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Teaching quality: relationships between passion, deep strategy to learn, and epistemic curiosity

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ABSTRACT

The purpose of this study was to examine the relationship between teaching quality and students' harmonious passion, deep strategy to learn, and epistemic curiosity in mathematics in 1,003 high school students. Data were analyzed using multilevel structural equation modeling, and results showed support for the hypotheses tested. First, we found that teaching quality – specifically, providing an optimal challenge, focusing on the process, and offering positive feedback – predicted students' harmonious passion. Second, students' harmonious passion predicted, at the individual and class level, students' deep strategy to learn. Third, students' harmonious passion predicted, at the individual and class level, students' epistemic curiosity. Findings were discussed regarding their implications for educational practice and methodological suggestions for future research.

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Mathematics; harmonious passion; teaching quality; high school

Introduction

Determining teachers' specific behaviors that promote students' positive educational outcomes is a growing research topic and has been a priority issue in recent years (Hagger & Chatzisarantis, 2015; Stroet, Opdenakker, & Minnaert, 2015a). Effective teachers make students reach their full potential (Maulana, Helms-Lorenz, & Van de Grift, 2015), they play a central role in enhancing students' academic functioning, and they affect students' learning in class through their quality and the interactions they have with them (Dietrich, Dicke, Kracke, & Noack, 2015; Fauth, Decristan, Rieser, Klieme, & Büttner, 2014). Moreover, this role could be particularly important for secondary education math teachers since, at this stage, students meaningfully lose interest in school, and their math accomplishment gets significantly worse (Kiemer, Gröschner, Pehmer, & Seidel, 2015; Stroet, Opdenakker, & Minnaert, 2015b).

However, far too little research has been conducted to explain the specific behaviors of math teachers that lead to students' optimal functioning (Rimm-Kaufman, Baroody, Larsen, Curby, & Abry, 2015). This fact warrants special attention if we consider the importance of math skills on other school subjects (Gaspard et al., 2015) and its increasing influence on students' future professional performance (Seaton, Parker, Marsh, Craven, & Yeung, 2014). There is no doubt that there is a social and educational

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need to better understand how teachers can improve their students' mathematics learning.

Thus, in this study, we aimed to explore the relationship between teaching quality and other achievement-related variables. First, we tested how math teachers' quality affects another variable that is also booming: students' passion for the subject. To this effect, research on passion has shown that teachers, and what they do in the classroom, can help students promote their passion (e.g., Bonneville-Roussy, Vallerand, & Bouffard, 2013; Coleman & Guo, 2013; Fredricks, Alfeld, & Eccles, 2010; Ruiz-Alfonso & León, 2017). Second, research on passion has also shown that the more passion, the more positive educational outcomes such as academic engagement (Stoeber, Childs, Hayward, & Feast, 2011), dedication (Bonneville-Roussy, Lavigne, & Vallerand, 2011; Stoeber et al., 2011; Vallerand et al., 2007), persistence (Bonneville-Roussy et al., 2013), competence, and goals orientation (Bonneville-Roussy et al., 2011; Fredricks et al., 2010; Phelps & Benson, 2012; Vallerand et al., 2007). Therefore, our second aim was to explore how passion relates to other educational outcomes that are yet to be explored, such as students' deep strategy to learn and intellectual curiosity.

Teaching quality: providing optimal challenge, offering positive feedback, and focusing on the process

Teaching quality refers to teachers' behaviors that promote positive educational outcomes (Cochran-Smith & Fries, 2005), and it covers the aspects of teacher–student relationships in the classroom (Cornelius-White, 2007). There are several frameworks to analyze the characteristics and practices of successful teachers (Kunter et al., 2013), and there are also different terms to refer to the classroom processes related to students' learning, such as *quality of teaching* (Hattie, 2009), *instructional quality* (Rjosk et al., 2014), *teacher quality* (Zablotsky & Rosenberg, 2013), and *teaching effectiveness* (Seidel & Shavelson, 2007). However, despite this wide range of terms to represent similar ideas – a "conceptual confusion" very common in our field (Murphy & Alexander, 2000) – researchers agree that the classroom processes and the quality of teaching are important predictors of students' learning and outcomes (Creemers & Kyriakides, 2008; Zablotsky & Rosenberg, 2013).

According to self-determination theory (SDT; Deci & Ryan, 1985, 2017), quality teaching is when teachers support students' needs regarding autonomy, competence, and relatedness (Assor, Kaplan, & Roth, 2002), and strategies such as providing optimal challenge, focusing on the process, and offering positive feedback make it easier for teachers to achieve this purpose (León, Medina-Garrido, & Ortega, 2018). In greater detail, "provision of optimal challenge" refers to teachers accounting for students' level when teaching or assigning class activities instead of assigning very difficult or straightforward tasks. This allows students to improve and progress according to their level and capacities (Cheon & Reeve, 2015). "Focusing on the process" denotes that teachers stress the importance of internalizing the meaning and utility of class activities, valuing the procedure and not just the final result (Kusurkar, Croiset, & Ten Cate, 2011; Tessier, Sarrazin, & Ntoumanis, 2010). Finally, "offering positive feedback" alludes to teachers guiding students to improvement through instructions phrased constructively and positively, teachers stressing both what the students have done well and what should be improved and how (Kusurkar et al., 2011). Although many

other strategies contribute to teaching quality (e.g., León, Medina-Garrido, & Núñez, 2017), in this study, we focus on the three teaching behaviors described above.

Although previous research has shown that teachers and what they do in the classroom can help students promote their passion (Núñez & León, 2015; Vallerand, 2016), this study will consider an unexplored relation: how teaching quality – specifically, the three indicators explained above – affects students' passion.

On passion and teaching quality

Passion is "a strong inclination toward a self-defining activity, object, concept or person that one likes, loves or highly values, and in which one invests a significant amount of time and energy" (Vallerand et al., 2003, p. 757). Most of the contemporary research on passion toward activities has been conducted under the framework of the dualistic model of passion (Vallerand, 2015; Vallerand et al., 2003), in which Vallerand and colleagues propose two types of passion: harmonious and obsessive. These types reflect different experiences and outcomes, and the supremacy of one or another in people depends on how the activity is internalized into their identity. According to this model, harmonious passion is a consequence of an autonomous internalization of the activity into the person's identity, and it leads to adaptive outcomes. Thus, when people are harmoniously passionate, they freely engage in the activity, perceive that the activity is in line with their values and other aspects of their life, and they experience positive affect and high levels of concentration, flow, and energy (Vallerand, 2015).

On the contrary, obsessive passion results from a controlled internalization of the activity into the person's identity. Hence, although obsessively passionate people also find the activity they are passionate about meaningful and enjoyable, they feel internal or external pressure to engage in the activity, they experience negative emotions while doing it, and they show difficulties to experience flow and to remain fully concentrated on it. This type of passion also leads individuals to sense that the activity they love conflicts with other aspects of their life (Bonneville-Roussy et al., 2011; Bonneville-Roussy et al., 2013; Luh & Lu, 2012; Vallerand, 2015; Vallerand et al., 2003). In this paper, we focus on harmonious passion because of its positive outcomes in the educational field (e.g., Bonneville-Roussy et al., 2011; Bonneville-Roussy et al., 2013; Ruiz-Alfonso & León, 2016).

Concerning the relationship between passion and teaching quality, few studies have been conducted to determine which teaching behaviors could foster students' passion. In this regard, Fredricks et al. (2010), for example, explored how passion is manifested in the academic context and noticed that the most passionate students were those who perceived their teachers to be supportive and caring. These students also showed more passion toward those activities that were consistent with their interests. Similarly, Coleman and Guo (2013) observed that middle school students who were passionate about learning perceived their context as autonomy supportive, and Bonneville-Roussy et al. (2013) also noticed that students who perceived their teachers as autonomy supportive rather than controlling showed higher levels of passion. Lastly, a very recent study conducted by Ruiz-Alfonso and León (2017) showed that teachers – specifically, math teachers – who attempt to explain the usefulness of the content they teach and the activities they propose tend to promote harmonious passion in their high school students. To our knowledge, this study was the first empirical research on examining the

relationship between a specific teaching behavior and students' passion. As already noted, research on this topic is still insufficient, so efforts to explore which teaching aspects could promote students' passion are highly warranted.

On harmonious passion and cognitive processes: the deep strategy to learn and the epistemic curiosity

Drawing on the theoretical framework of the dualistic model of passion (Vallerand et al., 2003), harmonious passion in particular considerably influences cognitive processes. Harmoniously passionate people are highly involved in the activity they love, they are more aware and attentive, they fully partake in the activity with mindful attention, and they are more likely to think about the passionate activity when they are not engaged in it (Vallerand, 2015). Thus, researchers have analyzed in different contexts how harmonious passion positively affects diverse cognitive processes such as on-task attention and concentration (e.g., Forest, Mageau, Sarrazin, & Morin, 2011; Ho, Wong, & Lee, 2011; Vallerand et al., 2003), resilience and mental toughness (e.g., Gucciardi, Jackson, Hanton, & Reid, 2015), absorption (e.g., Ho et al., 2011; Stoeber et al., 2011), and mindfulness (e.g., St-Louis, Verner-Filion, Bergeron, & Vallerand, 2018). However, although harmonious passion would be expected to also affect other cognitive processes such as students' approaches to learning or epistemic curiosity, to this date the role of passion has not yet been studied within the nexus of these variables.

Students' approach to learning refers to how students cope with their study and how they use diverse strategies to process and learn the contents they receive in class (León, Núñez, & Liew, 2015). These approaches are not characteristic of the students but are the result of the interaction between the students and the context (Struyven, Dochy, Janssens, & Gielen, 2006). They vary from memorizing the contents without reasoning or thinking critically to analyzing and comparing the information presented in the classroom with previous knowledge and knowledge in other subjects (Cano-Garcia, García, Justicia, & García-Berben, 2014; Duncan & McKeachie, 2005). Within the educational literature, there are mainly three approaches that several publications have described in detail: the surface, achieving, and deep approach; with an underlying motive and strategy (e.g., Biggs & Tang, 2007; Dinsmore & Alexander, 2012; Struyven et al., 2006). Students adopt a surface approach when they learn the material by rote and memorize the ideas to reproduce them with little personal engagement in it. The achieving approach denotes that students focus their attention on optimizing their study and maximizing their grades. Lastly, the deep approach occurs when students engage in the task meaningfully, comprehending, analyzing, and relating the new ideas to their previous knowledge or experience (Biggs & Tang, 2007; Fox, McManus, & Winder, 2001; Struyven et al., 2006). Within each approach, we can assess students' deep strategies of going about learning (how they study) or students' deep motives for learning (why they study) (Biggs, 1979).

Promoting students to think critically, to relate what they know to the new knowledge, and to deeply process the information they receive is a priority issue in current education (Yang, 2012). Consequently, in this paper we focus on students' deep strategies to learn, and we consider harmonious passion as a potential variable to promote students' deep approach toward learning.

On the other hand, epistemic curiosity (EC) refers to the "drive to know", the desire for knowledge that motivates the acquisition of new ideas and exploratory behavior (Berlyne, 1954). According to Litman and Jimerson's (2004) theoretical model of curiosity, there are two types of EC regarding the different motives behind the acquisition of new information, and each of them is associated with different outcomes (Litman, 2008). Thus, interest-type EC (I-type EC) refers to the anticipated pleasure of acquiring new knowledge and discoveries, just for the intrinsic pleasure of doing so. Conversely, deprivation-type EC (D-type EC) refers to the individual's need to reduce and eliminate undesirable states of ignorance (Litman, 2008; Piotrowski, Litman, & Valkenburg, 2014).

Although no study to date has analyzed the relationship between students' deep strategy, EC, and harmonious passion, a positive relationship between them is expected. On the one hand, as we explained above, harmonious passion has been linked to different cognitive processes (e.g., Gucciardi et al., 2015; Ho et al., 2011; St-Louis et al., 2018), and, on the other hand, both deep strategy to learn and EC have been associated with students who enjoy studying and voluntarily engage in the learning process (e.g., Chin & Brown, 2000; Dinsmore & Alexander, 2012; Litman, 2008; Piotrowski et al., 2014). Therefore, it could be expected that the more harmoniously passionate students also show greater curiosity and use a deeper strategy to learn than those students that are less passionate.

The present study

To date, no studies have examined the relationship between students' harmonious passion, deep strategy to learn, and EC. Also, the association between specific teaching characteristics – providing an optimal challenge, focusing on the process, and offering positive feedback – and students' harmonious passion has never been examined before. In this study, we aim to analyze how these variables relate to each other within the secondary education context, specifically, in mathematics.

Therefore, the following research questions were addressed to examine whether: (Research Question 1) teaching quality – specifically, providing optimal challenge, focusing on the process, and offering positive feedback – predicts students' harmonious passion; (Research Question 2) students' harmonious passion predicts, at an individual and class level, students' deep approach to learning; and (Research Question 3) students' harmonious passion predicts, at an individual and class level, students' EC.

With respect to our first research question, we hypothesize, according to previous literature suggesting that certain teaching aspects foster students' passion (e.g., Bonneville-Roussy et al., 2013; Coleman & Guo, 2013; Fredricks et al., 2010), that teaching quality – specifically, providing optimal challenge, focusing on the process, and offering positive feedback – will predict students' harmonious passion. With respect to our second and third research questions, we hypothesize that students' harmonious passion will be positively associated with students' deep strategy to learn and EC. This is consistent with the dualistic model of passion (Vallerand et al., 2003), which states that harmonious passion significantly predicts cognitive processes, and with previous research suggesting a close relationship between deep strategy to learn and EC with students who relish learning and deliberately engage in it (e.g., Chin & Brown, 2000; Dinsmore & Alexander, 2012; Litman, 2008; Piotrowski et al., 2014). In sum, the following multilevel model was proposed (see Figure 1).

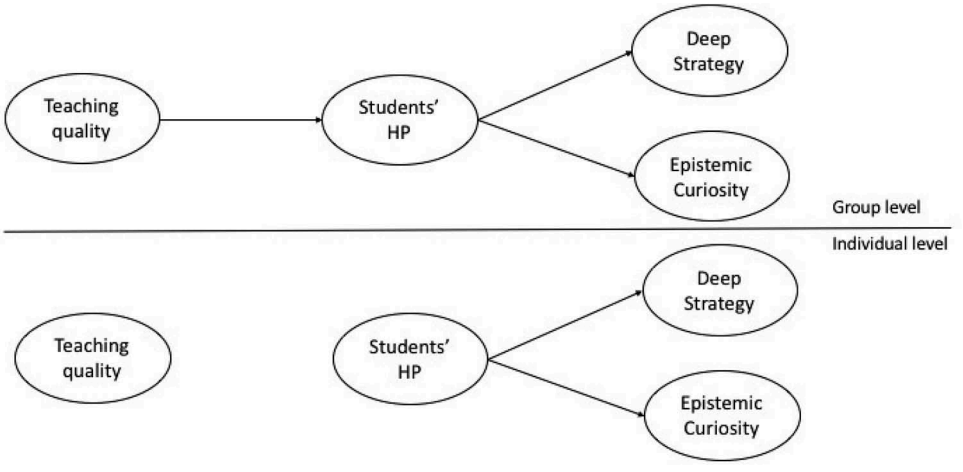

Figure 1. Proposed multilevel model.
Note: HP = Harmonious Passion.

Method

Participants

We recruited 1,121 students (566 females, 548 males, 7 not specified) from seven high schools in Gran Canaria, Spain. Students were from second to fourth grades of secondary education (8th to 10th grades in the US system), and their mean age was 15.08 (*SD* = 1.0). Some responses were discarded because they were incomplete or because students were identified as non-passionate toward mathematics, so the final sample comprised 1,003 students (516 females, 482 males, 5 not identified), from 52 classes. The students' mean age was 15.08 (*SD* = 1.0). All participants were informed of the data confidentially, and participation was strictly voluntary.

Procedure

We contacted high schools by phone to request an appointment with the high-school mathematics teachers to explain the study and request their cooperation. The school principals and teachers authorized students' participation in the study. Each researcher personally administered questionnaires, briefly explaining the study, the anonymity of the data, and the need for accuracy in responses. Researchers asked participants by an open-ended question to indicate which type of math they loved the most (e.g., algebra, calculus, statistics, geometry), and then researchers instructed students to complete the Passion Scale for this type of math activity. Some students could not complete this section because they did not have a favorite math-related activity, so they were automatically classified as non-passionate toward math and removed from the final sample. The surveys were administered during the first period of the last semester.

Measures

Participants completed a questionnaire with demographic questions and measures of harmonious passion, deep strategy to learn, and epistemic curiosity. Students also completed questions about the three indicators of teaching quality: optimal challenge, focus on the process, and positive feedback. To examine reliability, we used McDonald's (1999) Omega, since it has shown evidence of better accuracy than Cronbach's alpha (McNeish, 2018; Revelle & Zinbarg, 2009), it does not require data to be continuous (Bonanomi, Cantaluppi, Nai Ruscone, & Osmetti, 2015), and it does not require factor loading to be equal for all items (Zhang & Yuan, 2016). To examine the scales' structure, we performed a confirmatory factor analysis (CFA) for each variable. We extend information about the estimation method and missing data in the data analysis section. All scales were rated on a 7-point Likert-type scale, ranging from 1 (*I do not agree at all*) to 7 (*I strongly agree)* (see Appendix 1 for items).

Harmonious passion

We used six items of the Passion Scale (Vallerand et al., 2003), adapted to Spanish and to the educational context, to assess students' harmonious passion (e.g., "This activity reflects the qualities I like about myself"). The Spanish translation of the scale was performed by two Spanish-speaking researchers and revised by a bilingual specialist, according to the standards for cross-cultural adaptation (Muñiz, Elosua, & Hambleton, 2013). Regarding the CFA, the χ^2 value and fit indexes were χ^2 (1112, 18) = 614.839 (p = .00), RMSEA = .182, $SRMR_{within}$ = .044, $SRMR_{between}$ = .042, CFI = .97 and TLI = .95, and McDonald's Omega was .89.

Deep strategy to learn

We used the three items (e.g., "I often think of a real-life situation in which the material that I am learning would be useful") from the Deep Strategy subscale of the Shortened Study Process Questionnaire (Fox et al., 2001). Regarding the CFA, the model is just identified, so that no fit index could be computed. McDonald's Omega was .63.

Intellectual curiosity

We used 10 items (e.g., "I find it fascinating to learn new information") from the Spanish-Argentine variant (Litman, Cosentino, & Solano, 2018) of the Epistemic Curiosity Scale (Litman & Spielberger, 2003). Regarding the CFA, the χ^2 value and fit indexes were χ^2 (1112, 18) = 775,510 (p = .00), RMSEA = .097, $SRMR_{within}$ = .039, $SRMR_{between}$ = .073, CFI = .97 and TLI = .96, and McDonald's Omega was .91.

Teaching quality

We used 16 items from the scale developed by León et al. (2017) to assess teaching quality. These items cover the students' perceptions of specific teacher behaviors of three teaching quality indicators: positive feedback (if the teacher provides specific, quick, and positive feedback), optimal challenge (if the teacher explains in class and assigns the activities accounting for the students' level), and focus on process (if the teacher emphasizes the importance of learning and working in class rather than just focusing on passing and getting good marks). To examine the three-factor scale structure, we performed a confirmatory

factor analysis in which we tested a three-factor second-order model. Regarding the CFA, the χ^2 value and fit indexes were χ^2 (1112, 18) = 13512,266 (p = .00), RMSEA = .070, $SRMR_{within}$ = .041, $SRMR_{between}$ = .032, CFI = .97 and TLI = .97, and McDonald's Omega was .95. To provide more accurate data, we compared our CFA model of three factors to a simpler model of one factor, and reported the associations between the three latent constructs of this model before adding a second-order factor to the model. Fit indexes were better for the three-factor model (χ^2 (1112, 202) = .793 (p = .000), RMSEA = .107, $SRMR_{within}$ = .050, $SRMR_{between}$ = .030, CFI = .969, TLI = .963) than for the one-factor model (χ^2 (1112, 208) = 8189.797 (p = .000), RMSEA = .186, $SRMR_{within}$ = .074, $SRMR_{between}$ = .033, CFI = .903, TLI = .888), and because in the original version (León et al., 2017) authors model it as a second order, we prefer the second-order option.

Data strategy

Because assessment of the school effects, the classroom, or teachers' behaviors on students' outcomes must be based on analysis performed at the group and not at the individual level (Lüdtke, Robitzsch, Trautwein, & Kunter, 2009; Marsh et al., 2012; Stapleton, McNeish, & Yang, 2016), we tested our hypotheses running a multilevel structural equation model (MSEM) where teaching quality predicted students' harmonious passion, and this, in turn, students' deep strategy to learn and epistemic curiosity. Moreover, to complete our analysis, we ran an additional MSEM to test the effect of harmonious passion on I and D types of epistemic curiosity separately.

In multilevel modeling, we can deal with variables that have the same value for all students in the class (e.g., Number of students per class) and variables estimated according to the aggregation of students' perceptions. Regarding the latter, we can find contextual or climate variables (Marsh et al., 2012). Contextual variables are group-level aggregations of student-level variables that are specific to students in a class (in our study: class-average harmonious passion, class-average deep strategy, and class-average epistemic curiosity), and values are assigned according to individual characteristics and not based on a common reference. On the other hand, climate variables are those resulting from asking students about one variable that is common to students in the same class (in our study: the teaching quality indicators), so the reference is the same for all students in one class. In this study, we focus on contextual (harmonious passion, deep strategy, and epistemic curiosity) and climate constructs (teaching quality).

Our goal was to test the relationships between climate and students' variables, and, according to Marsh et al. (2012), teaching quality should be introduced at the classroom but not at the individual level because students' responses at this level do not reflect the contextual influences but just their individual perceptions. Students' harmonious passion, deep strategy to learn, and epistemic curiosity were introduced at the individual and classroom levels because it allows to separate the variance between the two levels of analysis (Friedrich, Flunger, Nagengast, Jonkmann, & Trautwein, 2015). Also, it allows to obtain more information about the relationship between the variables, and about the variables themselves (Morin, Marsh, Nagengast, & Scalas, 2014). Consequently, harmonious passion, deep strategy to learn, and epistemic curiosity are not only indicators at the individual level, but, if aggregated, they are also an indicator of a shared characteristic of the class.

To test the mediational effect of harmonious passion between teaching quality and deep strategy and epistemic curiosity, we computed the unstandardized indirect effects and its standard errors using the delta method (Sobel, 1982).

Regarding the estimation method, we used a weighted least square mean adjusted (WLSM) estimator, because the observed variables (items) were ordered categorically and this estimation method is more accurate than the maximum likelihood method (Schmitt, 2011). We also handled missing data using the WLS estimation method in the presence of missing data. It provides robust estimates under some common assumptions of missing data (Asparouhov & Muthén, 2010). Analyses were conducted using the software Mplus 7.4 (Muthén & Muthén, 2017).

Results

Preliminary analysis

Means, standard deviations, intraclass correlations, and correlations between major variables are shown in Table 1.

Teaching quality, harmonious passion, deep strategy to learn, and epistemic curiosity

We tested the hypothesized model, in which Teaching Quality predicts students' Harmonious Passion, and this, in turn, predicts students' Deep Strategy to Learn and Epistemic Curiosity.

The χ^2 test and fit indexes for the MSEM were χ^2 (1112, 1100) = 10230.016 (p = .000), RMSEA = .086, $SRMR_{within}$ = .061, $SRMR_{between}$ = .108, CFI = .94, TLI = .93. As depicted in Figure 2, at the group level, Teaching Quality predicted Harmonious Passion (β = .631; *SE* = .099; p < .001), and Harmonious Passion predicted Deep Strategy (β = .874; *SE* = .132; p < .001) and Epistemic Curiosity β = .953; *SE* = .081; p < .001. At the individual level, Harmonious Passion predicted Deep Strategy (β = .614; *SE* = .131; p < .001) and Epistemic Curiosity (β = .749; *SE* = .018; p < .001).

Concerning the mediational effect of Harmonious Passion in the relationship between Teaching Quality and Deep Strategy to Learn, the unstandardized effect in the fully mediated model was significantly different from 0 (β = .127; *SE* = .041; p= .002). Regarding the mediational effect of Harmonious Passion in the relationship between Teaching Quality and Epistemic Curiosity, the unstandardized effect in the fully mediated model was also significantly different from 0 (β = .152; *SE* = .047; p= .001).

Table 1. Descriptive statistics and correlations between major variables.

	Mean	*SD*	ICC	1	2	3	4	5	6
1 Deep Strategy	4.717	1.267	.067		.820	.841	.427	.565	.346
2 Curiosity	3.918	1.259	.099	.535		.722	.582	.604	.458
3 Passion	3.869	1.471	.105	.327	.498		.473	.509	.442
4 Positive feedback	4.898	1.685	.385	.294	.327	.252		.959	.949
5 Optimal challenge	4.494	1.767	.293	.255	.318	.253	.703		.935
6 Focus on process	4.944	1.729	.260	.183	.236	.170	.626	.498	

Note: Upper diagonal triangle: group-level correlations. Lower diagonal triangle: individual-level correlations.

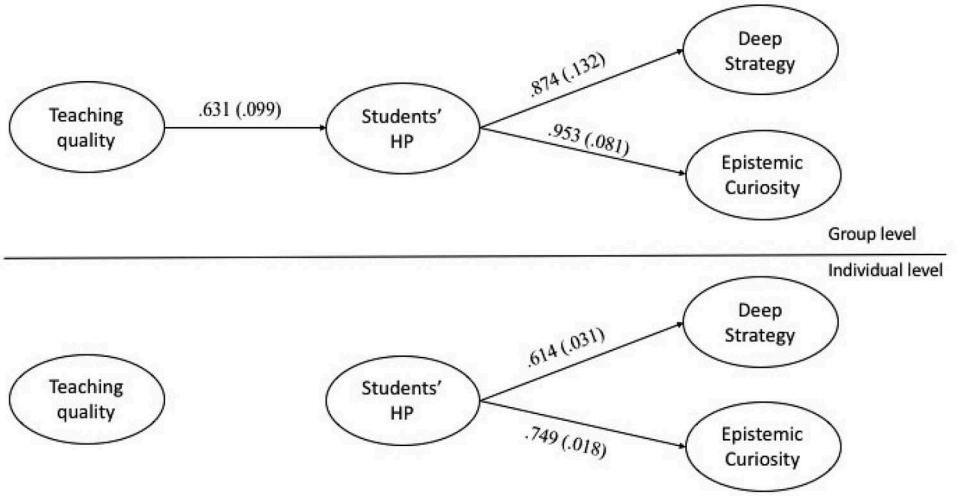

Figure 2. Results of the multilevel structural equation model.

Note: The standardized parameters are above the arrows; standard errors are between parentheses. HP = Harmonious Passion.

Finally, regarding the additional model to test separately the effect of Harmonious Passion on I and D types of Epistemic Curiosity, the χ^2 test and fit indexes for the MSEM were χ^2 (1112, 1190) = 162433.099 (p = .000), RMSEA = .086, $SRMR_{within}$ = .061, $SRMR_{between}$ = .107, CFI = .94, TLI = .93. As depicted in Figure 3, at the group level, Teaching Quality predicted Harmonious Passion (β = .631; *SE* = .099; p < .001) and Harmonious Passion predicted Deep Strategy (β = .874; *SE* = .132; p < .001) D-type Epistemic Curiosity (β = .981; *SE* = .113; p < .001), and I-type Epistemic Curiosity (β = .822; SE = .070; p < .001). At the within level, Harmonious Passion predicted Deep Strategy (β = .614; *SE* = .031; p < .001), D-type Epistemic Curiosity (β = .580; *SE* = .021; p < .001), and I-type Epistemic Curiosity (β = .689; *SE* = .017; p < .001).

Discussion

Building on prior research about the role of teachers in fostering students' passion and the effect of harmonious passion in cognitive processes, in this study we attempted to analyze, on the one hand, the effect of teaching quality as a passion predictor and, on the other hand, how passion predicts cognitive processes such as deep strategy to learn and epistemic curiosity.

To the best of our knowledge, never before has it been examined how the three specific teaching quality indicators tested in this study – optimal challenge, focus on the process, and feedback – affect students' harmonious passion, and how this, in turn, relates to the deep strategy to learn and epistemic curiosity. Moreover, it seems particularly important to explore teachers' specific behaviors that promote better mathematics learning, since it is common for secondary students' interest to decline and mathematics to become tedious, difficult, or even boring for students at this stage (Gersten et al., 2009).

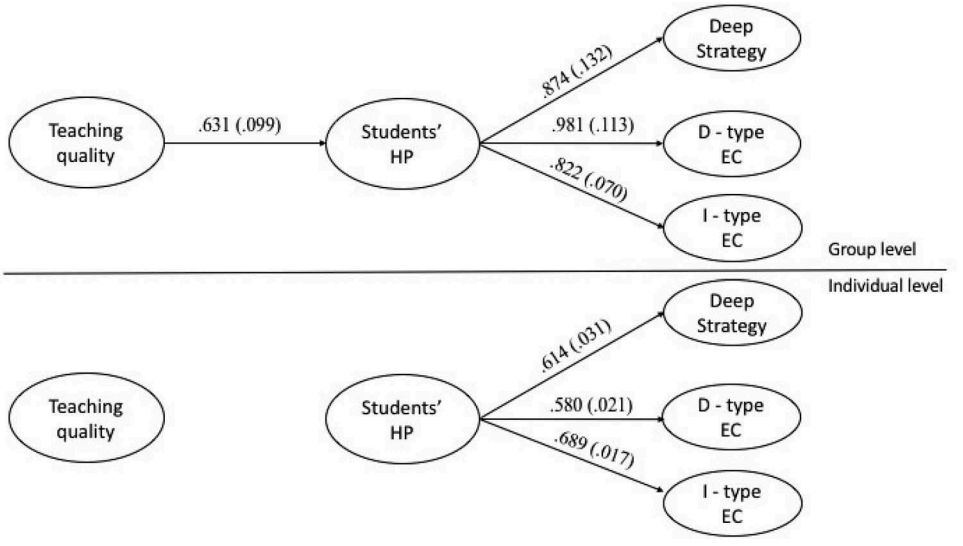

Figure 3. Results of the multilevel structural equation model testing separately the effect on I and D types of EC.

Note: The standardized parameters are above the arrows; standard errors are between parentheses. HP = Harmonious Passion.

This study provided support for the tested hypotheses. First, teaching quality – specifically, optimal challenge, focus on the process, and positive feedback – predicts students' harmonious passion (Hypothesis 1). Second, students' harmonious passion predicts their deep strategy to learn (Hypothesis 2). And, third, students' harmonious passion predicts students' EC (Hypothesis 3).

On the one hand, we provided evidence of the relationship between teaching quality and students' harmonious passion. Although no research has specifically tested the teaching behaviors assessed in this study, previous research on passion has shown that the more students perceive their teachers as autonomy supportive, the more harmonious passion they show. Consequently, in this study we focused on three strategies that support students' autonomy (Tessier et al., 2010). Accordingly, it could be considered that our findings are consistent with those studies that showed a positive relationship between these variables (e.g., Bonneville-Roussy et al., 2013; Coleman & Guo, 2013; Fredricks et al., 2010). Continuing with autonomy supportive teaching, Bonneville-Roussy et al. (2013) noticed that college students who perceived their teachers as autonomy supportive rather than controlling showed higher levels of harmonious passion. Coleman and Guo (2013) observed, in a sample of middle school students, that passionate learners tend to perceive their context as autonomy supportive. Finally, Fredricks et al. (2010) also noticed that passionate students often perceived their teachers to be caring, encouraging, and supportive and that they observed that their teachers usually provided choices and opportunities to work on varied activities. However, unlike in our study, none of these studies have analyzed the relationship between teaching quality and passion taking into account the nested data structure, so their results could be interpreted as a reflection of individual rather than contextual differences (Hospel & Galand, 2016).

On the other hand, our results also provide evidence on the association between students' harmonious passion and their deep strategy to learn and EC. Although no studies

to date have analyzed these connections, our results fit well within the dualistic model of passion (Vallerand et al., 2003). Earlier studies have suggested, in different contexts, a close relationship between harmonious passion and other cognitive processes such as concentration (e.g., Forest et al., 2011; Ho et al., 2011), resilience and mental toughness (e.g., Gucciardi et al., 2015), or absorption (Stoeber et al., 2011). Although it is difficult to establish comparisons between our results and previous ones, ours could also be in line with the vast literature that has suggested a close relationship between deep strategy to learn and EC with students who relish learning and deliberately engage in it (e.g., Chin & Brown, 2000; Dinsmore & Alexander, 2012; Litman, 2008; Piotrowski et al., 2014). Moreover, in the additional model to test the effect of harmonious passion in the D and I types of EC, our results provide evidence that the harmonious passion correlated with both types of epistemic curiosity. Previous research on individual differences in EC has empirically shown that D and I types of EC meaningfully differ and are related to different personality traits, motives for acquiring information, learning goals, and affective experiences (Lauriola et al., 2015; Litman, 2008). However, although on the basis of curiosity research one might expect harmonious passion to correlate better with I-type EC, in our study it was not uncommon to see that it was related to both I and D types, since both D and I are characterized, even separately, by features that previous studies have pointed out as consequences of harmonious passion (e.g., Bonneville-Roussy et al., 2011; Fredricks et al., 2010; Phelps & Benson, 2012; Stoeber et al., 2011; Vallerand et al., 2007).

Finally, to complete our model, we looked at the mediational pathways of students' harmonious passion between teaching quality and students' deep strategy and EC. In doing so, we observed a significant indirect effect in all relations, so we can conclude that teaching quality can enhance students' deep strategy to learn and EC through their harmonious passion. For example, if teachers focus on the process and not only on the final result, they offer positive feedback and they take into account students' level when teaching. As a result, students may feel greater harmonious passion toward mathematics, and thus engage in the subject for the pleasure of acquiring new knowledge and adopting a deep approach.

In sum, and as was expected, our study provides evidence – for the first time in the literature, in an academic discipline such as mathematics, and taking into consideration the nested data nature – of the relation between specific teacher behavior, such as providing optimal challenge, focusing on the process, and offering positive feedback, and the students' harmonious passion. We also provide evidence, for the first time, of the relationships between students' harmonious passion and their deep strategy to learn and EC.

Limitations and future research

Despite the novel features of the present research, the following limitations should be considered. First, because it is a cross-sectional study, it is impossible to establish causal relationships between the variables tested. Consequently, although previous research evidence that teacher behaviors have an influence on students' practices and that harmonious passion predicts cognitive processes, in this study, we cannot provide accurate information about the direction of the effects. Thus, we propose future research to assess these directions conducting longitudinal studies, and to test if the mediating variables can be considered as mechanisms to establish clear associations between the variables (Kazdim, 2007).

The second limitation refers to the nature of our data. Although aggregated students' perceptions are reliable measures of classroom characteristics (Morin et al., 2014; Wentzel, Muenks, McNeish, & Russell, 2017), we suggest future research to add other approaches, including the teachers' own perception and observers' ratings.

As for the third limitation, and because we aimed to test specifically the effect of harmonious passion on deep strategy and EC, we just considered those students who felt some harmonious passion for mathematics. This does not mean that all students were completely passionate about mathematics but that they felt some, albeit minimal, harmonious passion towards it. This sampling decision was based on the difficulty of assessing the harmonious passion of students if they did not love any activity related to mathematics, since loving the activity is one of passion's requirements (if there is no passion, not even a small amount, there can be no harmonious passion). However, it could be interesting for future research to consider these completely non-passionate students to compare them, first of all, with the passionate ones, and then to analyze the effect of the harmonious passion on the other variables.

Fourth, because previous research on individual differences in epistemic curiosity has shown that D and I types of EC are related to different motives for acquiring information, learning goals, and affective experiences, and that they have different consequences on the educational outcomes, it could be interesting for future research to better explore the relationship between passion and these types of EC. Thus, it could be interesting for future studies to even include the obsessive passion in their analysis to assess which kind of passion tends to correlate better with each type of epistemic curiosity.

Finally, because no previous studies have analyzed the variables that we have tested, it is very difficult to establish comparisons between our results and previous ones. Therefore, more studies using multilevel analyses are needed to reproduce and give consistency to our results. It would also be interesting for future research to test other classroom practices that promote students' passion.

Implications

We believe that this study provides useful information for teachers and schools. First of all, considering our results and those of previous research, we encourage the educational community to be aware of the importance and the wider benefits of harmonious passion in the educational context.

Second, although our results must be supported by future longitudinal studies to establish causal relationships, in view of previous studies showing an effect of teaching quality on students' academic functioning, our research could be giving some clues about practical tools that teachers could use to improve their students' harmonious passion. Thus, it could be interesting for teachers to emphasize the importance of internalizing the meaning and usefulness of class activities, valuing the process and not only the final result. Teachers could address this issue by assessing the students' daily work, stressing the importance of understanding the subject instead of the final evaluation, or explaining to their students that the exam is not the most important part of the subject. Additionally, other teacher behaviors related to students' harmonious passion were the organization of the classes according to the students' level and the guidance of students through constructive and positive instructions. To achieve this

purpose, it is important for teachers to prepare the activities and the exam according to what the students have done in class, as well as to emphasize what students have done well, and what they should improve and how while correcting the students' work.

Finally, although much more research is needed on promoting students' harmonious passion, it could be also interesting for schools to propose training programs to show teachers how they can improve their students' passion, and the importance of passion in other aspects that contribute to the optimal functioning of the subject and the classroom.

Conclusion

We adopted a multilevel model to test if teaching quality – specifically, optimal challenge, focus on the process, and offering positive feedback – predicts students' harmonious passion and if the latter, in turn, predicts their deep strategy to learn and epistemic curiosity. As expected, the results confirmed the hypotheses tested. Considering our results and previous studies where passion has been associated with other important outcomes, we encourage teachers to realize their importance in fostering students' passion. The results of this study contribute to providing information to math teachers about three specific strategies that they could apply to foster students' passion: providing students' optimal challenge, focusing on the process, and offering them positive feedback.

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Appendix 1. Self-report measures of teaching quality, harmonious passion, epistemic curiosity, and deep strategy to learn

Items to assess the teaching quality

1. When my teacher explains something, he or she considers my level.
2. My teacher suggests activities that are in line with my level.
3. When my teacher suggests activities, he or she considers my level.
4. The exams are similar to the activities we do in class.
5. My teacher first tells me what I have done well and then what I have to improve.
6. My teacher corrects my activities in advance, giving me enough time to study for the exams.
7. My teacher congratulates me when I attempt to keep improving.
8. My teacher guides me to improve and corrects any mistakes I may make.
9. My teacher values me for my work and my perseverance.
10. My teacher values my progress in the subject.
11. When I do a class activity wrong, my teacher tells me what I can do to learn and improve.
12. My teacher considers my daily work in class.
13. My teacher does not burden me with the evaluation. Instead, he or she worries more about me understanding the subject.
14. In a math problem, my teacher values the procedure and not just the results.
15. My teacher does not value just the final exam.
16. My teacher insists that the exam is not the most important part of the subject.

Items to assess the harmonious passion

1. This activity is well adapted to the other activities in my life.
2. The new things that I discover with this activity allow me to appreciate it even more.
3. This activity reflects the qualities I like the most about myself.
4. This activity allows me to live many and varied experiences.
5. This activity is well integrated into my life.
6. This activity is in harmony with the rest of things that are a part of me.

Items to assess the epistemic curiosity

1. I find it fascinating to learn new information.
2. I can spend hours on a single problem because I just can't rest without knowing the answer.
3. I enjoy learning about subjects that are unfamiliar to me.
4. I feel frustrated if I can't figure out the solution to a problem, so I work even harder to solve it.
5. I enjoy exploring new ideas.
6. I brood for a long time in an attempt to solve some fundamental problems.
7. When I learn something new, I would like to find out more about it.
8. I work hard on those problems that I believe need to be solved.
9. I enjoy discussing abstract concepts.
10. Difficult conceptual problems can keep me awake all night thinking about solutions.

Items to assess the deep strategy to learn

1. I find that I have to do enough work on a topic to form my own point of view before I am satisfied.
2. I often think of a real-life situation in which the material that I am learning would be useful.
3. I try to relate new material, as I am reading it, to what I already know on the topic.