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Original article

The influence of motivational and emotional factors in mathematical learning in secondary education

Influence des facteurs motivationnels et émotionnels dans l'apprentissage des mathématiques dans l'enseignement secondaire

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ABSTRACT

Introduction. – While motivation has, for decades, been investigated as a key component of academic learning and performance, academic emotions have often been left out of the scope of investigation. According to several researchers, mathematics learning seems to be particularly affected by students' emotions.
Objective. – This paper is aimed at characterizing the emotions and motivation of eighth grade students in a mathematical setting and highlighting the cluster of emotions–activity emotions vs outcome emotions–which best predict math value, math self-concept, behavioral engagement and math performance.
Method. – Data were collected through questionnaires from 115 students and analyzed through means comparisons and linear regressions.
Results. – Results indicated that eighth grade students give a relatively high value to mathematics have a positive mathematics self-concept and are moderately engaged in mathematical tasks. Regression analysis showed that mathematics value and behavioral engagement are better explained by activity emotions while mathematics self-concept and performance are better predicted by outcome emotions.
Conclusion. – The implications of these findings in terms of educational practices are discussed at the end of this study.

Mots clés :
Émotions académiques
Valeur accordée aux mathématiques
Concept de soi en mathématiques
Engagement comportemental
Performance en mathématiques

RÉSUMÉ

Introduction. – Si la motivation a été investiguée depuis des décennies comme une composante clé de l'apprentissage et de la performance académique, les émotions académiques, ont, pour leur part, très peu été prises en compte dans les recherches. Selon plusieurs chercheurs, l'apprentissage des mathématiques semble être particulièrement affecté par les émotions des étudiants.
Objectif. – Le présent article a pour objectif de caractériser les émotions et la motivation des 34 élèves de grade 8, en contexte mathématiques et de mettre en évidence les patterns d'émotions – « activity emotions » (les émotions associées à la réalisation d'activités) ou « outcome emotions » (les émotions associées au(x) résultat(s) de ces activités) – qui prédisent le mieux la valeur perçue, le sentiment de compétence, l'engagement comportemental et la performance en mathématiques.
Méthode. – Les données ont été recueillies auprès de 115 élèves à l'aide de questionnaires et traitées via des comparaisons de moyennes et des régressions linéaires.
Résultats. – Les résultats indiquent que les élèves âgés entre 13 et 15 ans accordent une valeur relativement élevée aux mathématiques, ont un concept de soi relatif aux mathématiques positif et s'engagent modérément dans cette discipline. Les régressions linéaires montrent que la valeur perçue et

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l'engagement comportemental sont les mieux expliqués par les « activity emotions » tandis que le sentiment de compétence en mathématiques et les performances sont les mieux prédits par les « outcome emotions ».
Conclusion. – Les implications de ces résultats en termes de pratiques pédagogiques sont discutées en fin d'article.

1. Introduction

Mathematics achievement in both international and national tests shows insufficient mastery of basic skills for a large number of students. Pisa 2009 data show that 22% of 15-year-old students from OECD countries face severe difficulties in mathematics (OECD, 2010). In addition, students' emotional relationship to mathematics is also a cause of concern: more than half of 15 years old OECD students frequently experienced anxiety in this domain (OECD, 2010). Moreover, more than 40% of OECD students do not perceive the value of mathematical subjects (Demonty, Blondin, Matoul, Baye, & Lafontaine, 2013) and more than an half have a negative mathematics self-concept (OECD, 2010). Such observations raise the question of the joint role played by motivational, affective and cognitive factors in mathematics learning and performance.

The crucial role played by motivational factors in students' learning and performance has been highlighted by researchers for decades. Many results have confirmed the need to take these dimensions into account when addressing academic achievement (Boekaerts, 1997; Eccles & Wigfield, 2002; Govaerts, 2006; Pekrun & Perry, 2014, Pelgrims, 2006; Viau, 2009). Even if emotions are a more recent topic of investigation, it is already clear that their impact on key areas of individual life, such as, academic performance, social relationships, physical health and psychological well-being (Mikolajczak, Quoidbach, Kotsou, & Nélis, 2009), make them a compulsory dimension when addressing the educational field (Govaerts, 2006; Linnenbrink, 2006; Op't Eynde, De Corte, & Verschaffel, 2007; Pekrun & Perry, 2014; Pekrun, Elliot, & Maier, 2009). Recent studies agree on a plural conceptualization of learning, which brings into play motivational, cognitive and affective processes in close interaction. The cognitive dimension refers to academic outcomes with academic achievement as the most studied. The Control-Value theory of achievement emotions proposed by Pekrun (Pekrun, 2006; Pekrun & Perry, 2014) shares this conceptualization.

However, if motivation as an antecedent of academic emotions has been quite well documented (Frenzel, Pekrun, & Goetz, 2007; Goetz et al., 2008; Govaerts, 2006; Op't Eynde et al., 2007; Pekrun et al., 2009; Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010; Pekrun & Stephens, 2012), the role played by academic emotions as antecedents of motivation have received little empirical attention to date (Kim & Hodges, 2012). Yet, as several researchers have highlighted (Kim & Hodges, 2012; Op't Eynde & Turner, 2006; Pekrun & Perry, 2014), academic emotions, academic achievement and motivation interact in bidirectional ways so that it is of major importance to address the issue of academic emotions as antecedents of motivation to gain a more accurate picture of mathematical learning.

Moreover, most of the studies on motivation and/or emotions addressing the mathematical domain focus on typical achievement situations–such as attending class, doing homework and taking tests and exams–(Govaerts, 2006; Goetz, Frenzel, Pekrun, & Hall, 2005) or on specific mathematical content such as problem solving (Focant, 2004; Govaerts, 2006; Marcoux, 2012; Op't Eynde et al., 2007). It seems less common to study the discipline of mathematics as a whole, that is, to investigate cognitive, motivational and emotional dimensions of mathematical learning in general. And yet, according to several researchers (Adihou, 2011; McLeod, 1992; Op't Eynde, De Corte, & Verschaffel, 2002; Schoenfeld, 1985), students develop a global relationship to mathematics which guides their classroom behaviors and interactions. Furthermore, if mathematics self-concept (e.g. Goetz, Cronjaeger, Frenzel, Lüdtke, & Hall, 2010; Guay, Marsh, & Boivin, 2003; Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2013; Pinxten et al., 2015) and academic emotions (e.g. Goetz et al., 2010; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Pekrun, 2014) have been studied on a varied and international public, to our knowledge none of these studies concern Belgian elementary students. Additional research is therefore required to gain a more accurate picture of the motivational and emotional relationship of Belgian eighth grade students with mathematics in general. The aim of the present study is, on the one hand, to measure the motivation and the emotions that eighth graders experienced with mathematics and, on the other hand, to produce insights into the capacity of academic emotions to predict motivation, behavioral engagement and mathematics performance. These objectives are studied through the Control-Value Theory, proposed by Pekrun and Perry (2014), which is outlined below.

2. The Control-Value theory of achievement emotions

The Control-Value theory of achievement emotions (Pekrun & Perry, 2014) is worth studying for several reasons. Firstly, this model (Fig. 1) covers many previous models and therefore takes the main motivational dimensions into account while including the academic emotions in their own right. More precisely, it reconciles the Expectancy-Value theories, attributional theories of achievement emotions, perceived control theories and models showing the impact of emotions on learning and performance (Pekrun, 2006). Secondly, it highlights the relationships between emotional and motivational dimensions from a perspective of understanding learning and achievement behaviors. More precisely, perceived value of and perceived control over achievement activities and their outcomes are the key determinants of academic emotions, which, in turn, affect learning and achievement. Furthermore, appraisals of a given activity or outcome regarding perceived control and perceived value are shaped by the social environment in which the learning takes place, such as the quality of instruction, autonomy support, goal structures, etc. (Pekrun & Perry, 2014).

So, in this model, emotions mediate, on the one hand, the relation between motivational appraisals and learning and achievement behaviors–that is, cognitive resources, use of learning strategies, learning regulation and academic achievement–and, on the other hand, the relation between social environment and those behaviors. Last, but not least, this model takes emotions as antecedents of motivation and social environment, meaning that emotions can also affect appraisals and shape social environment (Pekrun & Perry, 2014).

In order to shed light on our twofold research objectives, we focused only on several variables presented in Pekrun's model, namely self-concept of ability, which is one dimension of perceived control, perceived value, academic emotions and academic achievement. Given its crucial role in student learning and