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Predictors of students' enjoyment in learning Mathematics

متغيرات متنبئة بمتعة الرياضيات

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Abstract

Despite the role that emotions play in students' learning, little research has been carried out to study the predictors of the individual emotion that students experience throughout and as a result of their learning. The present research attempts to do that for the enjoyment emotion, where it considers four variables related to different aspects of students' learning (value of mathematics, self-concept of learning mathematics, teacher's support and effort in learning mathematics) as predictors of this emotion. Seven hundred and twenty students, from grade eight, nine and ten, participated in the research. Stepwise regression analysis was used to analyze the data. The research results indicated that self-concept was the variable that explained the variation in students' enjoyment more than the other variables (49.2% of the variance). Value of mathematics came next (10.6% of the variance), then teacher's support (2.6% of the variance) and then student's effort (1% of the variance). The research results indicate that special stress needs to be put on promoting student's self-concept in order to cultivate students' emotions.

Keywords: Enjoyment; Value of Mathematics; Teacher's Support; Effort; Predictors.

ملخص

على الرغم من الدور الذي تلعبه العواطف في تعلم الطلاب، فقد تم إجراء القليل من البحث لدراسة تنبؤ المشاعر الشخصثة التي يمر بهاا الطلاب خلال تعلمهم ونتيجة له. يحاول البحث الحالي القيام بذلك بالنسبة لمتغير الاستمتاع، حيث يأخذ في الاعتبار أربعة متغيرات يمكن أن تتنبأ به وتتعلق بالجوانب المختلفة لتعلم الطلاب (قيمة الرياضيات، المفهوم الذاتي لتعلم الرياضيات، دعم المعلم وجهده في تعلم الرياضيات). شارك في البحث سبعمائة وثمانية وعشرون طالبًا من الصف التاسع والعاشر وأكملوا استبيانًا يتكون من خمسة مقاييس تتعلق بمتغير النتيجة والمتغيرات المتنبئة .تم تحليل البيانات باستخدام تحليل الانحدار التدريجي في SPSS 23. أشارت نتائج البحث إلى أن مفهوم الذات هو المتغير الذي يفسر أكثر من المتغيرات الأخرى التباين في استمتاع الطلاب. جاءت قيمة الرياضيات ثانيا في تفسير التباين في استمتاع الطلاب، ثم دعم المعلم ثم جهد الطالب. تشير نتائج البحث إلى ضرورة التركيز بشكل خاص على تعزيز مفهوم الطالب لذاته من أجل تنمية عواطف الطلاب الأيجابية وخصوصا المتعة، الأمر الذي سيؤثر بدوره بشكل إيجابي على نتائج تعلمهم.

الكلمات المفتاحية: المتعة، قيمة الرياضيات، دعم المعلم، الجهد، المتغيرات المتنبئة.

Introduction

Ahmed, van der Werf and Minnaert (2010) say that research on emotions in education has received the educational psychologists’ attention due to the recognition of emotions as psychological factor in fostering students’ learning and achievement. They emphasize that despite this attention to the emotional aspect in education, there is a scarcity of research on emotional components in the classroom, as subjective feelings, expressive actions, and physiological reactions. The previous emphasis is applicable concerning research on the individual emotion, where most of the research has been done on anxiety (e.g., Hembree, 1990; Ünlü, Ertekin & Dilmac, 2017). This specifically applies to the study of individual emotions in educational settings. The present research attempts to contribute to this field by studying the predictors of students’ enjoyment in learning mathematics. Specifically, the present research verifies the following variables as predictors of student’s enjoyment in learning mathematics: value of mathematics, self-concept of learning mathematics, teacher’s support, and effort in learning mathematics. The interest in the four variables as predictors is due to the aspects that these variables are related to. The value of mathematics is related to the subject matter and to the cultural aspect. Self-concept of learning mathematics and effort in learning mathematics are related to the learner, where self-concept is an ‘affect’ variable, while effort is a ‘behavior’ variable. The fourth variable; social support is related to the context or social aspect.

Students’ emotions in the classroom

Students experience a wide range of discrete emotions in the classroom, where part of these emotions are positive such as enjoyment and pride, and another part is negative, such as anxiety and boredom, (Goetz, Frenzel, Pekrun, Hall & Lüdtke, 2007). This experience of emotions by students led to researchers’ interest in the aspects influenced by students’ emotions, as well as the factors that influence those emotions.

Generally speaking, researchers who were interested in the aspects influenced by students’ emotions found that these emotions impact different aspects of students’ learning as their creativity (Chiu, 2019; Greene & Noice, 1988), self-regulated learning (Pekrun, 2006), their achievement outcomes (Zeidner, 1998), and their subjective wellbeing (Pekrun, Goetz, Titz, & Perry, 2002). On the other hand, researchers who were interested in the factors that impact students’ emotions found that students’ positioning affects these emotions (Daher, 2020), while students’ use of meta-cognitive processes affect indirectly students’ emotions (Daher, Anabousy & Jabarin, 2018). Furthermore, researchers pointed at self-efficacy as a partial mediator of students’ learning enjoyment, while classroom practices acted as a source of this enjoyment (Hagenauer & Hascher, 2010). Moreover, analyzing students’ diaries, Hagenauer and Hascher (2010) found that a teacher’s neglect of students’ needs for competence and relatedness were significant sources of impeded learning enjoyment. In addition, Al-Shara (2015) found that the implementation of learning resources was the most important factor that affected students' enjoyment, while the lowest factor that influenced students' enjoyment of learning was the teachers' teaching style. Daher (2015) found that the phases of the modelling activity impact students’ emotions during these phases.

Researchers' attention was given also to the learning activity and its context as one factor that influences students' emotions. This context is at the center of the cognitive model of emotions (Ortony, Clore & Collins, 1988), which claims that emotions are related to the context in which the activity occurs, to the goal of the activity and the attributes of the objects of emotions. According to this model, emotions are affected by how students look at subject matter. Here, we consider the activity and its context as predictors of students' emotions in learning mathematics. This consideration is represented in the present research by the teacher's practices and students' value of the mathematical activity.

Students' value of mathematics

Lim and Chapman (2013) describe the perceived value of mathematics as including students' beliefs on the usefulness, relevance and value of mathematics in the present and the future. Studies have shown that achievement is positively related to value (Aiken, 1974; Fennema & Sherman, 1978). Amunga and Musasia (2011) say that it is important for students to be proficient in mathematics because it plays an important role in career choices and professional development, where under-achievement in mathematics restricts one's success in courses at tertiary levels. Other researchers did not find significant relations between students' value of mathematics and achievement. Simegn and Asfaw (2017) found that the relation between achievement and value of mathematics scales Grade 10 students is a weak correlation.

Few studies were involved with the relationship of value of mathematics and emotions. Pekrun (2006) suggests the control-value theory in which control and value appraisals are proposed as proximal antecedents of achievement emotions, where in turn, achievement emotions influence learning and achievement through cognitive and motivational mechanisms. In addition, Goldberg (2012) found that extrinsic value positively predicted enjoyment and anxiety. Our present consideration of value of mathematics as predictor of enjoyment, together with other variables, contributes to the research in this field.

Students’ self-concept as learners of mathematics

Wang (2007) stresses that professional organizations of mathematics education and mathematics education researchers have considered affective factors, which self-concept is one of, as an important aspect of mathematics education. Self-concept is one's perception of his/her strength, weakness, state of mind, and value (Huitt, 2004; Marsh & Craven, 1997). It is influenced by one’s sense of identity, by one’s perception of social interaction and by the judgments made of us by others (Purkey & Novak, 1996, as reported by Tang, 2011). Marsh and Craven (1997) argue that enhancing a child’s academic self-concept could result in improved academic achievement. This improvement in academic achievement could be a result of academic effort, where students who perceive their academic skills positively tend to participate in more effort-oriented activities such as engaging in class activities, finishing homework, and studying for exams (Valentine, DuBois, & Cooper, 2004). Marsh, Trautwein, Ludtke, Koller and Baumert (2005) argue that the possible improvement of student performance is based on a reciprocal relationship between self-concept and academic achievement. Moreover, students’ mathematics self-concept is an important outcome of education and is related to successful mathematics learning (Marsh and O‟Mara, 2008). Self-concept is also related to motivation to learn. Liu (2010) found that all of the academic self-concept related variables and the motivation components in foreign language learning were positively and significantly correlated.

Self-concept was also found to be correlated with emotion. Goetz, Nett, Martiny, Hall, Pekrun, and Dettmers (2012) reported that the observed correlations between homework emotions and classroom emotions showed clear linkages of both emotions with students' academic self-concept and achievement outcomes, with self-concept being slightly more strongly related to classroom emotions. Moreover, Goldberg (2012) found that self-concept was a negative predictor of anxiety and a positive predictor of boredom. In addition, Roja, Panimalar, Sasikumar and Fathima (2013) found positive relationship between emotional maturity and self-concept. These correlations encourage further study of the relationship between students’ self-concept and their emotions.

Teacher’s practices and students’ learning

The question of how or whether teachers impact student learning features, as her or his emotions, has preoccupied educational researchers for a long time. Jong, Shang, Lee and Lee (2010) pointed out that Just-in-time emotional support by the teacher should be given to students who learn through virtual games for relieving their emotions during working with technology. Goetez, Ludtke, Nett, Keller, and Lipnevich (2013) found that the supportive presentation style of the teacher was positively related to students’ enjoyment and negatively related to their boredom. Moreover, Anttila, Pyhältö, Soini and Pieatarinen (2017) found that different teacher’s variables affect the academic emotions of pre-service teachers when engaging in various task-related elements of teacher education. Furthermore, Lei, Cui and Chiu (2018) conducted a meta-analysis that provided strong evidence linking teacher support and students’ academic emotions, where students’ culture, age, and gender moderated these links. In addition, Bieg, . (2017) argue that emotions in the classroom are elicited by appraisal antecedents, where subjective experiences of control play an important role. At the same time, perceptions of control could be influenced by the classroom social environment, which includes the teaching methods. Subjective experiences of the student could also be related to her or his value of mathematics.

Student effort to learn mathematics

Effort is a construct that can explain differences in students' learning, as their achievement. Sorensen and Hallinan (1977) categorized the factors that can explain differences in achievement among students: learning opportunities, effort, and ability. Carbonaro (2005) commented that by focusing on learning opportunities and effort, the importance of both social structure and human agency are highlighted as factors that explain differences in learning.

Research on the relationship between emotions in mathematics learning and effort indicates that students' emotions toward the subject matter activities and outcomes, such as enjoyment and anxiety, influence their effort. Ghaderizefreh and Hoover (2017) suggested this relationship when the subject matter is statistics. Here, we study the other direction, examining the influence of effort on enjoyment.

Research rationale and goals

Students' emotions play a main role in their learning outcomes. Understanding predictors of students' emotions would enable the educator to cultivate their positive emotions, and thus their learning outcomes. The present research attempts to study the predictors of one positive emotion of the student, which is enjoyment. Enjoyment is considered by frequent researchers as component of attitude (Doornekamp, 2004; Tapia & Marsh, 2005), where other components are self-confidence, value of mathematics (ibid), support (Doornekamp, 2004), vision of mathematics and perceived competence (Di Martino & Zan, 2010, 2011), and motivation (Lim & Chapman, 2013). One of the previous components of attitude; perceived competence, could be related to self-concept. In the present research, we intend to examine four variables that are related to different aspects of students' learning as predictors of student's enjoyment in learning mathematics. Specifically, the present research intends to verify whether value of mathematics, self-concept of learning mathematics, teacher's support and effort predict students' enjoyment in learning mathematics. The value of mathematics is related to the cultural aspect of the subject matter. Self-concept of learning mathematics is related to the affective aspect, while effort in learning mathematics to the behavioral aspect. The fourth variable; social support is related to the context or social aspect. The importance of the research lies in the examination of four variables that belong to four aspects of learning as predictors of one affective variable: students' emotions.

The results of the study would indicate the relational contribution of each one of the predictors to the outcome variable; i.e. to students' emotions in learning mathematics.

Research questions

1. Which set of variables among the variables ‘mathematics value’, ‘student self-concept’, ‘teacher support’ and ‘student effort’, can best predict ‘student enjoyment’ in learning mathematics?
2. How much variance in student emotions in learning mathematics could be explained by the predictors?

Methodology

Participants: The population was 5108 students of Grades eight, nine and ten in governmental schools in Qabatia Governate in Palestine. 2809 of these students were males, so they constituted 55% of the population, while 2298 of these students were females, so they constituted 45% of the population. The questionnaire was distributed, in the academic year 2016/2015 and during January, 2017 to 24 classes; eight classes from each grade, where four classes were male classes, while the other four were female classes. The sample was comprised of 720 students, distributed among 381 males and 339 females. Krejcie and Morgan (1970) describe how to determine the sample size for research activities. For a population’s number of 5000, they specify a sample’s number of 357. When distributing the questionnaire among the students from the 24 classes, 720 students completed the questionnaire. We used all the returned questionnaires in the current research as their number is more than the minimum needed number. The distribution of males (381) and females (339) was also appropriate (53% males and 47% females), as it approximately satisfied the distribution of males and females in the population.

Data collection tool

The data was collected using a random cluster sampling. The data collection tool was a questionnaire that included two parts. The first part requested background information about the respondent; namely grade, gender and ability. The second part of the questionnaire requested the respondent’s choice of the extent of her or his agreement with a statement related to five variables: student enjoyment, student value of mathematics, student self-concept, teacher support and student effort. Mathematics enjoyment, value of mathematics and self-concept scales were taken from Vandecandelaere, Speybroeck, Vanlaar, De Fraine and Van Damme, (2012). Teacher support scale was taken from Johnson, Johnson, Buckman, and Richards (1985). Furthermore, Student effort scale was adapted from Engagement and Effort Scale (SEES) (Vallerand, Fortier & Guay, 1997).

Each of the variables was represented by 8 items. Examples on the items are: ‘Our lessons in mathematics are mostly fascinating and interesting’ (enjoyment), ‘Most of mathematics can be useful later on’ (value of mathematics), ‘sometimes when I don't understand a mathematical topic at the beginning, I know that I will not understand it’ (self-concept), ‘the mathematics teacher spends enough time to help me when I ask him to’ (teacher support) and ‘I study very hard to learn mathematics’ (effort). The participants rated the items on 5 - point Likert scale, with 1 being “I strongly do not agree” and 5 being “I strongly agree”.

Validity and reliability analysis

Validity and reliability analyses were performed for the five scales. To ensure face validity, the Arabic version of the questionnaire was presented to mathematics educators and teachers to give their opinion regarding the accuracy of items formulation as related to Grades eight, nine and ten. The necessary corrections were made to the formulation of the scale items in accordance with their comments. To ensure reliability, the questionnaire was distributed to an exploratory sample of thirty students. Cronbach’s Alpha was computed for each of the five scales. This computation gave .84 for enjoyment, .85 for self-concept, .79 for value of mathematics, .80 for teacher’s support and .78 for effort. These reliability results indicate good reliability for the scales (Field, 2009) because these reliabilities are around .80.

Data analysis

In order to answer the research questions, we computed at the beginning Pearson correlation coefficient between each predictor in the present study (student value of mathematics, student self-concept, teacher support and student effort) and between the outcome variable (Emotions).

In addition, we computed Pearson correlation coefficient between each pair of predictors. To determine the strength of the correlation between two variables, we depended on Cohen (1988): $0.1 < | r | < .3$ indicates small correlation, $0.3 < | r | < .5$ indicates medium/moderate correlation and $| r | > .5$ indicates large/strong correlation, where r represents Pearson correlation coefficient.

To determine the variance percentage that the predictor explains of the outcome variable, as well as the regression weights of the predictors as determining the outcome variable, we performed stepwise regression analysis. This analysis served us to examine what set of variables from the four independent variables could best predict emotions in learning mathematics.

The collected data satisfied the assumptions of regression analysis (Grande, 2015). First, the dependent variable – enjoyment, is measured on a continuous scale. There are two or more independent variables, which can be either continuous or categorical. Here, we have four independent ratio variables (Value of mathematics, Self-concept in learning mathematics, effort in learning mathematics, and teacher support in learning mathematics). Third, there should be independence of observations (i.e., independence of residuals). To examine this independence, we used the Durbin-Watson statistic, which gave the DW statistic value of 1.789, which is accepted as it lies between 1.5 and 2.5 (Lester, Inman, & Bishop, 2014). In addition, the standardized residuals lie in a rectangular shape, emphasizing the independence of observations, as in Figure 1 (Grande, 2015).

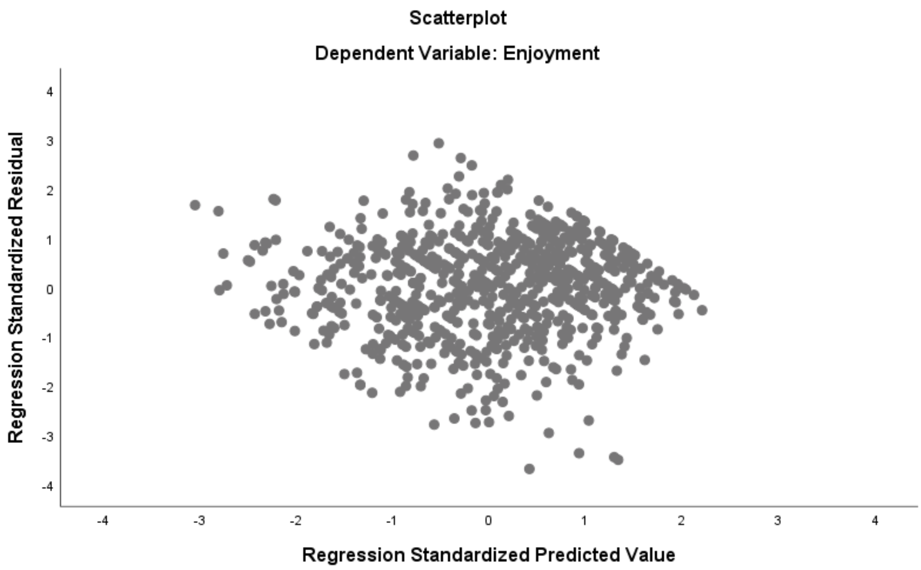

Figure (1): Standardized residuals.

Fourth, there needs to be a linear relationship between (a) the dependent variable and each of your independent variables, and (b) the dependent variable and the independent variables collectively. To examine this assumption, we drew the normal probability plot of the regression standardized residual, which is shown in Figure 2.

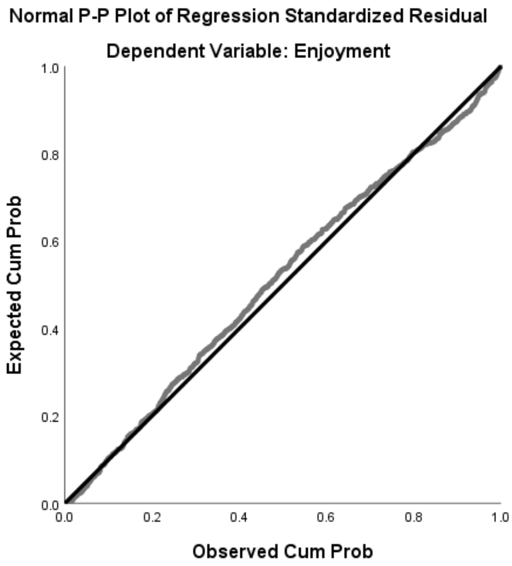

Figure (2): Probability plot of regression standardized residual.

The plot in Figure 2 is more-or-less around the line, which means that the relationship between the predictors and the outcome variable is linear. Being around the line, the plot also indicates that the residuals have normal distribution, which is the sixth assumption of the regression.

Seventh, the data must not show multicollinearity, which occurs when two or more independent variables t are highly correlated with each other; i.e., greater than 0.9 (Dohoo, . 1997). Computing correlations between the independent variables, all of them were less than 0.9, as in Table 1, which proved the absence of multicollinearity.

Eighth, the predictor variables should correlate with the outcome variable with value more than .3, which is satisfied in our case, as in Table 1.

Findings

This study was conducted in order to examine the effect of four psychological and educational variables on his/her enjoyment in learning mathematics. These variables were: Value of mathematics (Value), Self-concept in learning mathematics (SC), effort in learning mathematics, and teacher support in learning mathematics (TS). Before performing the stepwise regression analyses, the correlations between the predictors, between them and the outcome variable, descriptive statistics and internal consistencies of the variables were computed. Table 1 describes the results of these computations.

Table (1): Correlations between the predictors, between them and the dependent variable (enjoyment), descriptive statistics and internal consistency.

	Enj	**Value**	**SC**	**TS**	**Effort**
Enj		.68**	.70**	.53**	.63**
Value			.59**	.51**	.73**
SC				.39**	.53**
TS					.54**
M (SD)	3.34 (1.04)	3.83 (.73)	3.15 (.77)	4.08 (.84)	3.97 (.71)
Cronbach alpha	.88	.75	.75	.88	.78

**p<.001

Table 1 shows that all the correlations of the predictors with the outcome variable (enjoyment) were strong. In addition, the correlations between the predictors were less than .7 except between value and effort which is little more than .70. Mason and Perreault (1991) point at a large bivariate correlations, like .8 and .9 as commonly used cutoffs that indicate strong linear associations, suggesting collinearity that could be a problem, which is not the case in this research.

Performing the stepwise regression analysis gave four significant models as shown in Table 2.

Table (2): ANOVA for students’ emotions in learning mathematics as an outcome.

Model	Predictor		Sum of Squares	df	Mean Square	F	Sig.
1	SC	Regression	381.785	1	381.785	699.162	.000
		Residual	393.710	721	.546		
		Total	775.495	722			
2	SC, Value,	Regression	464.364	2	232.182	537.301	.000
		Residual	311.131	720	.432		
		Total	775.495	722			
3	SC, Value, TS	Regression	484.716	3	161.572	399.515	.000
		Residual	290.779	719	.404		
		Total	775.495	722			
4	SC, Value, TS, Effort	Regression	492.284	4	123.071	312.011	.000
		Residual	283.211	718	.394		
		Total	775.495	722			

We computed R, R^2, R^2 change and F change for each of the four models. Table 3 shows the results of the computations.

Table (3): Stepwise regression models of value of mathematics, self-concept in learning mathematics and teacher support and effort.

Model	Predictor	R	R^2	Adjusted R^2	SE	R^2 Change	F Change	df1	df2	p
1	SC	.702	.492	.492	.739	.492	699.162	1	721	.000
2	SC, Value	.774	.599	.598	.657	.106	191.098	1	720	.000
3	SC, Value, TS	.791	.625	.623	.636	.026	50.325	1	719	.000
4	SC, Value, TS, Effort	.797	.635	.633	.628	.010	19.186	1	718	.000

Table 3 shows that the fourth model that included the variables (self-concept in learning mathematics, value of mathematics, teacher support and effort) could explain 63.3% of the variance of student enjoyment. In addition, in the first step of stepwise regression, ‘self-concept’ was included and explained 49.2% of the variance of enjoyment. In the second step of stepwise regression, ‘value of mathematics’ was included and explained 10.6% of the variance of enjoyment. In the third step of stepwise regression, ‘teacher support’ was included and explained 2.6% of the variance of enjoyment. In the fourth step of stepwise regression, ‘effort’ was included and explained 1% of the variance of enjoyment.

Computing the coefficients of the regression for each one of the four models gave the results in Table 4.

Table (4): Coefficients of the regression and their significance.

		B	**SE**	**Beta**	**t**	**p**	**95% C.I.**	
							Lower Bound	**Upper bound**
1	(Constant)	.367	.116		3.169	.002	.140	.595
	SC	.945	.036	.702	26.442	.000	.874	1.015
2	(Constant)	-.813	.134		-6.072	.000	-1.076	-.550
	SC	.628	.039	.466	16.014	.000	.551	.705
	Value	.570	.041	.402	13.824	.000	.489	.650
3	(Constant)	-1.215	.141		-8.595	.000	-1.492	-.937
	SC	.593	.038	.440	15.504	.000	.518	.668
	Value	.453	.043	.320	10.495	.000	.368	.537
	Teacher support	.235	.033	.190	7.094	.000	.170	.301
4	(Constant)	-1.400	.146		-9.599	.000	-1.687	-1.114
	SC	.567	.038	.421	14.854	.000	.492	.642
	Value	.333	.051	.235	6.585	.000	.234	.432
	Teacher support	.195	.034	.158	5.748	.000	.129	.262
	Effort	.223	.051	.153	4.380	.000	.123	.323

Table 4 shows that at the end of the stepwise regression analysis, it was concluded in the first stage that self-concept in learning mathematics has the strongest relationship with enjoyment in learning mathematics (β= .702, t= 26.442, p= .000). In the second stage, it was concluded that, in addition to self-concept in learning mathematics (β= .466, *t*= 16.014, *p*= .000), value of mathematics was included in the model, as an important predictor of enjoyment in learning mathematics (β= .402, *t*= 13.824, *p*=.000). In the third stage, teacher support (β= .190, *t*= 7.094, *p*= .000) was added to self-concept in learning mathematics (β= .440, *t*= 15.504, *p*= .000), and value of mathematics (β= .320, *t*= 10.495, *p*=.000). In the fourth stage, effort (β= .153, *t*= 4.380, *p*= .000) was added to self-concept in learning mathematics (β= .421, *t*= 14.854, *p*= .000), to value of mathematics (β= .235, *t*= 6.585, *p*=.000) and to teacher support (β= .158, *t*= 5.748, *p*= .000).

Discussion and conclusions

The present research intended to examine a set of four psychological and educational variables (Value of mathematics, Self-concept in learning mathematics, effort, and teacher support) affect enjoyment in learning mathematics. Self-concept proved to be the variable that explains more than the other variables the variation in students' enjoyment. This result could be related to that self-concept is related to expectation, as the student who has high self-concept expects to enjoy her or his learning.

In addition to the above, this result agrees with previous research that pointed at academic self-concept as having a relationship with students' emotions. Goetz, Nett, Martiny, Hall, Pekrun, Dettmers and Trautwein (2012) reported that both homework emotions and classroom emotions have linkages with students' academic self-concept and achievement, with self-concept being slightly more strongly related to classroom emotions. Moreover, Roja, Panimalar, Sasikumar and Fathima (2013) found positive relationship between emotional maturity and self-concept. At the same time, the result of the present research does not agree with previous research that reported insignificant relationship between self-concept and enjoyment as Goldenberg (2012). Furthermore, Goldberg (2012) found that extrinsic value positively predicted enjoyment and anxiety, and self-concept was a negative predictor of anxiety and a positive predictor of boredom. The present research reports other results, so this issue of the relationship of self-concept and enjoyment needs further study.

Value of mathematics was found to influence student's enjoyment in learning mathematics after self-concept. This construct is related to the utility of learning mathematics. Suárez, . (2019) found that homework utility perception contributed to students spent-time on homework, to managing that time, and doing homework. Jahan, Norrish, Jasim and Abbas (2014) argued that the positive change of medical students' attitudes towards learning communication was likely mediated by the increase in awareness of the utility of learning good communication skills through regular daily clinical exposure to patients. Thus, the utility of learning impacts the different aspects of students' learning, including the affect aspect. The present research indicates that is also the case with students' enjoyment in learning mathematics.

The main influence of self-concept and value on students' emotions could be understood in light of the Control-Value Theory of Academic Emotions, which looks at how motivational and competency related beliefs affect the emotions that students experience in achievement settings (Pekrun, 1992, 2006). The theory postulates that “achievement emotions are induced when the individual feels in control of, or out of control of achievement activities and outcomes are subjectively important – implying that appraisals of control and value are the proximal determinants of these emotions” (Pekrun, 2011, p. 32). Thus, according to the theory, control and value are main antecedents of students' emotions. It is argued that self-concept could be related to control.

The teacher's role in influencing students' learning is disputed (Al-Shara, 2015; Hascher, 2010). In spite of this dispute, teacher's support plays an important function in students' emotions. This is because the social persuasions can boost students' confidence in their academic capabilities. This is true particularly when accompanied by instruction that help the students reach their academic goals. Moreover, this is especially true when teachers work on teaching specific behaviors such as decoding tasks, perseverance, seeing difficulties as opportunities, and learning from mistakes (Dweck, 2000). Future research is requested to examine teacher's support as a predictor of student's enjoyment in learning when this support satisfies the features previously mentioned.

The influence of teacher's support could be explained using the social persuasions framework of Usher and Pajares (2009) who point at the social persuasions that students receive from parents, teachers, and peers as serving as a source of self-efficacy. The present research showed that teacher’s support indeed explains some of the variance in students’ emotions, but it does that after the student’s self-concept and value of mathematics. Thus, this support has a role in cultivating students’ emotions, but to make this support more influential, the teacher needs to take into account the quality, amount and timing of the support (Anttila, . 2017). In this way, the support provided fits the task at hand and students’ individual needs (ibid). In addition, the effort put in learning mathematics by the student also predicted her / his emotions in this learning; though, it explained a little amount of variance in the present research. Future research needs further the study of effort as affecting the positive and negative emotions of students.

The two last variables, i.e. teacher’s support and effort in learning mathematics did not have a high contribution to explaining variance in students’ emotions in learning mathematics. We kept them in the model as the statistical computations did not exclude them. Further research is needed to verify the impact of the previous two predictors on students’ emotions in learning mathematics.

The present research findings indicate methods to encourage students’ enjoyment in their learning of mathematics. This encouragement could be performed, as the results of the present research indicates, by cultivating students’ self-concept, value of mathematics, support and effort. This could be done through various methods. For example, encouraging students’ self-concept could be done through psychological support from school and students’ organization and participation in different activities (Zhang, Cui, Zhou, Cai & Liu, 2018).

Affect research in educational psychology should acknowledge the predictors of students’ positive emotions in order to plan how to cultivate them. The present research considered variables of different learning aspects as predictors of enjoyment in learning. Future research should address the full range of emotions experienced by students at school and university.

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References

- Ahmed, W. van der Werf, G. & Minnaert, A. (2010). Emotional experiences of students in the classroom: A multi-method qualitative study. *European Psychologist,* 15. 142–151.
- Aiken, L. R. (1974). Two scales of attitude toward mathematics. *Journal for Research in Mathematics Education, 5*(2). 67-71.
- Amunga, J. K. & Musasia, A. M. (2011). Disparities in mathematics achievement among secondary schools: The case of Kenya. *Problems of Education in the 21st Century.* 28. 8-18.
- Chiu, F.-C. Hsu, C.-C. Lin, Y.-N. Liu, C.-H. Chen, H.-C. & Lin, C.-H. (2019). Effects of Creative Thinking and Its Personality Determinants on Negative Emotion Regulation. *Psychological Reports*, 122(3), 916–943. https://doi.org/10.1177/0033294118775973
- Daher, W. (2015). Discursive positionings and emotions in modelling activities. *International Journal of Mathematical Education in Science and Technology,* 46(8). 1149-1164.
- Daher, W. (2020). Students' Positioning and Emotions in Learning Geometric Definition. *Journal on Mathematics Education,* 11(1). 111-134.
- Daher, W. Anabousy, A. & Jabarin, R. (2018). Metacognition, Positioning and Emotions in Mathematical Activities. *International Journal of Research in Education and Science,* 4(1). 292-303.
- Dohoo, I. Ducrot, C. Fourichon, C. Donald, A. & Hurnik, D. (1997). An overview of techniques for dealing with large numbers of independent variables in epidemiologic studies. *Preventive Veterinary Medicine, 29* (3). 221-239.

- Fennema, E. & Sherman, J. A. (1978). Sex-related differences in mathematics achievement and related factors: A further study. *Journal for Research in Mathematics Education,* 9. 189-203.
- Field, A. (2009). *Discovering statistics using SPSS*. London, UK: Sage.
- Ghaderizefreh, S. & Hoover, M. (2017). Graduate students' emotions and achievement in statistics. Literacy information and computer education journal, 8(3). 2661-2666.
- Goldberg, D. (2012). *The importance of understanding the academic emotions of high school students at-risk for academic failure* (Unpublished Dissertation). McGill University, Montreal, Canada.
- Goodman, S. Jaffer, S. Keresztesi, M. Mamdani, F. Mokgatle, D. Musariri, M. Pires, J. & Schlechter, A. (2011). An Investigation of the Relationship between Students' Motivation and Academic Performance as Mediated by Effort. *South Africa Journal of Psychology, 41* (3). 373-385.
- Grande, T. (2015, October 28). *Multiple linear regression in SPSS with assumption testing* [Video file]. Retrieved from https://www.youtube.com/watch?v=ueNrP5TyZaE.
- Greene, T. R. & Noice, H. (1988). Influence of positive affect upon creative thinking and problem solving in children. *Psychological Reports,* 63. 895–898.
- Hembree, R. (1990). The nature, effects and relief of mathematics anxiety. Journal for *Research in Mathematics Education,* 21. 33-46.
- Jahan, F. Norrish, M. Jasim, N. & Abbas, Z. (2014). Undergraduate Medical students' attitudes towards learning communication skills. *Scientific journal of medical science,* 3(11). 371-377.
- Krejcie, R. V. & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement,* 30. 607-610.

- Lester, P. E. Inman, D. & Bishop, L. K. (2014). *Handbook of tests and measurement in education and the social sciences*. Lanham, Maryland: Rowman & Littlefield.
- Lim, S. Y. Chapman, E. (2013). Development of a short form of the attitudes toward mathematics inventory. *Educational Studies in Mathematics,* 82. 145–164.
- Mason, C. H. & Perreault, W.D. (1991). Collinearity, power, and interpretation of multiple regression analysis. *Journal of Marketing Research*, 28. 268–280
- Pekrun, R. (2006). The Control-Value Theory of Achievement Emotions: Assumptions, Corollaries, and Implications for Educational Research and Practice. *Educational Psychology Review,* 18(4). 315-341.
- Peixoto, F. Sanches, C. Mata, L & Monteiro. V. (2017). *European Journal of Psychology of Education*, 32(3). 385-405.
- Pintrich, P.R. Smith, D.A.F. García, T. & McKeachie, W.J. (1991). *A manual for the use of the motivated strategies questionnaire (MSLQ)*. Ann Arbor, MI: University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning
- Simegn, E. M. & Asfaw, Z. G. (2017). Assessing the influence of attitude towards mathematics on achievement of grade 10 and 12 female students in comparison with their male counterparts: Wolkite, Ethiopia. *International Journal of Secondary Education,* 5 (5), 56-69.
- Suárez, N. Regueiro, B. Estévez, I. del Mar Ferradás, M. Guisande, M.A. Rodríguez, S. Individual precursors of student homework behavioral engagement: The role of intrinsic motivation, perceived homework utility and homework attitude. Frontiers in Psychology, 10, 941.
- Vandecandelaere, M. Speybroeck, S. Vanlaar, G. De Fraine, B. & Van Damme, J. (2012). Learning environment and students' mathematics attitude. *Studies in Educational Evaluation,* 38. 107-120.

- Ünlü, M. Ertekin, E. & Dilmac, B. (2017). Predicting relationships between mathematics anxiety, mathematics teaching anxiety, self-efficacy beliefs towards mathematics and mathematics teaching. *International Journal of Research in Education and Science (IJRES), 3*(2). 636-645. DOI: 10.21890/ijres.328096.
- Zhang, D. Cui, Y. Zhou, Y. Cai, M. & Liu, H. (2018). The Role of school adaptation and self-concept in influencing Chinese high school students’ growth in math achievement. Frontiers in Psychology, 9, Article 2356. DOI: 10.3389/fpsyg.2018.02356.