2013

þÿIs it Important to Know Stude
Perceived Value of Mathematics?

Solomontos- Olga, Kountouri

Is it Important to Know Students' Perceived Value of Mathematics?

OLGA SOLOMONTOS-KOUNTOURI: Department of Psychology, Neapolis University, Cyprus

MICHAILINA SIAKALLI: School of Business, Neapolis University, Cyprus

PETROS YIALLOUROS: Department of Psychology, Neapolis University, Cyprus

ABSTRACT: *This study investigates the perceived value of mathematics in students from Greek Cypriot Gymnasium. It also examines individual differences in the perceived value of mathematics in relation to students' gender, grades, marks in mathematics, socioeconomic status (SES) and parent education (PE). The perceived value of mathematics is measured overall and with four dimensions: Interest, General Utility, Need for High Achievement and Personal Cost. A sample of 408 Greek Cypriot students from the three years of Gymnasium (mean age 13) completed the Mathematical Value Inventory (MVI). Results revealed that (a) girls value the General Utility of mathematics higher than boys; (b) boys evaluate Personal Cost of mathematics higher than girls; (c) the overall value of mathematics decrease with grade; (d) students with higher marks in mathematics show a higher overall value of mathematics; and (e) students with higher SES and students with higher PE show a higher overall value of mathematics. Implications are discussed for the Greek context. Also suggestions concerning intervention are given.*

Key words:

INTRODUCTION

Mathematics is a core subject in the school curriculum all over the world and mathematical competence is considered to be a key skill for each potential employee in the present-day world-market. Moreover, research has highlighted the role of mathematical competence as a "critical filter" to effectively screen students for a prestigious career (Ma & Johnson, 2008; Shapka, Domene, & Keating, 2008). The educational system of each country is also monitored on the basis of the success of the students on international mathematical tests e.g., International Mathematics and Science Study (TIMSS), Programme for International Student Assessment (PISA). Given the importance of students' mathematical competence to employment, and high-status career, a large body of research has been developed concerning effective mathematical curricula for successful educational programs. For example, Cyprus recent educational reform reflects this new trend by fostering activity, problem solving in the students and focusing also in technology based learning in the new mathematical curricula (MOEC, 2010). However, there is little attention paid to the perceived value that students attribute to mathematical literacy. According to Luttrell et al. (2010) students are truly mathematical literate, if they positively value mathematics. If students do not value mathematics in a positive way, then any mathematical curricula or method will have little impact on students' literacy.

The goal of the present study is to investigate students' perceived value of mathematics. As most of the studies are carried out with USA, the present study focuses in the unexplored context of Greek Cypriot Gymnasiums. Different factors are employed, which might be related to the value that Greek Cypriot Gymnasium students attribute to mathematics. These factors are: students' gender, grades (i.e., years in Gymnasium), mathematical performance (i.e. marks), socioeconomic status and parent education. Results provide important information to Cypriot researchers, policy makers and practitioners in the critical period of Educational reformation in Cyprus.

THEORETICAL FRAMEWORK

Eccles and her colleagues developed the Expectancy-Value Model to explain how students' value system and expectancy beliefs affect their levels of engagement, persistence, and achievement in various subjects - such as mathematics (for an overview see Eccles (Parsons) et al., 1983; Eccles, 2005). They also demonstrated that the subjective value assigned to a subject has several dimensions (Eccles & Wigfield, 1995). Specifically, the value assigned to a subject has the following 4 dimensions. (A) Interest, which is defined by the importance that students attached to a subject because of intrinsic motivation and genuine interest for the subject (Deci & Ryan, 1985). (B) General Utility, which is the importance students attached to a subject because of the usefulness of the subject to help them achieve short and long term goals (Husman & Lens, 1999; Kauffman & Husman, 2004). (C) Need for High Achievement, which is the personal value students attributed to the good performance of the subject and developing good conceptual understanding of the subject (Eccles et al., 1983; Lutrell et al., 2010). (D) Personal Cost, which is the negative aspects of dealing with the subject, such as performance anxiety and fear of failure; and the effort needed to achieve the objectives of the course (Lutrell et al., 2010).

Eccles' Model is receiving large research utilization, in the examination of the value attributed by the students to mathematics and its relation to their future educational choices (Eccles, 1983, 1984). Specifically, the overall value of mathematics predicts good performance and high marks in mathematics (Berndt & Miller, 1990), intentions to enroll in mathematical courses (Meece, Wigfield & Eccles, 1990), number of mathematical courses taken (Simpkins et al., 2006; Updegraff et al., 1996), plans for higher studies in the field of mathematics (Eccles et al., 2004) and expectations for career related to mathematics (Watt, 2006).

Gender, Grade, Marks, SES, and PE in Relation to Valuing Mathematics

Great importance is given to the investigation of gendered choices and achievement in mathematics. Findings from international mathematical tests (TIMSS, PISA) showed that gender differences in achievement in mathematics, in different countries, and in different time-periods is somewhat mixed. In most countries boys and girls have similar results in the fourth and eighth year of schoolings; however, boys advanced in later school years (Eurycide, 2010). The National Center for Education Statistics (2008) reported that there are no gender differences in academic achievement scores of boys and girls' in mathematics. The most recent PISA report (OECD, 2010) shows that in many countries, the girls, on average, performed somewhat worse than boys in mathematics. This prevalence of boys is due to the very high levels of performance of a comparatively small number of boys. However, in other countries, such as Cyprus, this pattern is reversed: In TIMSS 1995 in advanced mathematics there is no gender difference between Cypriot boys and girls, while in TIMSS 2007 girls have higher achievement than boys from year eight (Eurycide, 2010). Exploring a country such as Cyprus where girls seem to outperformed boys in international mathematical tests (Eurycide, 2010) can shed light on the intervening factor of cultural context.

Although, girls and boys have similar abilities, as well as achievements and marks in mathematics, girls and women are underrepresented in studies and careers related to mathematics (Eccles, 1987; Jacobs, 2005; Watt, Eccles, & Durik, 2006; Zarrett & Malanchuk, 2005). Researches turn their attention in the perceived value of mathematics given by boys and girls in order to explain gender imbalance in career choices. Findings suggest that both boys and girls report similar overall value in mathematics (Eccles et al., 1993; Jacobs et al., 2002). However, when beliefs about the importance of mathematics are examined separately, findings have shown that boys attach greater personal importance in mathematics than girls (Meece, Wigfield & Eccles, 1990; Updegraff et al., 1996); boys also report higher expectations for success and abilities in stereotypically male domains (such as mathematics) than girls (Eccles & Wigfield, 2002; Skaalvik & Skaalvik, 2004). Similarly, recent studies that used person-centered approaches, showed that boys are more likely than girls to be overrepresented in the group that value mathematics the most (Chow & Salmela-Aro, 2011; Chow, Eccles & Salmela-Aro, 2012). Thus, the key mediator to gendered related differences in mathematics participation and career aspirations were found to be the different value that boys and girls attached to mathematics (Eccles, 1987; Watt, Eccles, & Durik, 2006).

Another issue that stems from the gendered related valuing of mathematics is to identify the specific age at which girls' interest in mathematics' declines (e.g., Watt, Eccles, & Durik, 2006). According to Linver et al. (2002) girls' interest in mathematics starts to decrease from middle childhood and continues to decline across high school, even when their marks are higher than boys'. On the other hand, boys maintained high level of intrinsic value for mathematics and high self-perception for their mathematical abilities throughout secondary school (Watt, 2004; Watt et al., 2006). However, other researchers suggested no age-related differences in both genders, showing that as children get older, the value they attach to mathematics is reduced (Eccles et al., 1983; Eccles et al., 1993; Hyde et al., 1990; Jacobs et al., 2002). A recent study in a non-American sample showed that both boys and girls reported significantly better performance in mathematics and a higher self-concept of mathematical ability when they were at the age of 15, than when they were at the age of 16; with boys to have higher self-concept of mathematical ability at 16 than girls (Sainz & Eccles, 2012). It seems that both boys and girls are becoming less fond of mathematics as they get older.

Other factors that underpin the association of mathematics performance and mathematics valuing are: socioeconomic status and parent education. In the international studies (TIMSS, PISA), findings indicate that gender is less important than socioeconomic status in predicting achievement. Controlled for gender and immigrant background, index of economic, social and cultural status explains about 5 - 25 % of variance and it is statistically significant in all countries (Eurycide, 2010). Socioeconomic status and parents' years of schooling were found to be related indirectly to students' academic achievement through parents' beliefs and behaviors (Davis-Kean, 2005). It is suggested that the amount of schooling that parents receive influences how they structure their home environment, as well as how they interact with their children in promoting academic achievement. Especially, mother's years of schooling were found to play a significant role for girls in regard to achievement in mathematics (Linver & Davis-Kean, 2005). By investigating the effect of each and of all above factors in relation to the perceived value of mathematics in students from Greek Cypriot Gymnasiums we serve multiple purposes: extend the understanding of the impact of cultural factors; provide useful information in understanding mathematics underachievement; guide for effective teaching materials, methods and tools.

AIM AND HYPOTHESES OF THE STUDY

Our aim is to examine how students in Greek Cypriot Gymnasiums value mathematics and whether this value is associated with gender, grade, marks, socioeconomic status (SES) and parent education (PE). Based on our review of literature, we propose the following five hypotheses:

H_1: There are no gender related differences in the students' perceived value of mathematics.

H_2: The higher the students' grade (years in Gymnasiums), the lower the students' perceived value of mathematics.

H_3: The higher the students' performance (marks), the higher the students' perceived value of mathematics.

H_4: The higher the students' socioeconomic status (SES), the higher the students' perceived value of mathematics.

H_5: Students, whose parents have a higher educational level, perceive higher value to mathematics.

In addition, the relationship between those individual variables and the overall value of mathematics will be explored.

METHOD

Sample

The study used a cross sectional survey with a representative sample of students from Greek Cypriot Gymnasiums. The sample consisted of 408 adolescents, 49.6% males and 50.4% females. Participants' age ranged from 12 to 15; they were students from the three grades of Gymnasium (45.9% from year 1, 29.6% from year 2, and 24.4% from year 3). The study includes students from 7 different Gymnasiums in 5 different provinces in Cyprus (36.6% from Paphos, 21.4% from Nicosia, 15.7% from Ammochostos, 13.5% from Limassol, and 12.8% from Larnaca). The socioeconomic status (SES) of participants was estimated on the basis of the father and mother's occupations showed that 30.2% of participants have a high SES, 33.7% have a middle SES and 36.2% have a low SES. Parent education (PE) was estimated on the basis of father and mother's education: 42.2% of participants have a high PE, 45.8% have a medium PE, and 12% have a low PE.

Procedure

To conduct the survey, official permission from the Centre of Educational Research and Evaluation in Cyprus (CERE) was obtained. Then, letters describing the purpose of the study were given, firstly to the head teachers of the schools to allow the conduct of the survey in their schools. Secondly, letters describing the purpose of the study and permission slips were given to parents. The survey was conducted anonymously and voluntarily to those students who had parental consent (2% of the parents did not approve the participation in the survey). The questionnaire was administered to 426 students (96% of the questionnaires were valid).

Measures

Mathematical Value Inventory (MVI, Luttrell, et. al., 2010)

The MVI is a self-report questionnaire that measures students' valuing of mathematical literacy with 4 dimensions: Interest, General Utility, Need for High Achievement and

Personal Cost. MVI consists of 28 statements, 7 statements for each dimension. The scale of Interest included statements such as “I find many topics in mathematics to be interesting.” The scale of General Utility components such as, “Understanding math has many benefits for me.” The scale of the Need for High Achievement included statements such as “Earning high grades in math is important to me.” The scale of Personal Cost included statements such as “Math exam scares me.” The participants were asked to indicate agreement on a 5-point- likert scale (1 represents strongly disagree and 5 represents strongly agree). The questionnaire was translated into the language of Greek and back translated into English by professional linguists. Additionally, the Greek MVI was given to 5 Gymnasium students, who discussed the content of each item. Small modifications were made on the translated MVI statements to be more clear and precise in the Greek language.

Demographics

Information was collected on gender, grade, marks on Mathematics, father and mother’s occupation and education. The marks that students get in Gymnasiums are as follows: Mark A (19-20 out of 20), Mark B (16-18 out of 20), Mark C (13-15 out of 20), Mark D (10-12 out of 20) and Mark E (1-9 out of 20 = failed).

The socioeconomic status (SES) of the participants was determined by both parents’ occupations (Nash, 1995). The classification of occupations was completed according to the International Standard Classification of Occupations (ISCO), i.e. 1-9 major groups and 0 for armed force. Four more groups were added: unemployed (group 11), pensioners (group 12), dead (group 13), and housewives (group 14). The occupations of the students’ parents were then collapsed into three categories of SES using the following categorization: (a) Belonging to high SES when at least one of the parents is in category 1, 2, and higher rank in group 0 and the other to any other category. (b) Belonging to middle SES when at least one of the parents is in categories 3 or 4 and the other in any one of the lower categories. (c) Belonging to low SES when both parents are in category 5 or under and lower rank in group 0. Parent education (PE) was estimated on the following categorization of parents’ education. (a) High PE signifies that at least one of the parents holds a university degree. (b) Medium PE signifies that at least one of the parents has completed education up to Lyceum and the other has similar or lower education. (c) Low PE signifies that at least one of the parents has completed education up to the Gymnasium and the other has similar or lower education.

Analysis

The results are organized in three sections. Firstly, we reported findings of construct validity of the MVI. Secondly, we tested the gender differences, the grade differences, the mark differences, the socioeconomic status differences and parents’ education differences on the overall MVI and on the 4 MVI dimensions. For testing differences on the overall MVI and the above factors we used t-test and ANOVA. For testing differences on the 4 MVI dimensions we used MANOVA. Thirdly, we have explored the effect of each factor on the MVI score by using a multiple regression model.

RESULTS

To test for construct validity in comparison to the original MVI, a Principal Component Analysis (PCA) was performed on the 28 Greek items with Varimax (orthogonal) rotation. The factor analysis was supported by Bartlett's test of sphericity, χ^2 *(378) =3993.94*, *p< .001* and Kaiser-Meyer Olkin measure of sampling adequacy of *.9* above the recommended value of *.6*. Only factors with eigenvalues greater than 1 were retained. The criteria led to a four factor solution. The first component included the 7 items related to Interest, accounted for the *26.10%* of the variance, the second component contained the 7 General Utility items, accounted for the *11.44%* of the variance, the third component included 6 items of the Need for High Achievement, accounted for the *7.22%* of the variance, and the forth contained the 7 items related to the Personal Cost, accounted for the *5.78%.* The analysis revealed that *50.54%* of the variation in the 28 items can be explained using 4 factors (see Table 1). Overall, these results showed that the translated MVI is functioning in a similar way to the original MVI in a Greek Cypriot sample.

Table 1

Principal Component Analysis for the Greek MVI

Item	FACTOR			
I. Interest	I	II	III	IV
Mathematics fascinates me (27)	**0.80**	0.13	0.14	0.15
I am interested in doing math problem (20)	**0.78**	0.16	0.22	0.02
Solving math problems is interesting for me (24)	**0.74**	0.04	0.22	0.22
It is fun to do math (16)	**0.73**	-0.03	0.17	0.13
I find many topics in mathematics to be interesting (12)	**0.68**	0.29	0.13	-0.05
Learning new topics in mathematics is interesting (2)	**0.65**	0.23	0.12	0.03
I find math intellectually stimulating (9)	**0.35**	0.34	0.28	-0.07
II. General Utility				
There is almost no benefit from knowing mathematics (3r)	0.11	**0.68**	0.04	0.07

Having a solid background in mathematics is worthless (13r)	0.06	**0.67**	0.16	0.03
I see no point in being able to do math (17r)	0.18	**0.64**	0.09	0.23
After I graduate, an understanding of math will be useless to me (10r)	0.08	**0.63**	-0.03	0.06
I have little to gain by learning how to do math (6r)	0.07	**0.59**	-0.04	0.23
I do not need math in my everyday life (23r)	0.20	**0.56**	0.15	0.12
Understanding math has many benefits for me (21)	0.48	**0.40**	0.40	0.00
III. Need for High Achievement				
If I do not receive an "A" on an math exam, I am disappointed (4)	0.09	0.06	**0.70**	-0.03
Earning high grades in math is important to me (19)	0.23	0.32	**0.67**	-0.10
It is important to me to get top grades in my math classes (8)	0.25	-0.09	**0.67**	-0.01
Only a course grade of "A" in math is acceptable to me (25)	0.11	-0.20	**0.64**	0.36
I would be upset to be an "average student" in math (11)	0.22	0.11	**0.57**	0.07
I must do well in my math classes (28)	0.27	0.32	**0.53**	-0.22
Doing well in math courses is important to me (14)	0.32	0.40	**0.50**	-0.12
IV. Personal Cost				
Math exams scares me (26r)	0.10	0.00	-0.12	**0.67**
Solving math problems is too difficult for me (18r)	0.05	0.37	0.23	**0.63**
Trying to do math causes me a lot of anxiety (22r)	0.10	0.26	0.02	**0.63**
Taking math classes scare me (5r)	0.25	0.34	-0.14	**0.60**
I have to study much harder for math than for other courses (1r)	-0.10	-0.04	0.00	**0.60**
Mathematical symbols confuse me (15r)	0.12	0.37	0.14	**0.53**

I worry about getting low grades in my math courses (7r)	0.05	-0.07	-0.45	**0.48**

Note: The r index indicates items with reversed scores. Factor loadings in bold in the same column load on the same factor.

Descriptive statistics

The sum score for each subscale component (7 items each) ranges from 7 to 35 while the total score for the overall MVI (28 items) ranges from 28 to 140. All statements referring to the Personal Cost subscale and 6 statements of the General Utility subscales were reverse-scored in order to be aligned with the scores of the other statements. Higher scores are indicating higher value perception for the overall MVI score (highest 140) and for each dimension (highest 35). Table 2 shows the internal consistency within the current sample, as well as the means and standard deviations for overall MVI and for the 4 MVI dimensions.

Table 2

Coefficient Alpha, and Descriptive Statistics for MVI and for the 4 MVI Dimensions

	Interest	General Utility	Need for High Achievement	Personal Cost	Overall MVI
Coefficient alpha	.86	.78	.79	.76	.88
Mean	23.71	27.37	24.92	20.79	96.79
Standard Deviation	6.00	5.64	5.59	5.48	16.29

Gender differences in overall MVI and in the 4 MVI dimensions

Hypothesis 1 is partly supported. Independent-samples t-tests and Cohen's *d* showed that there are no statistically significant gender differences for the overall MVI score *(t(405) = -.18, p = .861, d = -.02)*. Concerning the 4 MVI dimensions results showed that there are no statistically significant gender differences for the Interest *(t(405)= .93, p =.351, d=.09)* and for the Need for High Achievement *(t(405)= -1.69, p =.092, d= -.18)*. However there are significant gender differences for General Utility *(t(405)= -2.00, p =.046, d= -.19)* and Personal Cost *(t(405)= 2.24, p =.026, d=.22)*. Girls have a higher perceived value for the General Utility of mathematics than boys; while boys have a higher value of Personal Cost of mathematics than girls (see Table 3).

Table 3

Descriptive Statistics for MVI and for the 4 MVI Dimensions for Boys and Girls

Gender	Girls (N=205)		Boys (N=202)	
	M	SD	M	SD
MVI	96.95	16.76	96.67	15.87
Interest	23.44	6.19	24.00	5.83
General Utility*	27.94	5.67	26.82	5.58
Need for High Achievement	25.39	5.66	24.45	5.51
Personal Cost*	20.19	5.51	21.40	5.42

*Note: *p<.05*

Grade differences in overall MVI and in the 4 MVI dimensions

Hypothesis 2 is supported. Firstly, a one-way ANOVA was conducted to explore the relationship between grades (year 1, year 2, year 3) and the overall MVI score. The one-way ANOVA was significant *($F(2,402)=4.46$, $p=.012$, $\eta^2=.02$)*, indicating that students in different grades do not have the same overall value for mathematics. Tukey's post-hoc test showed statistically significant differences between the students in year 1 and year *2 ($t(402)=2.37$, $p=.048$, $d=.28$)* and between the students in year 1 and year 3 *($t(402)=2.56$, $p=.029$, $d=.32$)*. No significant differences were found between the students in year 2 and year 3 *($t(402)=.03$, $p=.951$, $d=.038$)* (see Table 3). Students in higher grades (year 2 and year 3) value mathematics lower than students in the lowest grade (year 1).

To explore the relationship between the 3 grades and the 4 MVI dimensions a multivariate analysis of variance was conducted (MANOVA). The results showed a significant effect of grades *(Wilks' $\Lambda= .914$, $F(8,798)=4.61$, $p<.001$, $\eta_p^2=.044$)*. Separate univariate ANOVAs were conducted for each MVI dimension. There was a significant main effect of the grades on Interest *($F(2,402)=11.58$, $p<.001$, $\eta_p^2=.054$)* and Need for High Achievement *($F(2,402)=7.79$, $p<.001$, $\eta_p^2=.037$)*. Results of post hoc analysis with a Bonferroni correction showed that for the Need for High Achievement dimension, as well as for Interest, significant differences were observed between students in year 1 and year 2 *($t(402)=3.89$, $p<.001$, $d=.46$)*. Need for High Achievement scores are higher for year 1 students than for year 2 students while Interest scores are higher for students in year 1 than for students in year 2 *($t(402)=3.45$, $p=.002$, $d=.41$)* and year 3 *($t(402)=4.39$, $p<.001$, $d=.54$)*. There were no significant differences in Personal Costs *($F(2,402)=1.26$, $p=.284$, $\eta_p^2=.006$)* and General Utility *($F(2,402)=.53$, $p=.592$, $\eta_p^2=.003$)* (see Table 3).

Table 4

Descriptive Statistics for MVI and for the 4 MVI Dimensions for the 3 Grades

Variable	Year 1 (N=186)		Year 2 (N=120)		Year 3 (N=99)	
	M	SD	M	SD	M	SD
MVI*	99.25	14.22	94.78	17.96	94.12	16.99
Interest*	25.17	5.51	22.8	5.97	21.97	6.33
General Utility	27.65	5.53	27.08	6.16	27.06	5.19
Need for High Achievement*	25.97	4.88	23.48	5.90	24.57	6.01
Personal Cost	20.47	5.42	21.43	5.45	20.53	5.62

Note: *p<.05

Marks differences in overall MVI and in the 4 MVI dimensions

Hypothesis 3 is supported. One-way ANOVA showed that the overall MVI score varies statistically according to the marks in Mathematics that students achieved in the first semester *$(F(4,391)=32.76,\ p<.00,\ \eta^2=.25)$*. Tukey's post-hoc showed statistical significant differences between nearly all the groups of students with different marks. Only students with marks B and C *$(t(391)= -2.69,\ p=.057,\ d=-.38)$* and students with marks D and E *$(t(391)= -1.33,\ p=.67,\ d=-.62)$* have similar MVI scores. Students with higher marks have a higher perceived value in mathematical literacy. The highest overall MVI score was achieved by the students with the highest school performance in mathematics while the lowest MVI score *$(t(391)=-4.25,\ p<.001)$* was achieved by students with the lowest marks. The effect estimate for this is large *-2.23* (Cohen's d). Descriptive statistics are reported in Table 4.

Table 5

Descriptive Statistics for MVI and for the 4 MVI Dimensions in Relation to Marks

	Marks									
	Mark E		Mark D		Mark C		Mark B		Mark A	
	M	SD	M	SD	M	SD	M	SD	M	SD
MVI*	77.00	11.71	85.03	13.82	93.55	13.91	98.86	13.5	107.47	15.35

Note: *p<.05

SES differences in Overall MVI and in the 4 MVI Dimensions

Hypothesis 4 is supported. Firstly, a one-way ANOVA confirms that students with different SES have statistically significant differences in relation to their overall MVI score, $F(2,398)=9.20$, $p<.001$, $\eta^2=.04$. Tukey's post hoc test showed a statistically significant difference between students from high SES and lower SES *(t(398)=4.23, p<.001, d= .53)* and between students from high and middle SES *(t (398)=2.88, p=.012, d= .36)*. The effects estimates are small.

Secondly, socioeconomic status differences in the four MVI dimensions were tested using MANOVA. The multivariate effect was statistically significant (*Wilks'Λ= .935, F(8,790)=3.40, p=.001,* $\eta_p^2=.033$*)*. Follow up univariate ANOVAs and post hoc Bonferroni-corrected pairwise comparisons were conducted. There was a significant association between SES and General Utility *(F(2, 398)=5.46, p=.005,* $\eta_p^2=.027$*)*, students from high SES have higher General Utility scores than students from low SES *(t(398)= 3.26, p=0.003, d=.41)*. There is a significant association between SES and Need for High Achievement *(F(2,398)=4.99, p=.007,* $\eta_p^2=.024$*)*; students from high SES have higher Need for High Achievement than students from low SES *(t(398)=3.14, p=.005, d=.39)*. Finally, there is a statistically significant association between SES and Personal Cost *(F(2,398)=7.56, p=.001.* $\eta_p^2=.037$*)*. Students from high SES have higher Personal Cost than students from middle SES *(t(398)=2.80, p=.016, d=.36)* and students from low SES *(t(398)=3.78, p=.001, d=.46)*. Descriptive statistics are reported in Table 5.

Table 6

Descriptive Statistics for MVI and for the 4 MVI Dimensions in Relation to SES

	Socioeconomic Status					
Variable	Low SES (N=145)		Middle SES (N=135)		High SES (N=121)	
	M	SD	M	SD	M	SD
MVI*	93.57	15.89	96.13	16.56	101.90	15.54
Interest	23.29	6.14	23.36	6.22	24.73	5.58
General Utility*	26.52	5.36	27.22	5.90	28.75	5.41
Need for High Achievement*	23.90	5.61	25.07	5.52	26.04	5.48
Personal Cost*	19.86	5.68	20.48	5.22	22.38	5.29

Note: * p<.05

Parents' education Differences in Overall MVI and in the 4 MVI Dimensions

Hypothesis 5 is supported. One-way ANOVA showed that students with different PE, do not attribute the same overall value to mathematics ($F(2,405)=7.50, p=.01, \eta^2=.04$). Post hoc analysis showed that students with low educated parents have a lower overall MVI score in comparison to students with high educated parents ($t(405)=3.87, p=.009, d= .63$). Statistically significant differences were also observed between students with low educated parents, in comparison to students with medium educated parents ($t(405)= 2.96, p=.009, d= .5$). Table 6 shows the descriptive statistics for the overall MVI in relation to parents' education.

Table 7

Descriptive Statistics for MVI in Relation to Parent's Education

	Parents' Education					
Variable	Low PE (N=49)		Medium PE (N=187)		High PE (N=172)	
	M	SD	M	SD	M	SD
MVI*	89.06	14.74	96.68	15.43	99.11	17.00

Note: * p<.05

Relationship between individual's characteristics and the overall MVI score

Multiple regression was used to explore the relative relationship between the overall MVI score and the characteristics of the individuals (gender, grades, marks, SES and PE). Given that all of these characteristics are categorical variables, dummy variables had to be created. The overall model was significant $R^2=.303$, *Adjusted* $R^2=.282$, $F(11,373)=14.72$, $p<.001$(see Table 7). Overall, only grade level and marks in mathematics was related to the overall MVI score. Students in year 3 value mathematics lower than students in year 1. Students with the higher mark (A) value mathematics higher than students with lower marks (B, C, D, E). Altogether, the performance (marks in mathematics) is the most important in relation to all other variables to explain student's mathematical values.

Table 8

Multiple Regression Analysis Predicting the Overall MVI

Variable	B	SE	β	t
Constant	107.25	2.10		51.02
Gender	-1.62	1.42	-0.05	-1.13
Year 1 vs. 3*	6.55	1.78	0.20	3.68
Year 2 vs. 3	0.58	1.93	0.02	0.30
Marks E vs. A*	-29.58	6.43	-0.21	-4.60
Marks D vs. A*	-21.89	2.22	-0.53	-9.86
Marks C vs. A*	-14.12	1.98	-0.40	-7.13
Marks B vs. A*	-9.13	2.04	-0.24	-4.47
Low vs. High SES	-3.01	2.00	-0.09	-1.50
Middle vs. High SES	-2.88	1.86	-0.08	-1.55
Low vs. High educated parents	-2.41	2.53	-0.05	-0.95
Middle vs. High educated parents	0.71	1.63	0.02	0.44

Note: p<.05. *In addition the second item in the vs. comparison indicates the baseline category for creating the dummy variables.*

DISCUSSION

In this article, we explored the value that Greek Cypriot students (12 to 15 years old) give to mathematical literacy. Utilizing Luttrell's et al. (2010) Mathematics Value Inventory (MVI), we examined students' valuing of mathematics with the four dimensions: Interest, General Utility, Need for High Achievement, and Personal Cost. We also offer a translated MVI to researchers who want to investigate the value of mathematics in Greek speaking samples. The Greek MVI shows four factors with high internal consistency. Further, we identified mean level differences in the value students attributed to mathematics with regard to gender, grade, marks in mathematics, SES and parent education. In particular, we identified the groups of students who are at "risk" of low mathematical literacy. In the following, we discuss these results and we propose further research, as well as policy implications.

Our results on gender differences confirm some and contradict other results in the field of gender differences in mathematical literacy. We found no gender differences for the overall MVI score, which is consistent with claims that mathematics is becoming more gender neutral (e.g., Jacobs et al., 2002; Luttrell et al., 2010; Watt et al., 2006). The interesting finding from our Cyprus sample is that girls value the General Utility of mathematics higher than boys. Also boys are more likely than girls to devalue mathematics considering the personal cost of it in their lives. These findings contradict gender differences found in Western samples that showed boys to exhibit higher interest in mathematics (Fredricks & Eccles, 2002; Updegraff et al., 1996; Watt et al., 2006), to have higher mathematical self-concept (Eccles et al., 1993; Jacobs et al., 2002; Meece, Wigfield & Eccles, 1990; Updegraff et al., 1996), to have higher expectation for success in mathematics (Eccles & Wigfield, 2002) and to have higher value for mathematics (Chow, Eccles & Salmela-Aro, 2012) than girls. These results from Western countries are normally used to explain why girls and women get out of the track of mathematical studies and scientific high-status careers (Watt et al., 2006). In our Cyprus sample, girls recognize the General Utility that mathematics has in their lives and in their future career from early adolescence. Our finding, of girls higher valuing of mathematics, provides a good reason why girls in Cyprus do better than boys in the TIMSS test (Eurycide, 2010). The finding that boys devalue mathematics, while girls understand their usefulness, can also be interpreted within some important results from a study in Greek secondary education (Psalti et al., 2007). This study showed that boys interpret secondary school as a useless period, which works apart from society's employment demands; on the other hand, girls think that secondary education enables them to obtain the ticket for their occupational independence (Psalti et al., 2007).

As Cyprus Gymnasium students proceed from the first to the second year of secondary schooling, they value mathematics lower. This finding is in accordance to Western results showing that as students get older, they tend to devaluate mathematics (Chow, Eccles & Salmela-Aro, 2012; Eccles et al., 1983; Eccles et al., 1993; Hyde et al., 1990; Jacobs et al., 2002). The crucial point in our findings is that we identified the exact timing for that, which is the transition from the first to the second year of Gymnasium. This lower value for mathematics remains the same in the third year of Gymnasium. Moreover, we also identified that this decrease in overall valuing mathematics is due to the decrease in interest for mathematics and in the decrease of valuing mathematical achievement. It seems that second year Gymnasium students are less interested in mathematics and also have lower Need for High Achievement in mathematics than year 1 students. This is an alarming finding for Greek Gymnasiums in Cyprus, which seems not to help students to maintain Interest and Need for High Achievement for mathematics. However, a further investigation is needed in order to define the reasons that make second year Gymnasium students less motivated for mathematics. Paraphrasing Watt et al. (2006) "it is necessary to identify the multiple points at which *females (in our case both boys and girls*) opt out of maths pipeline, and to understand the reasons for their decisions to discontinue *(in our case, their interest to)* maths… can restrict or exclude (them) from certain kinds of university degrees, or other forms of education and training, which in turn lead to many high-status high-income careers (Watt et al., 2006, p.p. 643)."

Concerning our third hypothesis, results showed that students with higher marks in mathematics value higher mathematics in comparison to students with lower marks in mathematics. As expected students with high performance in mathematics, value mathematics higher. As Jacobs et al. (2005) points out students' values and expectancies are dropping faster than their marks, which results in their unwillingness to pursue careers in mathematics. The finding that students with low marks in mathematics also value mathematics lower put them in higher risk groups. Linver & Davis-Kean (2005) showed in a longitudinal study that both, marks in mathematics and interest in mathematics, decline by years of schooling. However, the decline of marks differed by gender and ability groups. Girls in the high-ability group and with high appreciation for mathematics had a less steep decline in marks. Therefore, the value that students give to mathematics can work as a protective factor against mark decline and against all the related consequences for their future career.

To measure socioeconomic status of the students we used two indicators: father and mother's occupation and education. Both indicators showed that the higher the parents' occupation and education is the higher the value students attributed to mathematics. Our findings are in accordance with other findings (e.g., Davis-Kean, 2005; Jacobs et. al., 2005; Linver et al., 2005; Simpkins et al., 2006), which showed that parents' income and education are related to higher interest in and engagement for mathematics. Therefore, Cypriot students from lower SES families have more chances to be at "risk," which can lead them on the long run to lower-status jobs.

We also investigated which individual factor (gender, grades, marks, SES and PE) can predict the overall MVI score. The results demonstrated the relative importance of the grade level and specifically the change between year 1 and year 3 students of the Gymnasium. In addition, the marks were even more important to predict the valuing of mathematics. All other factors, apart from the grade level and the performance in mathematics, were irrelevant to predict the overall MVI. These might be the most important results for Cypriot policy makers and educational reformers. Both grades and marks are factors on which the Educational system can intervene. Specific reformation on curriculum, on methods and on materials can help students to maintain both their marks in mathematics and the value attributed to mathematics.

Limitations

Our study is an important contribution to the literature as it investigates the value of mathematics in the new context of Gymnasiums' students in Cyprus. Nevertheless, the study suffers from some limitations. Firstly, due to the cross-sectional design of the study we do not know the direction of influence (causality) between the variables in the study. For instance, we do not know if achieving better marks will result in a higher valuing of mathematics, or if a higher valuing of mathematics will results in better marks. So, future studies, should use a longitudinal design to better explore the direction of effects. Secondly, the study is based on student's self-report data. Although future studies can also focus on teachers' and parents' reports, many studies showed that students' subjective experiences and opinions are very important to be considered. Thirdly, the construct validity of the Greek MVI is very good; expect some double loading of some items. Future research should focus on a representative sample of students from Gymnasiums to further validate the scale in this context.

Implications, future research

Despite the limitations, policy makers can get important information to improve the educational reform in Cyprus. Mathematics curriculum, methods of teaching and teaching materials, should take into account the values of Interest, General Utility, and Need for High Achievement of mathematics of students. The materials should be designed and offered in such a way that each component can be increased through the educational system. E.g. real world applied problems (increase General Utility and Interest); presenting the use of mathematics in different occupations (increase General Utility value); retain and support high expectations in students' mathematics performance (increase Need for High Achievement). Further, educators and parents should not just only devote time to develop skills and build up knowledge in mathematics, but they should also stress the values of mathematics (e.g. stress the usefulness, increase the interest, praise achievement). Moreover, further investigation should focus on the identification of the "high risk" groups of students. In the present study, high risk groups are boys with low marks in mathematics, students from low SES and also all students in the second year of Gymnasium are at risk for decreasing the interest in mathematics.

Future research is needed to investigate questions such as: (a) Does the high General Utility value that the Cypriot girls place on mathematics can predict their future-career? (b) Do boys maintain the high value that place on Personal Cost? (c) What are the reasons of the decline of the values of Interest and Need for High Achievement in the second year of Gymnasium? (d) Do any features from parents' socialization process explain girls' high General Utility value and boys' high rate of Personal Cost? Such investigations will be valuable both for Cyprus educational reformation attempts and assist Eccles et al. (1983) model researchers to delineate the role of cultural variation.

REFERENCES

Berndt, T. J., & Miller, K. E. (1990). Expectancies, values, and achievement in junior high school. *Journal of Educational Psychology, 82*, 319-326.

Chow, A., & Salmela-Aro, K. (2011). Task values across subject domains: A gender comparison using a person-centered approach. *International Journal of Behavioral Development, 35*, 202-209.

Chow, A., Eccles, J. S., & Salmela-Aro, K. (2012). Task Value Profiles Accross Subjects and Aspirations to Physical and IT-Related Sciences in the United States and Finland. *Developmental Psychology, 48*(6), 1612-1628.

Davis-Kean, P. E. (2005). The influence of parent education and family income on child achievement: The indirect role of parent expectations and the home environment. *Journal of Family Psychology, 19*, 294-304.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York: Plenum.

Eccles (Parsons), J. S. (1984). Sex Differences in Mathematics Participation. *Advances in Motivation and Achievement, 2*, 93-137.

Eccles (Parsons), J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. M. (1983). Expectations, values and academic behaviors. In J. T. Spence (Ed.), *Perspective on achievement and achievement motivation* (pp. 75-146). San Francisco: Freeman.

Eccles, J. S. (1983). Expectancies, values and academic behaviors. In J. T. Spence (Ed.), *Achievement and activity choices. Developmental perspectives on motivation* (pp. 145-208). Lincoln: University of Nebraska Press.

Eccles, J. S. (1987). Gender roles and women's achievement related dimensions. *Psychology of Women Quarterly, 11*, 135-172.

Eccles, J. S. (2005). Subjective Task Value and the Eccles et al. Model of Achievement-Related Choises. In A. J. Elliot, & C. S. Dweck, *Handbook of Competence and Motivation.* New York: Guilford Press.

Eccles, J. S., & Wigfield, A. (1995). In the mind of actor: the structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology, 21*, 215-225.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values and goals. *Annual Reviews Psychology, 53*, 109-132.

Eccles, J. S., Adler, T., & Meece, J. L. (1984). Sex differences in achievement: A test of alternate theories. *Journal of Personality and Social Psychology, 46*, 26-43.

Eccles, J. S., Vida, M. N., & Barber, B. (2004). The relation of early adolescents' college plans and both academic ability and task-value beliefs to subsequent college enrollment. *Journal of Early Adolescence, 24*, 63-77.

Eccles, J. S., Wigfield, A., Harold, R., & Blumenfeld, P. B. (1993). Age and gender differences in children self- and task- perceptions during elementary school. *Child Development, 64*, 830-47.

Eurycide. (2010). *Gender Difference in Educational Outcomes: Study of the Measures Taken and the Current Situation in Europe.* Brussels: Educational, Audiovisual and Culture Executive Agency.

Fredricks, J. A., & Eccles, J. S. (2002). Children's competence and value beliefs from chlldhood through adolescence:growth trajectories in two male-sex typed domains. *Developmental Psychology, 38*, 519-533.

Husman, J., & Lens, W. (1999). The role of the future student motivation. *Educational Psychologist, 34*, 113-125.

Hyde , J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in mathematics performance: a meta-analysis. *Psycological Bulletin, 107*, 139-55.

Jacobs, J. E. (1991). The infulence of gender stereotypes on parent and child math attitudes: Differences across grade-levels. *Journal of Educational Psychology, 83*, 518-527.

Jacobs, J. E. (2005). Twenty-five years of research on gender and ethnic differences on math and sciences career choices: What have we learned? *New Directions for Child and Adolescent Development, 110*, 85-94.

Jacobs, J. E., Davis-Kean, P., Bleeker, M. M., Eccles, J. S., & Malanchuk, O. (2005). "I can, but I don't want to": The impact of parents, interests, and activities on gender differences in math. In A. M. Gallagher, & J. C. Kaufman, *Gender differences in mathematics: An integrative spychological approace* (pp. 246-263). New York: Cambridge University Press.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*, 509-527.

Kauffman, D. F., & Husman, J. (2004). Effects of time perspective on student motivation:Introduction to a special issue. *Educational Psychology Review, 16*, 1-7.

Linver , M. R., Brooks-Gunn, J., & Kohen, D. E. (2002). Family processes as pathways from income to yound children's development. *Developmental Psychology, 38*, 719-734.

Linver, M. R., & Davis-Kean, P. S. (2005). The slippery slope: What predicts math grades in middle and high school? In J. E. Jacobs, & S. D. Simpkins, *Leaks in the pipeline to math,science, and technology careers* (pp. 49-64). San Francisco: Jossey-Bass.

Luttrell, V. R., Callen, B. W., Allen, C. S., Wood, M. D., Deeds, D. G., & David, R. C. (2010). The Mathematics value inventory for general education students:development and initial validition. *Educational and Psychological Measurement, 70*, 142-160.

Ma, X., & Johnson, W. (2008). Mathematics as the critical filter: curricular effects on gendered career choices. In H. M. Watt, & J. S. Eccles , *Gendered and Occupational Outcomes* (pp. 55-84). Washington, DC: American Psychological Association.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its consequences for young adolescents' course enrollment intentions and performances in mathematics. *Journal of Educational Psychology, 82*, 60-70.

MOEC. (2010). *Mathematics Program of Study.* Nicosia: Cyprus Pedagogical Institute ,Department of Program Development.

Nash, R. (1995). *Succeeding generations: Family resources and access to education in New Zealand.* Oxford: Oxford University Press.

National Center of Education Statistics. (n.d.). Mathematics coursetaking and achievement at the end of high school: Evidence from the Education Longitudinal Study of 2002 (ELS:2002). Statistical Anlaysis Report. Washington, DC, U.S. Department of Education. Retrieved from http://nces.ed.gov/pubs2008/2008319.pdf

OECD. (2010). *PISA 2009 at a change.* Paris: OECD.

Psalti, A., Sakka, D., & Deliyianni-Kouimtzi, V. (2007). Male and female identities at school: gender and educational choices. In V. Deliyianni-Kouimtzi, & D. Sakkas, *From teenager to adulthood* (pp. 65-87). Athens: Gutenberg.

Ryan, M. R., & Deci, E. L. (1985). *Intrinsic invitation and self-determination in human behavior.* New York: Plenum Press.

Sainz , M., & Eccles, J. (2012). Self-concept of computer and math ability: Gender implications across time and within IT studies. *Journal of Vocational Behavior, 80*, 486-499.

Shapka, D., Domene, D. J., & Keating, P. (2008). Gender, mathematics achievement, and the educational and ocuupational aspirations of Canadian Youth. In H. M. Watt, & J. S. Eccles , *Gender and occupational outcomes* (pp. 27-54). Washington DC: American Psychological Association.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42*, 70-83.

Skaalvik, S., & Skaalvik, E. S. (2004). Gender differences in math and verbale self-concept, performance expectations and motivation. *Sex Roles, 50*, 241-252.

Updegraff, K. A., Eccles, J. S., Barber, B. L., & O'Brien, K. M. (1996). Course enrollement as self-regulatory behavior: Who takes optional high school math courses? *Learning and Individual Differences, 8*, 239-259.

Watt, H.G.M. (2004). Development of adolescents' self-perceptions, values and task perceptions according to gender domain in 7th through 11th grade Australian students. *Child Development, 75*, 1556-1574.

Watt, H.G.M. (2006). The role of motivation in gendered educational and occupational trajectories. *Educational Research and Evaluation, 12*, 305-322.

Watt, H.G.M., Eccles, J. S., & Durik, A. M. (2006). The leaky mathematics pipeline for girls: A motivational analysis of high school enrolments in Australia and the USA. *Equal Opportunities International, 25*, 642-659.

Zarret, N. R., & Malanchuk, O. (2005). Who's computing;Gender and race differences in young adults' decisions to pursue an information technology career. *New Directions for Child and Adolescent Development, 110*, 65-84.