important to study beliefs in a variety of cultural contexts. In this respect Ecuador represents an interesting context. With about 14 million inhabitants the country consists of a multicultural mosaic of races: 25% Indians, 65% Mestizos, 7% Whites and 3% Afro-Americans and Asians. The first language is Spanish. However, most of the indigenous population speaks Quichua, and there are 18 different languages among native communities. Few Ecuadorians master a second language. The Ecuadorian economy is based on the production and exports of oil, bananas, shrimp and cut flowers. The GNI (Gross National Income) per capita in 2013 was $5760 compared to over $40,000 in most West European countries (source: http://data.worldbank.org/indicator/NY.GNP.PCAP.CD); the average salary was $478. From a socio-economic perspective Ecuador differs in many other respects from Western European countries. Two major indicators in this regard are the labor-market, and degrees of poverty and inequality. According to the Ecuadorian INEC (Instituto Nacional de Estadistica y Censos) the unemployment rate in 2013 was about 4%; however, the rate of underemployment ("empleo inadecuado") amounted to about 50%, and is still increasing. In December 2014 the national poverty level (monthly income $81 or lower) stood at 22.49%, and the extreme poverty level (income $46 or lower) at 7.65%). The Ecuadorian society is also characterized by a high degree of inequality; the GINI coefficient for 2014 is 0.44 compared to about 0.25 in most West European countries (source: http://www.ecuadorencifras.gob.ec/). An additional important reason for doing this study in Ecuador is that the quality and the outcomes of the country's education are among the weakest in Latin America (see e.g., SERCE, 2008). This holds especially true for mathematics. The results of the latest evaluation "Ser estudiante" of 2013 by the Instituto Nacional de Evaluación Educativa (Ineval) shows that in grade 7 of "Educación General Básica" (EGB) 30% of the students did not achieve the elementary achievement level in mathematics; in grade 10 this increased even to 43%. This means that on the Ineval scale 0–1000 they obtained a score below 550. In grade 7 only 13.3% reached the satisfactory level (score above 800), but in grade 10 this decreased to 9%.

After a brief review of the theoretical framework of the study and the previous research carried out within that framework, the design and the method of the investigation will be described, followed by the obtained results. The article ends with an overview of the major conclusions and a critical discussion.