The Effect of Self-Construct on Mathematical Performance, Mediated by 3×2 Achievement Goals and Math Self-Efficacy

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The research aimed to investigate the effect of self-construal on mathematical performance, mediated by 3× 2 achievement goals and math self-efficacy**.** The research sample comprised of 400 students who were selected via multi-stage sampling from a high schools located in Karaj—a city in Iran. The research tools included revised self-construal scale, 3×2 achievement goal questionnaire, and Mathematic self-efficacy scale. Data were analyzed using confirmatory factor analysis and structural equation modeling. Findings revealed that the proposed model of the research has acceptable goodness of fit. The analyses revealed that the direct effect of independent self-construal on the math self-efficacy and all the six goal-orientations were significant (p<.05). Moreover, the direct effect of interdependent self-construal on all goal orientations was also significant (p<.05) except for the direct effect of interdependent self-construal on the task-approach and self-approach goals. However, the direct effect of independent and interdependent self-construal on math performance and the direct effect of interdependent self-construal on math self-efficacy were not observed as significant. Bootstrap results show that the indirect effect of independent self-construal on Mathematical Self-Efficacy

and Mathematical Performance is significant, and the indirect effect of self-approach on Mathematical Performance is also significant (p<.05).

Keywords: self-construal, achievement goals, math self-efficacy, math performance.

Mathematics is a science of paramount importance in contemporary societies and can be a powerful tool for modelling a wide range of global knowledge, as well as an essential component of most IQ tests as shown by the national programs of most cultures (Dehaene, Piazza, Pinel & Cohen, 2003). Therefore, it is essential to identify the internal and external factors affecting students' math performance. Researches show that a crucial internal factor is self-construal (Singelis, 1994). The concept of "self" has been studied both culturally and individually (Singelis, 2000). From the cultural point of view, Markus and Kitayama (1991) compared the concept of "self" in individualistic and collectivistic cultures (Singelis, 2000), and have introduced two aspects of self-construal including independent and interdependent self-construal; it is how the individuals attach meaning to the self and identify and define themselves in a community (Cross, Hardin & Gercek-Swing, 2011).

Independent self-construal is stable, univalent, limited, and separate from the individual's social context. In western cultures, people display more independent self, are more concerned with their personal goals, and focus more on their own intrinsic characteristics and goals. Individuals with interdependent self-construal place higher importance on group-based self-construal as to personal goals. Moreover, establishing communication with others is important for them with the preferences being influenced by their context and social relationships (Singelis,

1994). Self-construal is also influenced by cultural norms, so that individuals show characteristics of independent self-construal in individualistic societies and interdependent self-construal in collectivistic societies (Markus & Kitayama, 1991). Research by Zha et al. (2006) studying the effects of collectivism and individualism on creativity and achievement of American and Chinese students showed that the Chinese, who were collectivistic, had more meaningful math skills as compared to Americans, who were more individualistic.

It is essential that self-construal have a direct impact on personal goal setting (Singelis, 1994). He argued that "the central meaning of individualism is giving priority to personal goals over in-group goals," whereas "collectivism places an emphasis on subordinating personal goals than those of the in-group" (Singelis, p. 590). The theories of Singelis imply that people with a dominant independent self-construal are more accustomed to setting personal goals than people with an interdependent self-construal. Regarding the individualistic and collectivistic cultures and the association of these cultures with motivational processes, it can be argued that collectivist cultures value mastery goals because of emphasis on social interaction and social coordination (Butler & Ruzany, 1993). Also, these cultures believe that performance goals are vital because of the emphasis on acknowledgment, comparison and social hierarchy (Klassen, 2004). Some studies have shown that individuals in collectivistic cultures have more personal avoidance and performance-avoidance goals than individualistic cultures (Elliot, Chirkov, Kim & Sheldon, 2001). Therefore, self-construal is related to the goal orientation.

One of the most recent categorization of goal-orientation is the one offered by Elliot, Murayama & Pekrun (2011) which expanded the four-dimensional, goal-oriented model into a six-dimensional model. It led to the formation of 3*2 achievement goal model that is composed of the following goals: task-approach goals focusing on the attainment of task-based competence; task-avoidance goals focusing on the avoidance of task-based incompetence; self-approach goal highlighting on the attainment of self-based competence; self-avoidance goals emphasizing the avoidance of self-based incompetence; an others-approach goal valuing the attainment of other-based competence; and others-avoidance goal focusing on the avoidance of other-based incompetence. Various studies have investigated the relationship between the achievement goals and competency-related beliefs, such as self-efficacy, self-construal and performance. However, few quantitative studies have directly addressed the relationship between the achievement goals and self-construal despite its highly important implications for the achievement goals (Luo et al., 2014). The research carried out by Luo, Hogan, and Paris (2011) showed that both independent and interdependent self-construal can positively predict the mastery-approach goals, while only interdependent self-construal can positively predict the mastery-avoidance goals. In addition, independent self-construal positively predicts the performance-approach and avoidance goals.

According to Coutinho and Neuman (2008), the performance approach and mastery approach can positively affect self-efficacy which is a strong predictor of performance. The research by Sins et al. (2008) demonstrated that mastery-approach goals and self-efficacy have mutual, positive and significant relationship. Therefore, one of the variables that

affect math learning is self-efficacy. Math self-efficacy is also considered an estimate of a situation or a particular issue of individuals' confidence about their ability to successfully complete homework or to answer a mathematical question (Hackett & Betz, 1989). Math self-efficacy beliefs are a positive predictor of math achievement (Kung & Lee, 2016). In the research by Diseth (2015), the relationship between achievement goals as a predictor of academic achievement and motivational factors showed that task-approach goals can positively predict self-efficacy, while self-approach goals can negatively predict the self-efficacy. In the research by David (2014), the relationships between task-approach/ task-avoidance and self-approach/self-avoidance goals were positively and significantly meaningful. In addition, another research by Luo &Yeung showed that interdependent self-construal can positively predict math ability-enhancing beliefs. In a study by Dowd & Artistico (2016), the participants with independent self-construal had significantly higher levels of self-efficacy. Furthermore, in the research by Luo et al. (2014), on "the attribution beliefs in relationship between self-construal, achievement goals and self-efficacy amongst Singaporean students", the relationship between self-construal, achievement goals and self-efficacy was confirmed. In line with the self-construal structural model of Luo et al. (2014), the present study examines the math performance structural model, self-construal, 2×3 achievement goals and math self-efficacy. The direct and indirect relationships between self-construal, 2×3 achievement goals, math self-efficacy and math performance are hypothesized in the proposed research model. Therefore, based on No. 1 conceptual model, the research question is whether or not the data collected has goodness of fit with the conceptual model?.
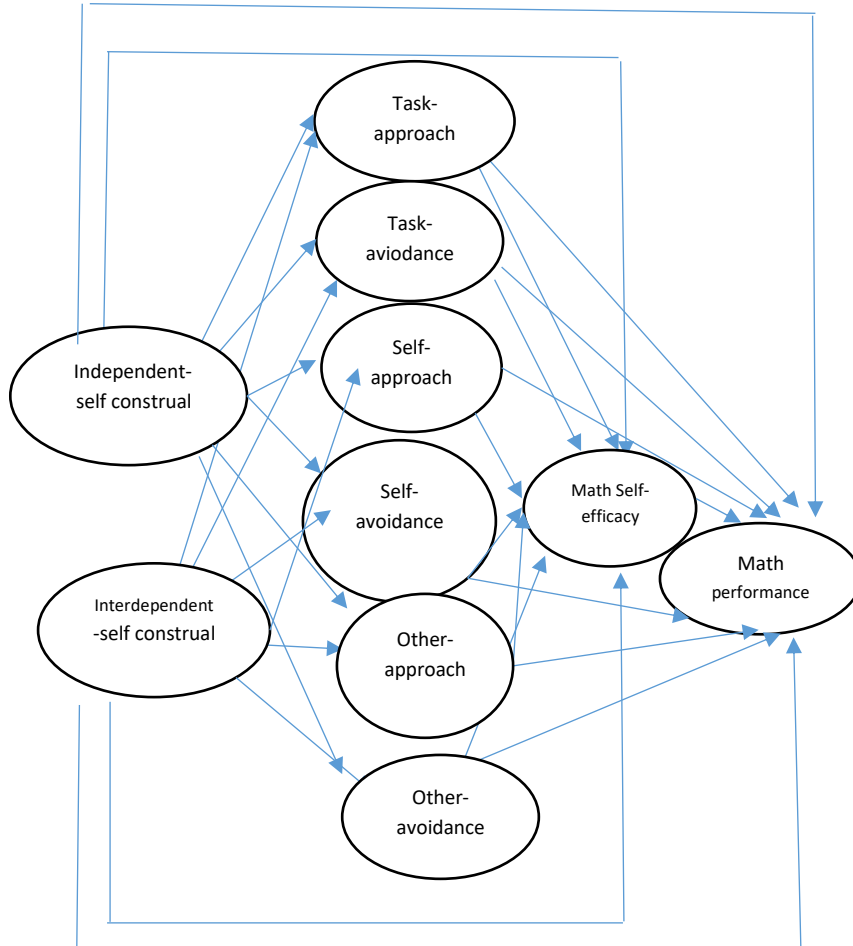
Figure 1. The conceptual model of the research

Method

Descriptive-correlational method was employed in the present research. The research population included all the male and female students studying in the second and third grades of Mathematics-Physics and Science in the four boroughs of Karaj in the school year of 2017-2018. The research sample comprised of 420 students who were selected via multi-stage cluster sampling. To accomplish this, we first selected four girl schools

and three boy schools out of which two classes were randomly chosen. Then, all the students in each class were included in the sample.

After the administration of the questionnaires, 20 uncompleted and inappropriately answered questionnaires were eliminated and as many as 400 questionnaires (148 male and 252 female individuals) were analyzed.

Tools

The Revised Self-construal Scale (Singelis, 1994)

Singelis' main self-construal scale included two interdependent and independent factors comprising of 24 questions and 12 items with 6 newly-added items to improve its internal validity. Hardin, Leong, and Bhagwat (2004) have studied the 30-item Self-construal Scale with both forms of two interdependent and independent factors (each factor, 15 items) and six factors. The responses are scored on a 7-point Likert scale from strongly disagree (1) to strongly agree (7). Confirmatory factor analysis was also run for two independent and interdependent self-construal factors and approved the model by the indices of X^2/ DF, RMSEA, GFI, IFI, PNFI, CFI which were equal to.385, .08, .80, .90, .63 and .90, respectively. After confirming the construct validity to determine the reliability of this scale in the sample group, we calculated Cronbach's alpha coefficient and ordinal theta for the independent and interdependent self-construal at .65, .71, .69, .77, respectively; the values are close to the previous studies, like the study by Kitayama et al (2014, Christopher et al. (2012) and Kam et al. (2012).

3×2 Achievement Goal Questionnaire

It was designed and developed by Elliot et al. (2011) as a new tool to measure goal orientation. This scale has 18 items and 6 subscales of task approach, task avoidance, selfapproach, selfavoidance, other-approach and other-avoidance. Each of the subscales has 3 items and the answers are scored on a 7-point Likert scale from strongly disagree (1) to strongly agree (7). Elliot et al. (2011) reported its Cronbach's alpha to be between .84 and .93. The Cronbach's alpha and ordinal theta were calculated at .79, .88, .79 and .89 in the present research. This questionnaire has also been studied in terms of its factor analysis and validation (Ning, 2018; Wang, Liu, Sun, & Chua, 2017). The questionnaire's goodness of fit was also measured in the present research and the indices of X^2/ DF, RMSEA, GFI, IFI, NFI, CFI were obtained to be 3.84, .08, .89, .96, .94 and .96, respectively. All the indices had acceptable goodness of fit and overall, the results of the confirmatory factor analysis approved the questionnaire's factor structure.

Mathematic Self-efficacy Scale

Developed by Middleton & Midgley (1997), it was used in this research. It has 4 items with score range of 4 to 16 scored on 4-point Likert scale (1=strongly disagree to 4=strongly agree). The internal consistency coefficient of this scale was obtained to be .85 via Cronbach's alpha in Middleton's and Midgley's study. In the present research, the Cronbach's alpha was equal to .79 and the ordinal theta to .80. The confirmatory factor analysis was also administered on this scale and the indices of NFI, CFI, GFI, AGFI, IFI were equal to .98, .98, .98, .91 and .98, respectively. The results of confirmatory factor analysis approved the scale's factor structure.

Mathematic Performance

The students' score in math was taken into account to measure the participants' math performance.

LISREL 8.80, SPSS 23 and Amos 24 software's were used to analyze the data in this study.

Results

Mean indices and standard deviation scores are presented in Table 1.

Table 1

Descriptive Statistics

Factor	N	Mean	SD
Independent self-construal	400	77.86	10.22
Interdependent self-construal	400	55.88	8.14
Task-approach	400	14.94	4.41
Task-avoidance	400	16.12	4.08
Self-approach	400	17.00	3.78
Self-avoidance	400	15.63	3.79
Other-approach	400	15.96	4.04
Other-avoidance	400	14.72	4.41
Math self-efficacy	400	11.90	2.74
Math performance	400	15.76	3.44

Table 1 shows the mean and standard deviation of the participants in the research variables.

Correlation matrix report is required a general simultaneous analysis of all the variables. Table 2 shows the correlation matrix between the latent variables, indicating that most variables have a significant and positive relationship.

As shown in Table 2, independent and interdependent self-construal were moderately correlated (r=.49). In addition, the

Interdependent self-construal was related to the six types of achievement goals. Also, both types of self-construal were correlated positively with math Self-efficacy, but only Independent self-construal - has a significant relationship with mathematical performance. In addition, Math performance has a significant relationship with Self-approach, Self-avoidance, Other-approach, Other-avoidance and Math self-efficacy.

Table 2
Correlation Coefficient Matrix

		1	2	3	4	5	6	7	8	9	10
1	Independent self-construal	1									
2	Interdependent self-construal	.49**	1								
3	Task-approach	**.15	**.19	1							
4	Task-avoidance	.07	**.17	**.51	1						
5	Self-approach	**.14	**.18	**.29	**.38	1					
6	Self-avoidance	.08	**.16	**.27	**.40	**.44	1				
7	Other-approach	**.45	**.51	*.11	*.11	*.13	*.10	1			
8	Other-avoidance	**.50	**.53	.07	.06	**.10	.09	**.40	1		
9	Math self-efficacy	**.24	**.17	.07	.06	**.21	.08	**.16	**.14	1	
10	Math performance	**.13	.09	.04	.09	**.17	**.16	*.10	*.11	**.53	1

**Sig level (p<.01) * Sig level (p<.05)

The goodness-of-fit indexes of the model are shown in Table 3.

Table 3

Indices of Goodness of Fit in the Overall Structural Model

X2	df	X2/ df	RMSEA	GFI	CFI	IFI	NNFI	PNFI
2447.04	1091	2.24	.056	.80	.90	.90	.89	.78

Table 3 presents fitness indices of the model which confirm appropriate fitness of the model with the results of the research. Most indices show good fit.

Figure 2 shows the final model after the elimination of insignificant effects. In this model, the values within parentheses are the standard path coefficients and the numbers outside the parentheses are significant values of *t*.
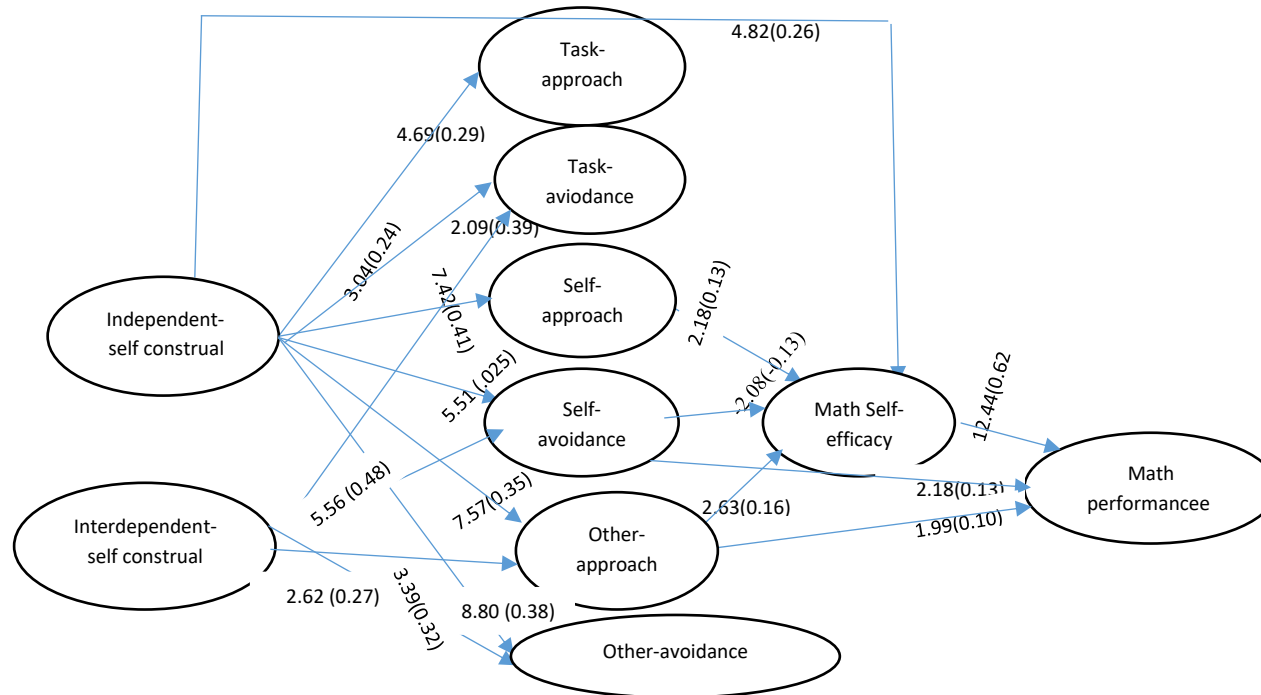
Figure 2. The research's final model

The results of Table 4 show the path coefficients and their significance for direct, indirect and total effects of the model.

Table 4

Direct, Indirect and Total Effects of the Variables

		Direct effect	**Indirect effect**	**Total effect**
From Independent self-construal To:	Task-approach	** (4.69).29	-	**.29
	Task-avoidance	**(3.04) .24		**.24
	Self-approach	** (7.42) .41	-	**.41
	Self-avoidance	** (5.51) .25	-	**.25
	Other-approach	** (7.57) .35	-	**.35
	Other-avoidance	** (8.80) .38	-	**.38
	Math self-efficacy	**(4.82) .26	-.07*	.19**
	Math performance	(-1.53)-.06	-.03*	-.09*
From interdependent self-construal To:	Task-approach	(.64) .17	-	.17
	Task-avoidance	** (2.09) .39		**.39
	Self-approach	(.04) .24	-	.24
	Self-avoidance	** (5.56) .48	-	**.48
	Other-approach	** (3.39) .32	-	**.32
	Other-avoidance	** (2.62) .27	-	**.27
	Math self-efficacy	(1.48) .14	-.12	-.02
	Math performance	(-.72)-.03	-.05	-.08
	Math self-	** (2.18)		

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From self-approach	efficacy	.13		
	Math performance	(1.11) .09	.08*	**.17
From self-avoidance	Math self-efficacy	** (-2.08)-.13		
	Math performance	** (2.18) .13	-.08	**-.05
From other-approach	Math self-efficacy	** (2.63) .16		
	Math performance	** (1.99) .10	.10	*.20

*The values within parentheses are the standard path coefficients and the numbers outside the parentheses are significant values of t. P<.05**

As shown in Table 4, the direct effect of independent self-construal on the math self-efficacy and all the six goals-orientations were significant (p<.05). Moreover, the direct effect of interdependent self-construal on all goal orientations except for the direct effect of interdependent self-construal on the goals of the task-approach and self-approach was also significant (p<.05). However, the direct effect of independent and interdependent self-construal on math performance and the direct effect of interdependent self-construal on math self-efficacy were not observed as significant.

Bootstrap method was applied to examine the significance of the indirect effects, which involved 1000 resamples and produced 95% confidence intervals. The effects are considered significant at $a= .05$ when the confidence intervals do not contain zero.

Table 5

Bootstrap Test Results of Significance of the Indirect Effects

Independent variable	Dependent variable	Boot SE	Boot LLCI	Boot ULCI	P
Independent self-construal	Math self-efficacy	.006	.003	.02	.01
	Math performance	.009	.02	.05	.02
interdependent self-construal	Math self-efficacy	.009	-.008	.02	.30
	Math performance	.009	-.007	.02	.25
self-approach	Math performance	.03	.04	.17	.01
self-avoidance	Math performance	.03	-.07	.05	.64
other-approach	Math performance	.03	-.02	.11	.20

Bootstrap results show that the indirect effect of Independent self-construal on Mathematical Self-Efficacy and Mathematical Performance is significant, and the indirect effect of self-approach on Mathematical Performance is also significant.

Discussion

Given the findings, the total indices of the goodness of fit via structural equation modeling indicated acceptable goodness of fit in the model. Results indicated that independent self-construal is significant, positively correlated to all six goal orientations. The finding are in line with the results of the research by Luo et al. (2011). Furthermore, the research by Elliot et al. (2001) showed no negative relationship between the independent self-construal and avoidance goals. The relationship between independent self-construal with other-avoidance and other-approach can be due to the fact that performance goals employed by students to show competency or avoiding the lack of competency toward others are consistent with the intrinsic motive of upgrading their own intrinsic qualities to differentiate

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them from others (Heine, Lehman, Peng, & Greenholtz, 2002). Individualism is associated with both orientations towards achievement in comparison to others and the acquisition of power while the achievement motivation is related to the task-based orientation (Brutus & Greguras, 2008). In terms of independent self-construal and self-based orientation, it can be concluded that features such as independence and achievement orientation are associated with individualistic cultures. Individuals in individualistic cultures are motivated to perform tasks by upgrading, mastering and developing perceived personal ability. On the other hand, one of the important characteristics of independent self-construal is to consider the intrinsic thoughts and feelings. In other words, self-based goals as a subset of mastery goals take into account an internal path as an evaluation point and increase the likelihood of individuals with dependent self-construal to have self-based orientation.

The relationship between interdependent self-construal with task-approach and self-approach was positive but not significant. However, it showed to have a positive and significant relationship with task-avoidance, self-avoidance, other-approach and other-avoidance. This finding is in harmony with the studies carried out by Luo, Hogan, Yeung, et al (2014) and Luo, Hogan, Tan, et al (2014). In collectivist cultures, individuals care for others and the aim of students' internal monitoring is to gain potential abilities (Li, 2002). Therefore, considering the role of others in these cultures, it is likely that Individuals with interdependent self-construal avoide lack of competency in comparison to the others and may have other-avoidance orientation. Moreover, individuals with interdependent self-construal always seek new skills and have internal monitoring to acquire and upgrade their abilities. They

may have an intrinsic comparison with themselves to ignore the lack of competency in themselves and thus, they probably have avoidant goals. Students who an independent viewpoint to be able to enhance their abilities through efforts are more likely to have mastery orientation. Another part of the research showed that interdependent self-construal has a positive and significant relationship with other-based orientation. Relationship with others is of great importance to individuals with interdependent self-construal because they emphasize on the group goals. On the other hand, other-based goals have an interpersonal evaluation point and competency means performing a task or duty better than others. Therefore, given the common characteristics of self-construal and other-based orientation, it is more likely that, individuals with dependent self-construal have other-approach goals.

The results of this study indicate that independent self-construal has a direct and indirect significant effect on math self-efficacy which is in line with the results of the research by Kononovas and Dallas (2009), Dowd (2013), Matsumoto, Yoo, and Nakagawa (2008), and Dowd and Artistico (2016). In a study by Luo et al. (2014), independent self-construal had a significant and positive indirect effect on math self-concept, whereas the effect of independent self-construal on math self-efficacy is insignificant and negative. Moreover, the results indicated that interdependent self-construal exerts insignificant, direct and positive effect on math self-efficacy which is in harmony with the results of the research by Suryaningrum (2018) and in contrast with the research by Luo and Yeung, (2016). The relationships between interdependent self-construal and math-enhancing abilities were significant and positive in Luo et al.'s   research. In explaining the positive and significant

relationship between the independent self-construal and self-efficacy, it can be argued that students with independent self-construal internalize the values of individualistic cultures. They are self-governing individuals who assert themselves and orientate towards success and development. These characteristics affect their beliefs in relation to a situation or challenge, and the strong attributes of their independence enhance their self-efficacy (Suryaningrum, 2018).

Results revealed that the direct effect of self-approach orientation with math self-efficacy is significant and positive. This finding is relatively in line with the studies conducted by Huang, (2016) and David (2014). The effect of other-approach orientation with math self-efficacy is significant and positive which is consistent with the findings of Dull, Schleifer and McMillan, (2015) and Diseth (2015). That the relationship between self-avoidance and math self-efficacy is significant and negative is consistent with the findings of Diseth (2015) but inconsistent with David's research (2014). Mastery-approach goals focus on achieving success through task mastery and interpersonal competency and has a positive relationship with academic performance leading to higher performance in mathematics (Matos, Lens, Vansteenkiste & Mouratidis, 2017); each time a better performance leads to a more successful performance experience, which paves the way for higher levels of self-efficacy. Furthermore, other-approach goals have significant and positive effects on math self-efficacy. Individuals with other-approach orientation have higher tendency to do a specific task better than others and demonstrate their eagerness for learning to show their dominance and power. These people feel proud when others have positive judgment about them, which will probably increase enhance their self-

efficacy. Furthermore, the relationship between self-avoidance orientation and math self-efficacy was observed to be significantly negative. People with self-avoidance orientation avoid making negative intrinsic judgment about their competence, and avoid challenging tasks because failure in these tasks implies insufficient incompetence. Therefore, lack of engagement with challenging tasks, fear of failure and incompetence may reduce their self-efficacy beliefs.

Findings indicated that direct relationships of self-avoidance with mathematic performance are significant and positive. These findings are in line with the results of the studies by Matos et al (2017) and Luo and Zhang (2015) and inconsistent with David 's research (2014). Moreover, the direct relationship of other-approach orientation with math achievement was significant and positive which is consistent with the results of the studies carried out by Diseth (2015) and Dull et al. (2015) and inconsistent with Luo and Zhang's research (2015). Additionally, the indirect effect of self-approach on math performance was significant and positive. Students with mastery goals and high levels of self-confidence want to master the new skills and tend to seek for help to boost their learning, perception and understanding and thus, lower the threats to self-worth (Luo & Zhang, 2015). The individuals with other-approach orientations seek to do their task and duty better than others because they measure their competence and ability as compared to others and thus, they may try more to enhance their performance to avoid others' negative judgments.

In addition, the results indicated that math self-efficacy has a significant and positive effect on math performance. This finding is in line with the results of the studies by Grigg et al. , 2018, Kung and Lee (2016), and Luo and Zhan (2015). Math

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self-efficacy affects the students' level of interest, and a belief in successfully performing a task may be crucial in stimulating and sustaining their interest because the students' beliefs about "self" gradually become consistent with their levels of performance, and the process of identity creation is also influenced by the beliefs in their abilities, which may finally influence performance.

Findings indicated that independent self-construal can directly and indirectly affect math performance insignificantly and negatively. This finding is in line with the results of the research by Luo et al., 2014. However, it is not consistent with the results of the studies by Zha et al. (2006) and Zusho, Pintrich, and Cortina (2005). They indicated that individuals living in collectivistic cultures show higher levels of skill as compared to those living in individualistic countries. Given that no difference was found between independent and interdependent self-construal with performance, it might be possible that the students' total performance in mathematics is related to other factors such as teacher's self-efficacy or pedagogical methods, classroom environment, perception of the class, learning strategies, etc.

The central limitation of the present study was failure to use distinct cultural groups to examine differences in self-construal. Another limitation was that all the participants were school students who spent their time in a highly individualistic and competitive academic environment. It is possible that an interdependent self-construal would be associated with more effective goal setting if participants were in a less individualistic and competitive setting.

In general, the present study offers the following suggestions based on the findings. Mathematics teachers are recommended

to improve the students' math self-efficacy by verbal encouragement, creating appropriate performance experiences and establishing interest in math. It is also suggested that teachers lead the students into intrinsic competence to be their own evaluation reference; compare their status with previous situations, and create self-awareness by examining and identifying their strengths and weaknesses; and enabling them to work hard to resolve weaknesses and to expand their strengths.

Acknowledgments

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