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Anxiety in the statistics class: Structural relations with self-concept, intrinsic value, and engagement in two samples of undergraduates

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ABSTRACT

This study investigated the motivational predictors (self-concept and intrinsic value) of anxiety in a statistics class and their outcomes (use of self-regulatory and deep processing strategies, persistence, and performance). Moreover the similarities and differences of these structural relations in two samples of undergraduates, and the mediation between variables were assessed. Two samples of Spanish undergraduates, undertaking science–technology degrees (n = 479) or degrees in social studies (n = 468), participated in this study. As hypothesised, statistics anxiety was predicted by self-concept and intrinsic value, and predicted the use of self-regulatory strategies, deep processing strategies, persistence, and performance; both self-concept and value predicted strategies, persistence, and performance; strategies and persistence predicted performance. For both samples, these relationships were similar, and the mediated relations between assessed variables were significant. These findings highlight the need for interventions aimed at preventing and minimising high levels of academic anxiety.

1. Introduction

Statistics is the only common subject in a wide array of university degrees in the fields of science, technology, health, law, and social sciences. In Spanish universities, introductory courses on statistics can be found in a wide range of university degrees such as Psychology, Medicine, Biology, Mathematics, Engineering, Economics and Business Studies, Sociology, and Social Education or Social Work, among many others.

However, the characteristics of students who enrol in these degree courses vary considerably in terms of variables such as the value assigned to statistics, and perceived competence in statistics and mathematics. These differences in personal characteristics condition the emotions experienced by students in class.

Anxiety is one of the most frequent and intense emotions experienced by some students in a statistics class (Chew & Dillon, 2014). Though some degree of anxiety may be helpful in the learning process, a high level of anxiety hinders optimum performance in learning: anxiety can paralyse students, who by intelligence and hard work should otherwise perform well (Sinatra, Broughton, & Lombardi, 2014). Anxiety also determines academic engagement, and in particular the use of deep processing strategies, self-regulatory strategies, and persistence in difficult tasks (Kesici, Baloğlu, & Deniz, 2011; Onwuegbuzie & Wilson, 2003).

The present study analyses structural relations between value, self-concept, anxiety in the statistics class, self-regulatory and deep learning strategies, persistence, and performance in two samples of undergraduates.

1.1. Academic emotions: anxiety

Pekrun and Perry (2014) defined academic emotions as affective arousal that is tied directly to achievement activities (e.g., attending class) or achievement outcomes (success and failure). The most widely assessed academic emotion in the literature is anxiety (Zeidner, 2014). Academic anxiety arises when students believe their cognitive and/or motivational skills may be overwhelmed by the demands of a highly valued academic situation (Pekrun & Perry, 2014; Zeidner, 2014).

One of the most extensively researched contexts of anxiety is mathematics (Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Núñez-Peña, Suárez-Pellicioni, Guilera, & Mercadé-Carranza, 2013; Steinmayr, Dinger, & Spinath, 2012; Steinmayr, Wirthwein, & Schöne, 2014). Maths anxiety is commonly characterized by adverse emotional reactions of fear, tension, nervousness, and discomfort in anticipation of situations demanding the presentation or application of mathematical knowledge.

Although the emphasis on mathematics can differ from one statistics course to another (Chew & Dillon, 2014; Galli, Chiesi, & Primi, 2011), the similarities between maths anxiety and statistics anxiety have prompted some researchers to assimilate both emotions. However, Baloğlu, (2004) points two differences between statistics anxiety and mathematics anxiety: statistics involves different mental procedures

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and requires more than manipulation of mathematical symbols; moreover, cognitive processes involved with statistics anxiety may be different from cognitive processes involved with mathematics anxiety. Statistics anxiety is defined as the feelings of apprehension that occur when an individual is exposed to statistical content problems, statistical analyses, instructional situations, or evaluative contexts (Baloğlu, 2003; Baloğlu, Deniz, & Kesici, 2011; Macher et al., 2013). As a multidimensional construct, several factors have been identified such as interpretation anxiety, fear of asking for help, fear of the statistics teacher, and test/class anxiety (Chiesi, Primi, & Carmona, 2011; Kesici et al., 2011; Oliver, Sancho, Galiana, & Cebriá, 2014).

1.2. Intrinsic value and self-concept

In describing the personal antecedents of academic emotions, several authors assert that students experience certain discrete emotions when they feel in control of, or lack control of, activities and outcomes that are subjectively important (Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011). Thus, the subjective appraisal of control (i.e., self-concept), and intrinsic value are determinants of academic emotions such as anxiety (Macher, Paecheter, Papousek, & Ruggeri, 2012; Macher et al., 2013).

Task value (or subjective task value) is, in addition to expectancy for success, the main variable in the expectancy–value model (Eccles & Wigfield, 2002). These authors distinguish several components of task value: intrinsic value, attainment value, utility value, and perceived cost. Eccles et al. defined intrinsic value (also termed interest value) as the inherent pleasure and enjoyment one gets from performing the activity, or the subjective interest the individual has in the subject (Eccles, 2009; Eccles & Wigfield, 1995; Wigfield, Tonks, & Klauda, 2009).

Self-concept is defined as the personal perception that arises from the interactions with the context (Arens, Yeung, Craven, & Hasselhorn, 2011; Jones, Audley, & Kiefer, 2012; Pinxten, Marsh, Fraine, van den Noortgate, & van Damme, 2014). Each undergraduate has a specific self-concept for each particular field of knowledge (e.g., mathematical self-concept), and even one for each subject (e.g., statistical self-concept) with two components, cognitive (perceived competence) and affective (emotional reactions) (Jansen, Schroeders, & Lüdtke, 2014).

Previous studies have shown that a good statistics self-concept and the intrinsic value of this subject were positively correlated to performance and negatively correlated to statistics anxiety (Baloğlu, 2003; Baloğlu et al., 2011; Chiesi et al., 2011; Hood, Creed, & Neumann, 2012; Kesici et al., 2011; Macher et al., 2012, 2013; Payne & Israel, 2010). Similar results have been found in mathematics (Ahmed et al., 2012; Ahmed, van der Werf, Kyuper, & Minnaert, 2013; Núñez-Peña et al., 2013; Steinmayr et al., 2012, 2014).

1.3. Academic engagement

Traditionally, different subtypes or components of academic engagement have been identified (Skinner, Pitzer, & Brule, 2014). Behavioural engagement has been defined as interactions with the academic setting that are active, goal directed, flexible, constructive, and persistent (Lawson & Lawson, 2013; Skinner & Pitzer, 2012). Some indicators of behavioural engagement in academic settings are effort, attention, concentration, and persistence. Cognitive engagement focusses on the analysis of the students' psychological investment of mental energy required for undertaking academic tasks (Lawson & Lawson, 2013; Skinner & Pitzer, 2012). According to Cleary and Zimmerman (2012) and Sinatra et al. (2014), cognitive engagement includes a continuum ranging from low cognitive engagement (shallow processing strategies) to high metacognitive engagement (deep processing and self-regulatory strategies).

Previous research has shown that higher levels of math and statistics anxiety negatively correlated with effort, persistence on complex or difficult tasks, use of self-regulatory strategies, and performance (Baloğlu et al., 2011; Kesici et al., 2011; Macher et al., 2013; Rodarte-Luna & Sherry, 2008). On the other hand, indicators of cognitive and behavioural engagement positively correlated with self-concept, intrinsic value, and performance (Dettmers et al., 2011; Ning & Downing, 2010; Pinxten et al., 2014; Wigfield et al., 2009).

1.4. Present study

Though previous studies on anxiety have provided valuable data on the relationships between these variables, there are several shortcomings in certain studies. For example, the studies under review evaluated only some, but not all of the variables analysed in the present study, and none examined all concurrently. Furthermore, few studies analysed the data using structural equation modelling. Finally, the vast majority of studies have been undertaken on samples of education or psychology undergraduates, but few studies have focussed on undergraduates from other fields such as science and technology.

In this context, the aim of this study was threefold: to analyse a model of structural relations between intrinsic value, self-concept, anxiety in statistic class, self-regulatory and deep processing strategies, persistence, and performance; to compare this model in two samples of undergraduates undertaking science–technology degrees *vs.* degrees in social studies; and to analyse mediational effects between assessed variables.

The hypothesised relations are based on the proposals of Dettmers et al. (2011), Macher et al. (2012), Pekrun and colleagues (Pekrun & Linnenbrink-García, 2012; Pekrun & Perry, 2014), and Zeidner (2014). These authors posit that academic emotions (e.g., anxiety in class) are influenced by different motivational variables (e.g., intrinsic value and self-concept), and determine the levels of engagement (e.g., self-regulatory strategies, deep processing strategies, and persistence) and achievement (e.g., performance). Based on this model and empirical evidence outlined above, we expected to find the relationships depicted in Fig. 1.

According to the model shown in Fig. 1, and bearing in mind the findings of previous studies, it was hypothesised that: (a) anxiety in statistics class would be negatively predicted by intrinsic value and self-concept, and would negatively predict engagement and performance; (b) intrinsic value and self-concept would positively predict engagement, and these variables would positively predict performance; c) these relationships would be equivalent in both samples; (d) the mediated relations between variables would be significant.

2. Method

2.1. Participants

The study involved two samples of undergraduates from state universities in North-eastern Spain. Sample 1 consisted of 479 undergraduates aged 18 to 36 years (mean = 20.4 years; SD = 2.6) enrolled in science–technology degrees (hereafter Scientific sample). Besides statistics, these degrees contain many compulsory subjects of mathematical content. Sample 2 consisted of 468 students aged 18 to 47 years (mean = 19.7 years; SD = 1.7) enrolled in social studies degrees (hereafter Social sample), in which statistics was the only subject with a mathematical content.

All of the undergraduates had enrolled for the first time in the statistics course, and most were first- or second-year undergraduates. As for gender, 69% of the Social sample, and 44% of the Scientific sample were women.

The undergraduates of the science–technology sample had received more previous instruction in mathematics in higher secondary education (baccalaureate), and had chosen degrees linked to other mathematics related subjects besides statistics (Baloğlu, 2003; Núñez-Peña et al., 2013). Thus, these undergraduates were expected to exhibit