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How affective-motivational variables and approaches to learning predict mathematics achievement in upper elementary levels

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ABSTRACT

The relationship between students' motivation and attitudes towards mathematics, the approaches to learning they use, and their achievement in mathematics has been widely documented in middle school and further academic levels. However, the empirical research in earlier educational stages remains scarce. This study analyzed the predictive value of affective-motivational variables and deep and surface approaches to learning on mathematics achievement in a sample of 524 upper elementary students. Multiple linear regression analysis was used to examine the predictors of mathematics achievement. Mathematics enjoyment positively predicted mathematics achievement and age and the use of the surface approach to learning negatively predicted mathematics achievement. The variables in the model explained 21.3% of the variance in mathematics achievement. Mean differences in the affective-motivational variables and approaches to learning occurred between students with very high and very low achievement in mathematics, yielding further evidence of important differences between the achievement extremes.

1. Introduction

Numerous studies have examined the determining factors of academic achievement in mathematics (e.g. Bodovski & Youn, 2011, Villavicencio & Bernardo, 2013). This interest is driven by the relevance of mathematics for both formal education and everyday life (Jansen et al., 2013). However, from the very early years of education, many students face failure in mathematics. In this sense their effective-motivation (i.e., motivation, self-efficacy beliefs, enjoyment, anxiety, and perceived usefulness or value of mathematics) and the strategic components they use to learn mathematics (i.e., approaches to learning) impact on their achievement, regardless of their cognitive ability or previous knowledge (Kember & Watkins, 2010; Murayama, Pekrun, Lichtenfeld, & vom Hofe, 2013; Steinmayer & Spinath, 2009). These effective-motivational and strategic components are particularly important in mathematics because most mathematical concepts seem to be abstract to learners at elementary educational levels (Lambic & Lipkovski, 2012). Further, the learners' lack of understanding regarding the importance of mathematics also influences engagement and achievement in the subject.

A brief description of these components and the findings from previous research that has examined the relationship between affective-motivational variables, approaches to learning, and mathematics achievement, are presented below. Following Tapia & Marsh's (2004) model, which differentiates between the affective-motivational components of value, self-efficacy, motivation, and enjoyment (Lim & Chapman, 2013; Tapia & Marsh, 2004), the present study includes an additional component: Mathematics anxiety. Two main approaches to learning are examined in the current study: Deep and Surface (Biggs, 1987).

1.1. Affective-motivational components and mathematics achievement

Previous studies report that students experience a wide range of emotions while being engaged in learning situations. Consequently affective-motivational components do not simply refer to liking or disliking mathematics but rather the perceived usefulness or value of mathematics, Mathematics self-efficacy, intrinsic motivation, Mathematics anxiety, and enjoyment.

1.1.1. Perceived usefulness

Also called "value", perceived usefulness refers to students' beliefs about the practical use and applicability of mathematics currently and in relation to their future (Adelson & McCoach, 2011). Perceptions of

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high value are associated with the acquisition of new knowledge (Guy, Cornick, & Beckford, 2015). Students who perceive mathematics as useful are more motivated to learn, practice, study, and employ key self-regulatory strategies than students who perceive mathematic as less useful (Cleary & Chen, 2009; Kajamies, Vauras, & Kinnunen, 2010; Villavicencio & Bernardo, 2013; Zimmerman & Schunk, 2008).

1.1.2. Mathematics self-efficacy

Characterized by Bandura (1977, 1997) as a person's belief in his or her capacity to execute behaviors necessary to achieve specific goals, self-efficacy is understood as an important aspect of learning. According to Fennema & Sherman's (1976) model, this component is defined as the confidence in learning mathematics. Specifically, mathematics self-efficacy refers to students' perception of themselves as learners and their capacity to succeed with mathematics. Numerous studies have found that students with low self-efficacy beliefs tend to avoid tasks involving mathematics whereas students with higher self-efficacy beliefs often show greater interest and persistence which leads to higher achievement (Berger & Karabenick, 2011; Rosário et al., 2012).

1.1.3. Intrinsic motivation

Intrinsic motivation is characterized by the tendency to engage in a task for the sake of interest in the task itself and the inherent pleasure derived from learning (Murayama et al., 2013). Under the influence of intrinsic motivation, the quality of the knowledge acquired by students is greater (Lambic & Lipkovski, 2012; Murayama et al., 2013; Schunk, Pintrich, & Meece, 2008; Villavicencio & Bernardo, 2013).

1.1.4. Mathematics anxiety

This concept refers to the experience of extreme discomfort when doing or even thinking about mathematics (Yaratan & Kasapoğlu, 2012). Mathematics anxiety is one of the most important determinants of a student's lack of success in mathematics (Ahmed, Minnaert, Kuyper, & Van der Werf, 2012). In this sense, students with Mathematics anxiety are nervous about mathematical situations and try to avoid such environments, reducing their motivation and engagement in these tasks (Jansen et al., 2013; Yaratan & Kasapoğlu, 2012). Authors such as Ashcraft, Krause, & Hopko (2007) and Krinzinger, Kaufmann, & Willmes (2009) suggest that the relationship between mathematics anxiety and achievement can be explained by the role of working memory. Specifically, higher levels of Mathematics anxiety are associated with shorter working memory span in laboratory tasks which causes (among others) a reduced capacity to perform the necessary calculations or processes at the required level of accuracy. The relevance of anxiety emerges from the fact that, while Mathematics anxiety can appear at any educational level, once established it can persist for a long time leading students to avoid mathematics-related courses and future career avenues (Ahmed et al., 2012; Yaratan & Kasapoğlu, 2012).

1.1.5. Enjoyment of Mathematics

In the context of mathematics, enjoyment is defined as the degree to which a person takes pleasure in doing and learning the subject (Adelson & McCoach, 2011). As Lambic & Lipkovski (2012) argue, motivation derived from the enjoyment of mathematics seems to have a greater influence on achievement than the other affective-motivational components. Similarly, Villavicencio & Bernardo (2013) report that enjoyment serves as a positive predictor of achievement in mathematics and that enjoyment is also related to self-regulatory mechanisms. According to these authors, this relationship reflects the fact that positive emotions such as enjoyment, hope, and pride, have been demonstrated to boost the use of flexible learning strategies and self-regulation skills, and the availability of cognitive resources for task engagement.

1.2. Approaches to learning and mathematics achievement

Another important variable that predicts learning outcomes is students' approaches to learning (Furnham, Monsen, & Ahmetoglu, 2009; McInerney, Cheng, Mok, & Lam, 2012; Murayama et al., 2013; Sengodan & Zanaton, 2012). Approaches to learning are characterized as the methods used by an individual to focus on and retain new information (Sengodan & Zanaton, 2012). There are many classifications of this construct. One such classification provided by Selmes (1987) distinguished between five approaches to learning in mathematics: deep, surface, organization, motivation, and hard work. However, it is not clear which components within Selmes' classification refer to strategies, attitudes, and motivation. Therefore, the present study adopted Biggs (1987) framework. Biggs' framework is one of the most widely accepted classifications and has been shown to have better conceptual and predictive value than other such frameworks (Kember & Watkins, 2010; McInerney et al., 2012; Murayama et al., 2013). It differentiates between two types of strategies that students can adopt to learn: *Deep* and *Surface*.

1.2.1. Deep approach to learning

Through elaborating the materials to be learnt, learners attempt to integrate new information with prior knowledge, organize new information, relate ideas, and monitor their understanding of the information. This pattern of learning is commonly translated into better performance (McInerney et al., 2012). Adopting a deep approach to learning implies a semantic understanding of the information which is assumed to be an essential component in acquiring meaningful and long-term knowledge (Murayama et al., 2013).

1.2.2. Surface approach to learning

This approach involves rote memorization of material without deep elaboration. This kind of learning is characterized by the repetitive rehearsal of the information. Contrary to deep strategies, the goal of studying is simply to fulfill situational demands (e.g., getting the assignments done or the courses passed) or to obtain external reinforcements (e.g., praise or gifts). As a result, the knowledge acquired via a surface approach fades quickly (McInerney et al., 2012; Murayama et al., 2013). As Murayama noted, for students who aim to pass, surface strategies may allow them to “survive” tests and examinations with minimal effort but such strategies will lead to low-quality learning.

Previous studies suggested that both Deep and Surface approaches to learning are predictive of achievement in mathematics, but in an opposite way. Specifically, deep approaches to learning lead to higher levels of achievement and more durable learning, whereas surface approaches are predictive of lower levels of achievement (Baeten, Kyndt, Struyven, & Dochy, 2010; McInerney et al., 2012; Yaratan & Kasapoğlu, 2012).

1.3. Conclusions from the previous research

The previous research findings exploring approaches to learning, together with the previously described relationship between affective-motivational variables and mathematics achievement, suggest the need to properly examine these factors. However, most previous research examining these relationships has been conducted in adolescent samples (Baeten et al., 2010; Pennebaker, Gosling, & Ferrell, 2013; Sengodan & Zanaton, 2012). This is even more evident in the case of approaches to learning, where the very few studies that have been conducted in younger samples have commonly described these components as an indeterminate set of predispositions such as persistence, emotion regulation, or attentiveness, rather than emphasize the strategic nature of this construct (Bodovski & Youn, 2011; Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010; Malmberg, Järvenoja, & Järvelä, 2013). Thus, further research is needed with younger students that extends this line of research. In this sense, a