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# Mathematics Anxiety, Motivation and The Basic Psychological Needs from the Perspective of Self-Determination Theory *

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## Abstract

The purpose of this study is to explore the effects of students' basic psychological needs on motivational regulations towards mathematics and mathematics anxiety levels. This study was conducted with 440 tenth grade high school students in Bolu who took mathematics courses during the 2010-2011 academic year. Data were collected through Mathematics Anxiety Scale and the Basic Psychological Needs and Academic Self-Regulation Scales which were adapted to Turkish language and mathematics education. According to the regression analyses, the basic psychological needs effected all the dimensions of motivational regulations with a degree of significance. Moreover, the basic psychological needs had an effect of mathematics anxiety which the effect of autonomy was significant. These results indicate that students' basic psychological needs should be supported in order to encourage them to give autonomous decisions in terms of their motivation towards mathematics and reduce their mathematics anxiety levels.

## Keywords

The basic psychological needs
Mathematics anxiety
Motivational regulations
Self-Determination theory

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## Introduction

Being well in mathematics is generally associated with being intelligent and talented, which is why mathematics is considered as an important criterion in examinations. As a matter of fact, mathematics has a significant effect on these exams. For this reason, individuals (e.g., students) may perceive mathematics as a compulsory way through the desired goal, a barrier on the way or a vehicle that helps them to run a step forward. Among people who experience such processes, it is possible to see those who escape from mathematics and give up their goals because of this chronic fail as well as those who just learn mathematics because of interest and curiosity. In this context, the important question is about how mathematics becomes a source of enjoyment for some and a source of fear for others. Within the scope of this study, the variables of motivation, anxiety and basic psychological needs that mediate these two emotions are analyzed and the findings are interpreted from the perspective of self-determination theory (SDT).

* This study was based on the master thesis of the first author.

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Self-Determination Theory (SDT), a theory on personality and motivation, conjectures about experience and development based on the interaction between individuals and social context ("Theory - selfdeterminationtheory.org", n.d.). According to SDT, humans share three universal and innate psychological needs that have positive results when supported and negative effects when hindered during this interaction (Ryan & Deci, 2000a).

The first need, *relatedness*, is about individual's emotion that he or she feels being loved by the ones who he or she cares and has relationship with (Vlachopoulos and Michailidou, 2006). This need is supported via the acceptance of the individuals by their social surroundings as they are and their confidence in emotional support, help and suggestions coming from social environment (Ntoumanis, Edmunds, & Duda, 2009). Within an educational setting, mutual respect, help and trust are crucial for the support of this need (Deci et al., 2001).

The second need is *competence* which is related to individual's perception of own ability (effectiveness) in the activities (Ryan, & Deci, 2000a). Nutriment of the competence need is possible when one feels competent "in the process of bringing about desired outcomes" (Milyavskaya et al., 2009, p. 1032) or "at least [one] becomes good at what [he or she] does" (Sheldon & Kriger, 2007, p. 885).

*Autonomy*, the third need, is about feeling that s/he can make choice in activities without any pressure (Deci et al., 2001). According to Ryan and Brown (2003) this need means that one experiences self-decision and one's own initiative by using free will.

Self-determination, which means determination based on the support of autonomy, is one's identification of own goals and to use own initiative to reach these goals (Ersoy Kart & Güldü, 2008). "Autonomously regulated people feel agentic in their own behavior, whereas controllingly regulated people feel like pawns to external forces" (Gagné, 2003, p. 203). SDT posits that people internalize external forces in their social context through various regulations or they adapt them to their personality. In this way, SDT defines motivational regulations and classifies these regulations according to the level of self-determination (Ryan & Deci, 2000a).

According to SDT, motivation can be separated into two as intrinsic and extrinsic. In intrinsic motivation, individual acts for internal satisfaction as interest, curiosity and enjoyment in the line of own values via full self-determination and regulates internally (Chirkov, Vansteenkiste, Tao, & Lynch, 2007). Intrinsic motivation derives from the propensity of development of human nature. SDT focuses on how to detect and develop intrinsic motivation rather than its source (Ryan & Deci, 2000a). Two crucial factors for detecting and maintaining intrinsic motivation are competence and autonomy needs (Deci & Ryan, 1985). Durmaz (2012) explains this situation with the two following extreme examples: someone who tries hard to learn drawing picture yet feels incompetent loses his or her desires or someone who is talented at drawing yet does not want to draw because of his or her other interests.

Since intrinsic and extrinsic motivation concepts began to be first used, there has been a perception that these are opposite to each other and while intrinsic motivation is positive, extrinsic motivation is negative. The reason for this misperception is the ignorance of humans' internal processes during the classification of motivation according to external forces. However, the types of extrinsic motivation can be lined in a continuum according to the level of self-determination and they can work in a harmony in a particular activity (Hayamizu, 1997). For example, a student who loves mathematics may study to escape from the internal pressure caused by a possible bad score.

Extrinsic motivation refers to a type of motivation in which individual aligns the external forces by social context to his or her own personality with the help of internal regulations and acts according to the context of external causality as a result of such regulations (Ryan & Deci, 2000a). According to SDT, extrinsic motivation has four types that can be located on a line from a less self-determined behavior to a more self-determined one based on the reason of motivation: *extrinsic (external), introjected, identified and integrated* (Hayamizu, 1997). In the *extrinsic type of motivation*, individual acts with a tendency of an expectation to get a reward or of an avoidance of a punishment in the external perceived locus of causality. Ones who are extrinsically motivated are somewhat controlled by others and become alienated to themselves (in terms of not aligning with identity) (Ryan & Deci, 2000a). The second type of motivation, *introjected*, refers to a motivation in which individual tends to act to protect the perception of ego to avoid internal punishment (i.e., guilt, fear and anxiety) or to reach internal reward such as self-esteem (Deci & Ryan, 2000). In this type of regulation that is partially self-determined, protection of ego or avoidance of guilt is in the foreground. *The type of identified motivation* flourishes due to personal importance and value given to the result of a goal (Ryan & Deci, 2000a). In this regulation type that has more degree of self-determination compared to the first two types, individual acts to reach a desired goal and this behavior and the identity coincide considerably (Ersoy Kart & Güldü, 2008). Seeing mathematics as an important vehicle for selection exams can be an example of this type motivation (Durmaz, 2012). *Integrated regulation* that consists of the synthesis of awareness and the self through regulations of individual's own value and needs is extrinsic motivation as it is acted as a result of its external reason. On the other hand, it refers to an example for intrinsic considering that individual's identity and ego coincide and it helps the needs of the individual (Ryan & Deci, 2000a).

Motivational regulations can be categorized into two as self-determined and controlled (Figure 1). While identified regulation, introjected regulation and external regulation are examples of controlled motivation, integrated and internal regulations are examples of self-determined behavior (Ersoy Kart & Güldü, 2008; Ryan & Deci, 2000a). In most studies, though integrated regulation is considered as extrinsic motivation, it is intrinsic motivation since it is self-determined (Hayamizu, 1997; Ryan & Connell, 1989). In this study, integrated regulation will be taken as intrinsic motivation.

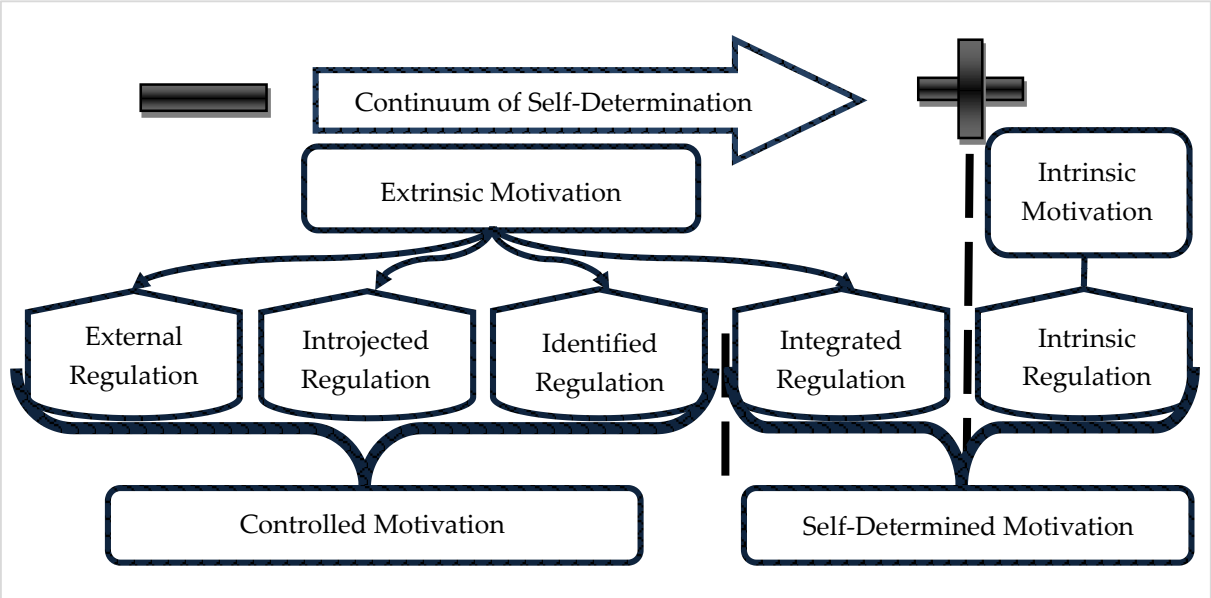


**Figure 1.** Classification of motivational regulation types according to the level of self-regulation (Ryan & Deci, 2000a, p. 72)

Unlike *scope theories of motivation* that foreground needs in being motivated, *process based theories of motivation* that analyze motivation in the context of the relation between cognition and motivators and *functional reinforcement theory* that analyzes motivation based on reward-punishment (Kırçı, 2007), Self-Determination Theory (SDT) considers human emotion, thought and behaviors as a whole. According to SDT, not only the reason for participation in an activity, the content of goals and reward-punishment relationship are crucial but also internal regulation processes and self-determination that means to use the freewill in these processes are fore grounded. The three psychological needs have important roles in terms of healthy attainment of internal regulation processes (Ryan & Deci, 2000a). In other words, people might naturally satisfy some of their psychological needs depending on the activity they are doing while carrying out their activities. For example, the main purpose of a child playing with the toys is not to satisfy his or her competency but to have fun. Therefore, the basic psychological need associated with the activity is allayed during the context of playing.

On the other hand, according to SDT, when the activities that support the psychological needs are planned, the individual's degree of self-determination in motivation towards these activities increases (Ryan & Deci, 2000a). As a result, positive emotions and consequences in the individual's life appear (Ryan & Deci, 2000b). This subserves the individual's well-being. When faced with the occasions in which these needs are thwarted, the degree of self-determination in motivation towards the activity subsides (Ryan & Deci, 2000a). The best example for this might be parents' interference in children's routine duties (*Wait, you can't do it. Let me do it for you!*). This may cause the child to develop negative emotions (such as disinterest, anxiety) towards the activity (Ryan & Deci, 2000b). In terms of mathematics education, when these needs are thwarted in a mathematical context, children may create anxiety or fear towards mathematics.

Anxiety and fear are often confused. Fear is a reflex that one feels against real threats. Whereas, anxiety appears when there is a threat against one's inner world (Bağcı, 2008). *Mathematics anxiety* is an anxiety felt about the content of mathematics (Yenilmez & Özabacı, 2003).

Mathematics anxiety appears as a result of negative emotions on autonomous nerve system (Erktin, Dönmez, & Özel, 2006). Moreover, it has adverse impact on learning by occupying the short and long term memories (Aydın, Delice, Dilmaç, & Ertekin, 2009). If mathematics anxiety becomes chronic, it may result in desperation, hopelessness and abscondment from mathematics, which may limit choices for the individual and thus, the individual may perceive mathematics as an obstacle for his or her dream.

There are studies that show negative relationship between anxiety and the degree of the satisfaction of basic psychological needs (Sebire, Standage, & Vansteenkiste, 2009; Slotter & Finkel, 2009). Some studies in various areas show that there are positive correlations between anxiety and the degree of satisfaction of basic psychological needs depending on the level of self-determination in motivational regulations (Koh et al., 2010; Thogersen Ntoumani & Ntoumanis, 2007). The perception that low level of anxiety works as a motivator (Baloğlu, 2001) is related to the person's involvement in the activities to reduce or remove the inner tension (the feel of guilt in negative results) (Deci & Ryan, 2000; Ryan & Deci, 2000b; Sebire et al., 2009). The studies on these relationship have found that anxiety and controlled motivation types are positively correlated (Munster Halvari, Halvari, Bjørnebekk, & Deci, 2010; Thogersen Ntoumani & Ntoumanis, 2006).

There has been an increase in number of researches about basic psychological needs in Turkey for the last decade. . The studies are conducted on scale adaptation (Ersoy Kart & Güldü, 2008; Evren et al., 2006; Kara, 2008; Kesici, 2008) as well as the relationship between various variables and basic psychological needs. Some of these variables are the state of well-being that individuals feel (Cihangir Çankaya, 2009a; Cihangir Çankaya, 2009b; İlhan & Özbay, 2010) and level of their success, motivation and depression (Yeşilyurt, 2008) and anxiety (Cihangir Çankaya, 2009b). Moreover, there are studies focusing on the relationship between motivational regulations and the state of well-being (Eryılmaz, 2010). However, few studies have been carried out on mathematics education (Durmaz, 2012; Durmaz & Akkuş, 2010; Valas & Sovik, 1994); as a result, more studies are required within the field.

Within the scope of this study, the relationships among basic psychological needs, motivational regulations and anxiety were analyzed. The purpose of the study was to identify the effect of the degree of satisfaction of 10th grade students' basic psychological needs (autonomy, competence and relatedness) in mathematics learning environment on motivational regulations (external regulation, introjected regulation, identified regulation and internal regulation) towards mathematics learning and mathematics anxiety. This study is crucial as it not only provides two scales that can be used to identify the factors that affect mathematics learning but also presents recommendations both related to determination of relationships among the variables mentioned above and mathematics education.

## Method

The model of this study is correlational survey because it analyzes the relationship among basic psychological needs, motivational regulations and anxiety. Karasar (2013) states that relational survey helps identify the relation or the degree among two and more variables that may be working together.

### *Study Group*

The study group is comprised of 10th grade students in Bolu who took mathematics lesson during 2010-2011. The pilot study was conducted with 230 students at 3 high schools randomly chosen after having had necessary permissions from Bolu governorship. The main study was conducted with 594 students at 9 high schools using the final version of the scales. A cluster sampling was used in the study since the groups in population were randomly chosen and individuals in these groups were sampled (Gay & Airasian, 2000). There were 168 returns in the pilot study and 440 in the main study.

According to the statistics of the National Education, there were 3886 tenth grade students during 2010-2011 school year in Bolu (Republic of Turkey Ministry of National Education Strategy Development Presidency, 2011), which means that the number of 10th grade students would be 3886 at most. Therefore, the size of the study sample is above the lower limit of 10% of population for $\alpha$ = 0.05 significance level and d = 0.05 sampling error (Agresti & Finlay, 1997).

### *Data Collection Instruments*

Three different scales were used in this study. The Basic Psychological Needs Scale (BPNS) and Academic Self-Regulation Questionnaire (ASRQ) were obtained from www.selfdeterminationtheory.org website after having had permissions to use (Edward L. Deci, personal communication, December 2, 2010). Necessary permission for the Mathematics Anxiety Scale was taken from Erktin (E. Erktin, personal communication, March 2, 2010).

The two scales (BPNS and ASRQ) were translated into Turkish language by two professional translators. The translations were completed as a result of mutual controlling and co-decision of the translators. Thereafter, the scales were adapted to mathematics education under the guidance of experts and Edward L. Deci. The degree of these Likert's type scales was reduced to 5 considering the participants' age range (14-18).

Various analyses were conducted for validity and reliability of the data collection instruments. For the reliabilities of the scales, Cronbach's alpha internal consistency coefficients were calculated for all subcategories during the pilot and main implementations. The Basic Psychological Needs and Academic Self-Regulation scales were examined through confirmatory factor analysis (CFA), which is a form of analysis to test a pre-hypothesized model (Kline, 2010). In CFA, goodness-of-fit indices such as Chi-square ($\chi^2$), $\chi^2$/sd, RMSEA (root-mean-square error of approximation), GFI (goodness-of-fit index), AGFI (adjusted goodness-of-fit index), NFI (normed fit index), NNFI (non-normed fit index), CFI (comparative fit index) are generally used to evaluate preferred models. in order for the model to be assessed, the cutoffs for the ratio of $\chi^2$/sd 5 and under, RMSEA less than 0.05, GFI and AGFI above 0.90 show model-data fitting (Hooper, Coughlan, & Mullen, 2008). Furthermore, Kline (2010) argues that the cutoff values 0.85, 0.80 and 0.10 for GFI, AGFI and RMSEA respectively are acceptable to evaluate a model fit.

***Basic Psychological Needs Scale (BPNS)***, which was first developed to identify the degree of satisfaction of basic psychological needs at work, was tested for reliability and validity (Baard, Deci, & Ryan, 2004; Deci et. al., 2001; Ilardi, Leone, Kasser, & Ryan, 1993). Gagné (2003) modified the scale with few changes for measuring the satisfaction of basic psychological needs in general. Various forms of the scale have been used in many studies, and its reliability and validity have been tested (Baard et al., 2004; Deci et. al., 2001; Gagné, 2003; Ilardi et al., 1993; Kashdan, Mishra, Breen, & Forh; 2009).

**Table 1.** Sub-Dimension of Basic Psychological Needs and Sample Items

| | |
|---|---|
| Autonomy | I generally feel comfortable to explain my views and ideas when studying mathematics or during mathematics lessons. |
| Competence | The things that I do when studying mathematics or during mathematics lessons often make me feel competent. |
| Relatedness | I really like people I interact with when studying mathematics or during mathematics lessons. |

There are 6 items for relatedness, 8 items for competence and 7 items for autonomy in BPNS and nine of the items are reversed in the scale. Sample items are provided in Table 1 for each sub-dimension. Gagné (2003) reported Cronbach's alpha internal validity coefficients as 0.86, 0.71, and 0.69 for relatedness, competence and autonomy, respectively.

**Table 2.** Cronbach's Alpha Values According to Pilot and Main Study

| | **Pilot Study** | | **Main Study** | |
|---|---|---|---|---|
| **Sub-dimension (Need)** | **No. of Items** | **Cronbach's Alpha** | **No. of Items** | **Cronbach's Alpha** |
| Autonomy | 7 | .54 | 3 | .60 |
| Competence | 6 | .55 | 2 | .52 |
| Relatedness | 8 | .63 | 5 | .78 |
| Total | 21 | .81 | 11 | .83 |

Internal validity coefficients in pilot and main study are given in Table 2. While the coefficients for the pilot study were found as 0.54, 0.55, and 0.63 for autonomy, competence and relatedness, respectively, they were calculated as 0.60, 0.52 and 0.78 in the main study, respectively. The reason for the coefficients for autonomy and relatedness calculated lower than the expected values was the fact that Cronbach's alpha, depending on formulation of its coefficient was affected by the number of items (Yang & Green, 2011).

According to confirmatory factor analysis (CFA) for the three factored structure of the scale, the fit indices are as follows: $\chi 2/sd=1.71$, RMSEA=0.04, NNFI=0.98, RFI=0.96, CFI=0.99, GFI=0.98, AGFI=0.96. This indicates that BPNS is a valid and reliable scale based on the aforementioned cutoff values (Kline, 2010).

***Academic Self-Regulation Questionnaire (ASRQ)*** was developed by Ryan and Connell (1989) to identify motivational regulations towards activities in learning environment. ASRQ has been used in various studies and its reliability and validity have been reported in these studies (Hayamizu, 1997; Patrick, Skinner & Connell, 1993; Ryan & Connell, 1989).

**Table 3.** Sample Items According to The Sub-Dimensions of ASRQ

| | |
|---|---|
| Intrinsic (Class) | Because I like doing class work. |
| Identified (Homework) | I do my homework because I want to understand the topic. |
| Introjected (Hard Question) | Because I want other students in the class to think that I am smart. |
| Extrinsic (Class) | So my teacher will not reprehend. |

ASRQ considers integrated motivation as intrinsic motivation. The questionnaire measures four different motivational regulation types (extrinsic, introjected, identified and intrinsic) in four different areas (doing homework, participating class work, answering hard questions and being good in school), the first three of which were used in the scale. Sample items according to the sub-dimensions and areas are given in Table 3. Moreover, Table 4 represents the distribution of the items in terms of the sub-dimensions and areas.

**Table 4.** Distribution of Items According to Sub-Dimensions and Areas in ASRQ

| Dimension | Areas (Pilot Study) | | | | Areas (Main Study) | | | |
|---|---|---|---|---|---|---|---|---|
| | Homework (HW) | Class Work | Hard Question | Total | Homework HW | Class Work | Hard Question | Total |
| Intrinsic Motivation | 2 | 2 | 2 | 6 | 2 | 2 | 2 | 6 |
| Identified Regulation | 2 | 2 | 2 | 6 | 1 | 1 | 1 | 3 |
| Introjected Regulation | 2 | 2 | 2 | 6 | 2 | 2 | 2 | 6 |
| Extrinsic Regulation | 2 | 2 | 2 | 6 | 2 | 2 | 2 | 6 |
| Total | 8 | 8 | 8 | 24 | 7 | 7 | 7 | 21 |

Table 5 shows Cronbach's Alpha coefficients calculated in the pilot and main studies according to the dimensions. The coefficients ranged from 0.57 to 0.82 in the pilot study and from 0.61 to 0.80 in the main study. The reason for the low values, as aforementioned, was because of Cronbach's Alpha's sensitivity to the number of items (Yang & Green, 2011).

**Table 5.** Cronbach's Alpha Coefficients of ASRQ in the Pilot and Main Studies

| | Pilot Study | | Main Study | |
|---|---|---|---|---|
| **Sub Dimension (Need)** | **No. of Items** | **Cronbach's Alpha** | **No. of Items** | **Cronbach's Alpha** |
| Intrinsic Motivation | 6 | .82 | 6 | .80 |
| Identified Regulation | 6 | .57 | 3 | .61 |
| Introjected Regulation | 6 | .65 | 6 | .62 |
| Extrinsic Regulation | 6 | .72 | 6 | .67 |

According to confirmatory factor analysis (CFA) for the four factored structure of the scale, the fit indices are as follow: $\chi 2/sd=4.09$, RMSEA=0.08, NNFI=0.90, RFI=0.87, CFI=0.91, GFI=0.87, AGFI=0.82. This indicates that ASRQ is a valid and reliable scale based on the aforementioned cutoff values (Kline, 2010).

***Mathematics Anxiety Scale (MAS)***

Mathematics anxiety scale (MAS) was prepared by Erol (1989) according to Turkey conditions and its internal validity coefficient was calculated as 0.91 (Erktin et al., 2006, p. 28). Erktin et al. (2006) identified four sub dimensions as "mathematics exam and evaluation anxiety", "anxiety for mathematics lesson", "mathematics anxiety in daily life" and "self-confidence about mathematics" via factor analysis. MAS has been used in several studies thereafter and its internal validity coefficients were all calculated high (Akgül, 2008; Aydın et al., 2009; Aydın Yenihayat, 2007; Dereli, 2008; Erden & Akgül, 2010; Nazlıçiçek, 2007; Oğuz, 2008; Örnek, 2007; Sırmacı, 2007; Üner, 2009).

**Table 6.** Distribution of Items and Sample Items for Dimensions of MAS

| Sub Dimensions | No. of Items | | Sample Item |
|---|---|---|---|
| | Original | Reduced | |
| Exam and Evaluation | 17 | 10 | I panic when I start the math section of a general exam. |
| Mathematics Lesson | 17 | 8 | During a mathematics lesson, I become happy for not being in his shoes when a friend is at the board. |
| In Daily Life | 7 | 6 | I get confused when I take the changes at the cafeteria, often I do not control the changes. |
| Self-Confidence | 4 | 3 | I hesitate to explain even the problems I can solve. |
| Total | 45 | 27 | |

Table 6 shows the distribution and sample items for the sub dimensions of MAS. All the items were used in the pilot study. Considering the other measures in the study, the number of items for the scale was reduced to 27 from 45 in the light of the results of the pilot study. In the pilot study, while Cronbach's alpha internal validity coefficient was 0.96 with all the items, it was 0.92 with the reduced version. This coefficient was calculated as 0.91 in the main study.

***Data Analysis***

Two main multiple regression analyses were conducted in the study. The first multiple regression model was evaluated using the sub-dimensions of the Basic Psychological Needs Scale (BPNS) as independent variables (autonomy, competence and relatedness) and each sub-dimension of ASRQ as separate dependent variable (intrinsic motivation, identified regulation, introjected regulation and extrinsic regulation). In the second analysis, the sub-dimensions of BPNS were used as independent variables and anxiety as dependent variable. In the data analysis, multiple regression analysis was conducted to explore the relationship between dependent and independent variables.

The assumptions of the multiple regression were checked for possible violations. Multicollinearity assumption was controlled using correlation matrix among independent variables, tolerance value and variance inflation factor (VIF). Violations are observed when correlation coefficient is above 0.90, Tolerance below 0.10 and VIF above 10 (Field, 2013). The inspection of the assumptions was reported in the result section. Finally, multiple regression is sensitive to outliers in the data. There were no outliers in the data set.

## Results

The results of the analyses will be explained in this section. First of all, descriptive statistics for all the variables were shared, then assumptions of multiple regression were controlled and their values were presented, and then the results of the regression analyses were given. Table 7 shows the means and standard deviations for all the variables.

**Table 7.** Descriptive Statistics for All the Variables

| Scale | Dimensions | Mean | Standard Deviation |
|---|---|---|---|
| BPNS | Autonomy | 19.37 | 5.47 |
| | Competence | 7.07 | 1.07 |
| | Relatedness | 19.93 | 4.69 |
| ASRQ | IM | 20.59 | 4.63 |
| | IR | 10.79 | 2.60 |
| | IntR | 10.13 | 2.57 |
| | ER | 17.74 | 4.07 |
| MAS | | 64.72 | 21.42 |

IM: Intrinsic Motivation; IR: Identified Regulation; IntR: Introjected Regulation; ER: Extrinsic Regulation

VIF and Tolerance values for the analyses were presented in Table 8. As seen in the table, all the values met the cutoffs. Moreover, all the variables were normally distributed.

**Table 8.** VIF and Tolerance Values for the Variables

| Scale | Dimension | VIF | Tolerance Value |
|---|---|---|---|
| BPNS | Autonomy | .65 | 1.51 |
| | Competence | .64 | 1.54 |
| | Relatedness | .55 | 1.81 |
| ASRQ | IM | .60 | 1.66 |
| | IR | .65 | 1.51 |
| | IntR | .52 | 1.91 |
| | ER | .58 | 1.70 |

Correlation coefficients among the variables were examined and presented in Table 9. As seen in the table, there was no multi-collinearity problem. These preliminary analyses indicated that all the assumptions were met. In addition, Table 9 shows that the highest correlation was between introjected regulation and extrinsic regulation (r = 0.63) and that the lowest correlation was between introjected regulation and MAS (r = 0.01).

**Table 9.** Correlation Values for the Variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1.Autonomy | - | | | | | | | |
| 2.Competence | .44** | - | | | | | | |
| 3.Relatedness | .56** | .57** | - | | | | | |
| 4.IM | .34** | .50** | .43** | - | | | | |
| 5.IR | .36** | .38** | .45** | .57** | - | | | |
| 6.IntR | .12** | .30** | .31** | .45** | .35** | - | | |
| 7.ER | .08 | .19** | .17** | .31** | .29** | .63** | - | |
| 8.MAS | -.46** | -.22** | -.28** | -.28** | -.30** | -.01 | .08 | - |

** Significance level $\alpha$=0.05 (Two-sided analysis)

The results of the regression analysis to estimate the relationship between each dimension of ASRQ and the dimensions of BPNS were presented in Table 10. The table shows that the dimensions of BPNS significantly predict (R=0.53, $R^2$=0.28, p<0.01; R=0.29, $R^2$=0.24, p<0.01; R=0.35, $R^2$=0.12, p<0.01; R=0.21, $R^2$=0.04, p<0.01, respectively) each of the dimensions of ASRQ (intrinsic motivation, identified regulation, introjected regulation and extrinsic regulation). The regression models for each dependent variable (intrinsic motivation, identified regulation, introjected regulation and extrinsic regulation) explained, respectively, 28.7%, 24.2%, 12.7% and 4.5% of variance in each model.

**Table 10.** Results of Regression Analyses Between ASRQ and BPNS

| | Variables | Beta | Standard Error | β | t | *p* | $R^2$ |
|---|---|---|---|---|---|---|---|
| IM | Constant | 5.82 | 1.11 | | 5.20 | .00 | .28 |
| | Autonomy | .15 | .10 | .07 | 1.47 | .14 | |
| | Competence | 1.03 | .14 | .35 | 7.11 | .00 | |
| | Relatedness | .25 | .07 | .19 | 3.50 | .00 | |
| IR | Constant | 7.64 | .44 | | 17.33 | .00 | .24 |
| | Autonomy | .09 | .04 | .12 | 2.38 | .01 | |
| | Competence | .17 | .05 | .16 | 3.10 | .00 | |
| | Relatedness | .15 | .02 | .29 | 5.29 | .00 | |
| IntR | Constant | 13.24 | 1.06 | | 12.47 | .00 | .12 |
| | Autonomy | -.19 | .10 | -.10 | -1.95 | .05 | |
| | Competence | .49 | .13 | .20 | 3.59 | .00 | |
| | Relatedness | .29 | .07 | .25 | 4.27 | .00 | |
| ER | Constant | 16.55 | 1.09 | | 15.11 | .00 | .04 |
| | Autonomy | -.074 | .10 | -.04 | -.71 | .47 | |
| | Competence | .37 | .14 | .15 | 2.63 | .00 | |
| | Relatedness | .12 | .07 | .10 | 1.70 | .08 | |

IM: Intrinsic Motivation; IR: Identified Regulation; IntR: Introjected Regulation; ER: Extrinsic Regulation

The order of significance of the independent variables on the dependent variables was identified according to standardized regression coefficients. According to results of t-test done at 0.05 significance level, the orders of relative significance of regression coefficients on the dependent variables were also reported. For intrinsic motivation, the order of significance was competence, relatedness and autonomy. While competence (p = 0.00) and relatedness (p = 0.00) were statistically significant predictors for intrinsic motivation (dependent variable), autonomy was not (p = 0.14). For identified regulation, the order of significance was relatedness, competence and autonomy, all of which were statistically significant predictors (p = 0.00, p = 0.00 and p = 0.01, respectively). For introjected regulation, the order, similar to that of identified regulation, was relatedness, competence and autonomy, all of which were statistically significant predictors (p = 0.00, p = 0.00 and p = 0.05, respectively). Finally, for the last dimension, extrinsic regulation, the order of significance was similar to intrinsic motivation, competence, relatedness and autonomy. While competence (p = 0.00) was the only significant predictor for extrinsic regulation, relatedness (p = 0.08) and autonomy (p = 0.47) were not significant.

The results of regression analyses for mathematics anxiety scale were presented in Table 11, which shows that the dimensions of BPNS significantly predicted the dependent variable, MAS (R = 0.46, $R^2$= 0.21, p < 0.01). The regression model explained 21.7% of the variance.

**Table 11.** Regression Analysis Results Between MAS and BPNS

| | Variables | Beta | Standard Error | β | t | *p* | $R^2$ |
|---|---|---|---|---|---|---|---|
| MAS | Constant | 108.19 | 4.62 | | 23.39 | .00 | .21 |
| | Autonomy | -3.72 | .43 | -.44 | -8.57 | .00 | |
| | Competence | -.19 | .60 | -.01 | -.32 | .74 | |
| | Relatedness | -.09 | .30 | -.01 | -.31 | .75 | |

The order of the significance of the independent variables on the mathematics anxiety was autonomy, relatedness and competence according to standardized regression coefficients. T-test statistics show that while autonomy (p = 0.00) was a significant predictor, competence (p = 0.75) and relatedness (p = 0.74) were not.

## Discussion

This study, through correlation and multiple regression analyses, focuses on the relationships among the basic psychological needs satisfaction, motivational regulations towards mathematics learning and mathematics anxiety of 10th grade students who took mathematics lesson during the 2010-2011 academic year.

Considering each dimension of basic psychological needs individually, we can state that the correlations between motivational regulations (except for identified regulation) and the satisfaction of each need showed a positive trend based on the increasing level of self-determination in motivational regulations. Moreover, regression analyses showed that the independent variables, the dimensions of BPNS, explained 28% of variance in intrinsic motivation, 24% of variance in identified regulation, 12% of variance in introjected regulation and 4% of variance in extrinsic regulation. These findings are consistent with the assertions of SDT which claims that the level of self-determination in motivational behaviors increases or internalization of external forces becomes easier when basic psychological needs are satisfied (Deci & Vansteenkiste, 2004; Ryan & Deci, 2000a, 2000b). The findings are also similar to those of Thogersen Ntoumani and Ntoumanis's (2007) study on sport and those of Munster Halvari, Halvari, Bjørnebekk and Deci's (2010) study on health.

Considering the continuum on the level of self-determination in motivational regulations from extrinsic to intrinsic, individuals are inclined to the fields they are competent at; however, internalization of motivational regulations shows variation based on the level of competence and relatedness. Namely, the fact that individuals like and willingly do mathematics, and that is to say, they have high level of intrinsic motivation can be related to individuals' self-competency and the view of their social environment about them. While according to SDT, autonomy and competence are the basis for intrinsic motivation, autonomy for all motivational regulations is the last in the order of the importance. The reason for this result can be associated with our education system that does not provide learning opportunities for students to develop autonomy in mathematics. As a matter of fact, the studies conducted have shown that although teachers find the constructivist approach in education as positive (Akpınar & Aydın, 2007), they continue to use traditional teaching methods where students' ideas are not valued by showing insufficient time as reason (Temizöz & Özgün Koca, 2008). In addition, the study conducted by Duatepe Paksu and Akkuş (2007) revealed that teachers used only 24.72 minutes of a 40-minute lesson for learning activities. Thus, this shows that teachers who have test-based practices do not (cannot) plan such learning activities.

It is observed that as the level of self-determination decreases to identified and introjected regulations, individual uses mathematics as a tool to reach the goal, which may cause an exchange in the order of importance of relatedness and competence needs. Having a test-focused educational perception and society's overvalue on mathematics for academic achievement may cause students see mathematics as a key for success (thus for integration to the society) by being influenced by their social environment, which moves the order of importance of relatedness need to the first place in identified regulation.

On the other hand, there was negative correlation between mathematics anxiety and basic psychological needs. Moreover, regression analyses showed that basic psychological needs as independent variable explained 21% of the variance in mathematics anxiety and all coefficients were negative. This finding supports the assertion of SDT that when basic psychological needs are thwarted, individuals develop negative emotions such as anxiety towards activities. Even though there are no studies in mathematics education, similar results can be found in the studies that have taken SDT as theoretical framework; for instance, findings of studies on organic chemistry education (Black & Deci, 2000), life in general among university students (Cihangir Çankaya, 2009b), health (Munster Halvari et al., 2010) and sport (Thogersen Ntoumani & Ntoumanis, 2007) are in this direction.

The analyses also revealed that mathematics anxiety had low negative correlation with intrinsic motivation, and as the level of self-determination increased, the correlation values tended to be non-significant and close to zero. In the literature, there are views about the fact that low level anxiety may protect the organism (Doğan & Çoban, 2008) and even become a motivator (Baloğlu, 2001). These point of views can be connected to the ideas stating that anxiety has an effect on the protection of self-respect over individuals who have non self-determined motivation (Ryan & Deci, 2000b; Sebire et al., 2009). Similar results can be found in the studies on health (Munster Halvari et al., 2010) and sport (Thogersen Ntoumani & Ntoumanis, 2007).

## Conclusion

A holistic evaluation of the results of the study revealed that while the satisfaction of basic psychological needs had an effect on motivation positively, it had an effect on anxiety negatively. Supporting these needs in learning environment may decrease anxiety and increase motivation, thus increasing the effectiveness of the environment. In terms of the implementation of the results of this study in classroom environment, a special attention is required to describe learning situations that satisfy basic psychological needs. SDT emphasizes the importance of social and individual processes in learning. Social interactions in classroom are crucial for development of young individuals. Therefore, considering the tendencies of pupil's development, enculturation of mutual trust among students and teacher and non-competitive classroom environment can support relatedness need. In addition, within the context that mathematical knowledge is constructed by people as a result of social and historical interaction (Ernest, 1998), being in a classroom environment in which students can do mathematics together can both satisfy students' need of relatedness and help students feel competent in mathematics.

Moreover, in classroom environments in which students' ideas are not judged by teacher as right or wrong and mathematical knowledge is constructed through a series of argumentation, students can realize that they can do mathematics. Such classroom environments change the authority of knowledge from teacher to class discussion. This leads students to give up thinking that teacher is the authority to approve their ideas. Therefore, the place to test their ideas is the argument made in the class, which supports students' competence need.

SDT is a theory that brings autonomy need up front. The assertions of SDT go against the fact that autonomy need is the only significant variable, when determining intrinsic motivation and mathematics anxiety statistically non-significant and significant respectively. It is now impossible to explain this finding with the existing data. However, hypothetically, it can be stated that students' autonomy need satisfaction is badly affected in the event that parents decide on behalf of students after results of university exam and teachers take control of problem solving processes. . This may derive from cultural variations or some other uncontrolled variables. Both quantitative and qualitative studies are necessary to undermine the reason behind it.

Students are generally not given responsibility of learning in relation to competence need. Phases of problem solving are led by teacher, and computation is left for students (Akkus & Hand, 2011). This prevents students from exploring their own mistakes and evaluation of learning processes. Especially in problem solving, result-based teaching methods rather than process-based ones do not support evaluation of the process made by students and teacher. At this point, encouraging students to reflect on their own problem solving process and make decision about their mistakes is crucial not only for competence need but also for autonomy need.

Within the scope of this study, the relationships among three variables (basic psychological needs, motivational regulations and mathematics anxiety) are explored. Future studies can extend the analyses in this study by including some other variables such as attitude and academic success. The products of this study (BPNS and ASRQ) can be implemented in other fields by replacing mathematics and can be used for different grade levels by adjusting the degree of the scales according to the age of study group.

In experimental studies, the focus is generally on cognitive skills. However, some of them also consider emotional skills such as attitude and anxiety. These studies mostly explore basic psychological needs and teaching methods that support students' active participation. Therefore, the effects of basic psychological needs can be studied with experimental research design.

The studies on SDT have generally been conducted via quantitative methods. Such studies can be supported with qualitative techniques. For example, through classroom observation, the factors that affect satisfaction of basic psychological needs of students can be revealed. The results of these studies can shed light for teachers and teacher candidates.

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