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MATHEMATICS ORIENTED IMPLICIT THEORY OF INTELLIGENCE SCALE: VALIDITY AND RELIABILITY STUDY

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Abstract
The present study aims to devise Mathematics-Oriented Implicit Theory of Intelligence Scale (MOITIS), which is used for measuring students' beliefs related to mathematical intelligence in a valid and a reliable way. The sample comprised 395 high school students in two groups studying in Diyarbakır in Turkey during 2012-2013 Education Year Spring semester. In order to obtain information about the scale's content and face validity, experts were consulted. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were performed in order to analyze the scale's construct validity. As a result of the EFA, a structure comprising 11 items and two factors was obtained and this explained 48.30% of the total variance. The emerging factors were named Entity Theory and Incremental Theory. CFA findings demonstrated that 11 items of the MOITIS and the two-factor structure has satisfactory goodness of fit indices. The reliability of Entity Theory and Incremental Theory subscales was examined by means of internal consistency and test-retest methods and the calculated reliability coefficients were found to be within acceptable borders. Findings of the item analysis showed that all of the items in the scale had discriminatory power. Based on these findings it could be argued that MOITIS is a valid and reliable instrument for measuring high school students' beliefs related to mathematical intelligence.

Key words: *Implicit theory of intelligence, mathematics-oriented implicit theory of intelligence scale, beliefs of mathematical intelligence, reliability, validity*

Introduction

Beliefs are defined as internal acceptance or propositions (Oliver & Koballa, 1992; Richardson, 2003) which are shaped by the individual's experiences (Nespor, 1987; Pajares, 1992), influence attitudes, behaviors (Fishbein & Ajzen, 1975; Hazır Bıkmaz, 2002; Mansour, 2009; Olson, Roese, & Zanna, 1996; Oztuna Kaplan & Macaroglu Akgul, 2009; Pintrich & Schunk, 2002) and cognitive processes (Schommer, 1998), determine how one perceives, gives meaning to an event, person or object and how s/he behaves towards it (Deryakulu, 2006; Fishbein & Ajzen, 1975; Pajares, 1992) and are supposed to be accurate by the individual without feeling any doubt (Deryakulu, 2006; Koballa & Crowley, 1985; Krows, 1999). This powerful deterministic influence of beliefs over individuals' ideas and behaviors require educators to consider self-efficacy belief, epistemological beliefs, beliefs towards learning and evaluation in terms of learning and teaching processes (Chan, 2004; Deryakulu, 2006; Eren, 2010). One of the beliefs that must be taken into consideration in the learning-teaching process concerns individuals' beliefs about the nature of intelligence (Garcia-Cepero & McCoach, 2009).

Dweck (1986) proposed the implicit theory of intelligence in order to explain individuals' beliefs of intelligence. Implicit theory of intelligence was structured on the basis of two opposite beliefs on intelligence (Braten & Strømsø, 2004; Dupeyrat & Mariné, 2005; Plaks, Grant & Dweck, 2005). One of these is the Entity Theory which is based on the idea that intelligence is genetically encoded (Cadwallader, 2009). Individuals who have adopted the entity theory believe that intelligence is a characteristic which is fixed and unchangeable (Ahmavaara & Houston, 2007; Gervey, Chiu, Hong & Dweck, 1999). Another belief within the implicit theory of intelligence is the Incremental theory which posits that intelligence is a characteristic that can be developed through individual's efforts (Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 1999; Elliot & Church, 1997; Kennett & Keefer, 2006). Individuals who adopt the incremental theory believe that

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man is born with a blank slate and his/her interaction with the environment determines development of intelligence. Whether students adopt the entity or incremental theory influence their *academic achievements* (Aronson, Fried, & Good, 2002; Blackwell, Trzesniewski & Dweck, 2007; Da Fonseca, Cury, Bailly, & Rufo, 2004; Good, Aronson & Inzlicht, 2003), *learning strategies* (Dahl, Bals & Turi, 2005; Stipek & Gralinski, 1996; Vermetten, Lodewijks & Vermunt, 2005), *achievement goal orientations* (Ablard, 2002; Dweck, 1999; Dweck & Leggett, 1988; Dweck & Molden, 2005; Mueller & Dweck, 1998; Sorich-Blackwell, 2001; Vandewalle, 1997), *motivation* (Carr & Dweck 2011; Dweck, 1986), *exam anxiety* (Cury, Elliot, Da Fonseca, & Moller, 2006; Dweck & Sorich, 1999; Stipek & Gralinski, 1996), *determination to cope with academic difficulties* (Henderson & Dweck, 1990; Leondari & Gialamas, 2002) and determine the level of their efforts during the learning process (Dupeyrat & Mariné, 2005).

Students who adopt the entity theory with regard to intelligence believe that intelligence is a fixed trait

- They are performance-oriented. These students try to show their efficacy to others (Braten & Strømsø, 2004), compare themselves with other students (Delavar, Ahadi & Barzegar, 2011) and use social comparisons as a criterion for success (Ames, 1992; Ames & Archer, 1998).
- Since they want to complete a task with success and show their talent and intelligence to others, they are willing to do tasks which can be completed in an easy and fast way (Dweck & Leggett, 1988; Roedel & Schraw, 1995). They tend to escape from challenging tasks in which there is a risk of low performance (Dweck & Leggett, 1988). When they come across with hardships, they tend to give up easily (Dupeyrat & Mariné, 2005).
- They view the failures that they encounter in the learning process as setbacks to overcome (García-Cepero & McCoach, 2009; Lee, 1996).
- They feel powerless against difficulties (Diener & Dweck, 1980; Goetz & Dweck, 1980; Henderson & Dweck, 1990). They tend to withdraw and avoid resisting when they make a mistake (Chiu, Hong & Dweck, 1997).
- They tend to question their abilities whenever they fail (Delavar, Ahadi & Barzegar, 2011; Hong, Chiu, Dweck, Lin, & Wan, 1999; Henderson & Dweck, 1990; Ziegler, Schober & Dresel, 2005). Whenever they come across a negative situation, they blame themselves for it and believe that their intelligence level caused their failure (Dweck, Chiu & Hong, 1995; Dweck, Hong & Chiu 1993; Dweck & Master, 2008; Hong, Chiu, & Dweck, 1995).
- They use superficial learning strategies which are effective over the learning of knowledge level behaviors (Stipek & Gralinski, 1996; Vermetten, Lodewijks & Vermunt, 2005) which requires only retrieval of information (Stump, Husman, Chung & Done, 2009).

As for the students who adopt the incremental theory related to intelligence and believe that intelligence can be improved,

- They are learning oriented (Dweck, 1991). They try to acquire new knowledge and skills and improve their talents (Ames, 1992; Ames & Archer, 1998; Braten & Strømsø, 2004; Dupeyrat & Mariné, 2005).
- They are motivated to do challenging tasks which encourage learning (Dweck, 1999; Dweck & Molden, 2005). When they encounter difficult tasks, they experience less anxiety in comparison with their peers who adopt the entity theory (Hong, Dweck, & Chiu, 1999).
- Whenever they encounter hardships, they tend to struggle more than their peers (Mangels, Butterfield, Lamb, Good & Dweck, 2006).
- They view failures in the learning process as an opportunity to develop learning and intelligence (Hong, Chiu, Dweck, Lin & Wan, 1999).
- They are patient when they encounter difficulties (Allison & Urdan, 1993; Ames, 1990; Dweck & Master, 2008).
- They adopt deep strategies like note-taking, summarization, question-answer in order to realize their goals towards learning (Dahl, Bals & Turi, 2005; Husman, Hilpert, Stump & Lynch, 2009; Pressley & Harris, 2006).

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- They think that the cause of their failure lies in the inefficiency of their learning methods and efforts (Delavar, Ahadi & Barzegar, 2011; Roedel & Schraw, 1995).

An analysis of the literature on implicit theory of intelligence demonstrates that some studies have tried to document the structures related to implicit theory of intelligence. To this end, the relationship between implicit theory of intelligence and achievement goal orientations (Braten & Strømsø, 2004; Dupeyrat & Mariné, 2005; Dweck & Master, 2008; Leondari & Gialamas, 2002), epistemological beliefs (Braten & Strømsø, 2005), learning approach (Dahl, Bals & Turi, 2005; Lawson, 2011; Stipek & Gralinski, 1996; Vermetten, Lodewijks & Vermunt, 2005), academic achievement (Barzegar, 2012), exam anxiety (Cury, Elliot, Da Fonseca, & Moller, 2006; Dweck & Sorich, 1999; Stipek & Gralinski, 1996) self-regulatory motivational beliefs and self-efficacy (Abdullah, 2008) was examined. A portion of implicit theory of intelligence studies have examined whether individuals' beliefs towards intelligence vary from discipline to discipline. Some of these have theoretically explained that intelligence related beliefs differ in terms of disciplines, while some have empirically examined whether discipline has an effect over beliefs. To exemplify, Myers, Nichols and White (2003) stated that teachers' fields may influence their beliefs regarding intelligence related beliefs and mathematics teachers may tend to adopt entity theories more in comparison with the social science teachers. Similarly, Stump, Husman, Chung and Done (2009) argued that entity theory may be adopted in the field of mathematics more often when compared with others and a student who adopts entity theory with regard to his/her mathematical ability may adopt incremental theory with regard to his/her verbal ability. Beach (2003), Beach and Dovemark (2007) and Jonsson, Beach, Korp and Erlandson (2012) have empirically shown that entity theory with regard to intelligence has been adopted in the field of mathematics more than in other fields. Ethnographic studies of Beach (2003), Beach and Dovemark (2007) demonstrate that mathematics teachers perceive mathematical ability to be a naturally acquired trait and view the differences in mathematics performance as a reflection of beliefs about intelligence. Similarly, a study by Jonsson, Beach, Korp and Erlandson (2012) showed that mathematics teachers adopt the entity theory more and the incremental theory less in comparison with social and applied sciences teachers.

The finding that individuals' level of adopting the entity theory and incremental theory differ in terms of disciplines in implicit intelligence related research (Beach, 2003; Beach & Dovemark, 2007; Jonsson, Beach, Korp & Erlandson, 2012) has given rise to the need to analyze implicit theory of intelligence not in general but rather in a field-oriented fashion (Broome, 2001; Burkley, Parker, Stermer & Burkley, 2010; Chen & Pajares; 2010; Quihuis, Bempechat, Jimenez & Boulay, 2002). Due to the fact that mathematics has a symbolic and abstract nature (Steiner, 2007) in contrast to applied sciences and social sciences and humanities, an individual who adopts the incremental theory in social and applied sciences may think that s/he has a fixed mathematical ability and will never learn complex mathematical operations and thus adopt the entity theory with regard to mathematical intelligence (Stump, Husman, Chung & Done, 2009). This has led the current implicit theory of intelligence related research to analyze mathematics-oriented implicit theory of intelligence separately from the general implicit theory of intelligence. In studies by Froehlich (2007), the implicit theory of intelligence scale developed by Dweck, Chiu and Hong (1995) was adapted to mathematics and a three-item Mathematics-Oriented Implicit Theory of Intelligence Scale (MOITIS) was obtained. The scale, which had a 6-point Likert type grading (1=I definitely agree, 6=I definitely disagree) was applied to students and when interpreting the scores, it was agreed that students with a mean score of ≤ 3 adopted the entity theory while students with a mean score of >3 adopted the incremental theory. In the same way, Hendricks (2012) used the expression "mathematics talent" instead of "intelligence" in the three-item general implicit theory of intelligence scale and adapted the scale to mathematics. In the present study, it is assumed that high scores obtained from the scale point to incremental theory whereas low scores point to entity theory. Such a scoring of mathematics-oriented implicit theory of intelligence means that students *either* adopt the entity theory or the incremental theory. However, considering the fact that students might adopt *both* the entity *and* incremental theories (Quihuis, Bempechat, Jimenez & Boulay, 2002), a

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two-factor MOITIS based on a theoretical structure of entity and incremental theories may measure beliefs of mathematical intelligence in a better way. Therefore, contributing to the literature through a two-factor MOITIS comprising entity and incremental theories, is highly significant in terms of enabling a "*both ... and...*" evaluation instead of an "*either ... or...*" evaluation. It has been acknowledged that the extent to which individuals adopt entity and incremental theory with regard to implicit theory of intelligence influence their cognitive and affective characteristics (Garcia-Cepero & McCoach, 2009; Spinath, Spinath, Riemann & Angleitner, 2003). In this respect, implicit theory of intelligence will give the chance to analyze implicit theory of intelligence in a mathematics-oriented way, develop a measurement instrument with satisfactory psychometric features and will guide practices towards increasing mathematics achievement by determining beliefs of mathematical intelligence in a valid and reliable way.

The Aim of the Study

The aim of the present study is to develop MOITIS. To this end, it aims to analyze *i)* the factorial structure, *ii)* determine mathematics achievement scores and criterion-related validity, *iii)* reliability of total scale and subscales and *iv)* discriminatory power of items in the scale.

Method

Sample

The study was carried out during 2012-2013 Education Year Spring semester with the participation of two different groups comprising 395 high school students. The first group comprised 322 students (167 girls and 155 boys) from two high schools in Diyarbakır in Turkey. However, data with a lot of missing responses, or with multiple responses to the same item were excluded from analysis. For such reasons, data from 18 students (7 girls and 11 boys) were excluded from analysis prior to statistical analysis. Thus, the first group comprised data from 304 students, 160 of whom were female (52.60%) and 144 of whom were male (47.70%). In this group there were 90 9th graders (29.60%), 102 10th graders (33.60%), 71 11th graders (23.40%) and 41 12th graders (13.50%). The scale's construct validity, internal consistency reliability and item analyses were performed on data collected from this group. In addition, within the scope of criterion-related validity, correlations between MOITIS and students' mathematics grades were calculated on the basis of data from this group. The second group comprised 105 students, 59 of whom were female (56.19%) and 46 were male (43.18%) studying at a high school in Diyarbakır in Turkey. The scale's test-retest validity was calculated on the basis of data from this group. Prior to performing statistical analyses on the test's test-retest reliability, data from 14 students who failed to participate in any of the two sessions administered for test-retest reliability with a two-week interval were excluded from analysis. Following this, test-retest reliability coefficient was calculated on the basis of data from 91 students (50 girls and 41 boys) who were present in both test sessions administered in order to maintain test-retest reliability.

Procedure

During the development of the MOITIS, steps recommended by Cronbach (1984), Crocker and Algina (1986) and DeVellis (2003) were followed. These steps followed in scale development are summarized below:

Determination of features(s) to be measured through the scores obtained from the scale: MOITIS aims to measure students' beliefs towards mathematical intelligence.

Definition of the behaviours representing the construct to be measured: In the development of MOITIS, the entity and incremental theories related to implicit theory of intelligence were taken into consideration. The entity theory aims to measure beliefs that mathematical intelligence is an inborn and unchangeable feature. As for the incremental theory, it aims to measure beliefs that mathematical intelligence is a feature that can be developed through individual's efforts.

Construction of the items in the scale: In the writing up of the items to be included in MOITIS, the implicit theory of intelligence scales in the literature were utilized (Abd-El-Fattah & Yates, 2006; Da Fonseca, Schiano-Lomoriello, Cury, Poinso, Rufo & Therme, 2007; Dweck, 1999;

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Dweck & Henderson 1989; Stipek & Gralinski, 1996); mathematics teachers' and experts in mathematics education and educational sciences were consulted. The item pool was constructed on the basis of the Entity Theory and Incremental Theory dimensions. Six items represented the entity theory dimension while five items represented the incremental theory dimension, and thus the item pool contained 11 items. A 5-point Likert type scale grading, comprising the expressions I definitely agree (5), I agree (4), I am undecided (3), I do not agree (2) and I definitely disagree (1).

Expert Opinion regarding the Items in the Draft Measurement Instrument and Revision of the Scale: In order to maintain the content and face validity of MOITIS, a measurement expert, 3 curriculum and instruction experts and 3 mathematics education experts were consulted. Since determination of the content of a theme requires a certain judgment, experts and developers of the measurement instrument should have common definitions (Tavsancıl, 2010). Especially in multidimensional measurement instruments with more than one subscales, experts are needed in order to understand whether the items targeting different constructs are related to the expected dimension or not (DeVellis, 2003). In relation to this necessity, experts were asked to evaluate the scale on the basis of entity and incremental theories. In line with the opinions of the experts, whether an item needs to be excluded or added was determined. In order to maintain intelligibility of the measurement device, 3 linguists were consulted. In line with the experts' opinions on the writing rules (e.g., spelling) and use of punctuation, the scale items were revised.

Making a pilot study on a small group prior to the administration: In order to obtain feedback on the intelligibility of the items on MOITIS and duration of the test, a pilot study was carried out on 15 high school students (8 female and 7 male). Interviews were conducted with students who took MOITIS. In the interviews, students' opinions on the intelligibility of the items in the scale were obtained. In addition, students' opinions were obtained as to the directives in the beginning of the scale, which explain the number of items and how to fill in the scale (DeVellis, 2003). Likewise, the interviews showed that no change was necessary in the directives and scale items. The approximate duration of the scale was calculated by obtaining the mean of the fastest response time and the longest response time in the pilot group, which comprised 15 participants. Following these procedures, the scale was ready to be administered on a large sample.

Administration of the scale on a wider sample and analyses for determining the psychometric features of the scale: The administration sessions were held with the participation of a group with sufficient number of participants in order to understand the psychometric features of the scale. The scale was administered to students in the class environment. Prior to the administration, students were informed about the aim of the research. Students were informed that the collected data were to be used solely for research purposes and not shared with any institutions or people. Similarly, prior to the administration phase, students were reminded that participation in the research was not compulsory and the sample comprised only volunteering students. Students were informed about how to fill out the scale, and that there are no false or true answers and they were to choose the most appropriate option for themselves. Students were warned not to influence each other. In addition, the researcher emphasized that giving realistic responses was highly significant in terms of obtaining reliable and valid results. Following the data collection process, statistical analyses were performed in order to determine the scale's psychometric characteristics.

Preparation of instructions for how to score and interpret the scale: The ranges of scores that can be obtained from MOITIS subscales were explained. In addition, information on how to interpret the high and low scores from the subdimensions was given.

Statistical Analysis of Reliability, Validity, and Item Analysis: After MOITIS was applied, statistical analyses were performed in order to understand the psychometric characteristics of the scale. Firstly, the scale's construct validity was examined and to this end, Exploratory Factor Analysis and Confirmatory Factor Analysis were performed. In order to examine criterion-related validity, the correlations between subdimensions of MOITIS and students' mathematics scores were calculated. The reliability of MOITIS was examined by means of internal consistency and test-retest methods. In order to determine the items' discriminatory power, corrected item total correlations

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were calculated and the upper and lower score groups each containing 27% of the total group were compared with each other. Data were analyzed on SPSS 20.0 and LISREL 8.54.

Findings

Construct Validity

Within the scope of MOITIS' construct validity, EFA and CFA were performed.

Exploratory Factor Analysis (EFA): Prior to performing EFA, whether the data set is appropriate for factor analysis should be examined. Sample size ranks in the first place in this analysis (Akbulut, 2010). There are different opinions on the number of participants to be included in factor analysis studies. Cattell (1978) maintains that in factor analysis studies, the number of participants should be 3-6 times greater than the number of items and 200 participants is acceptable while 500 participants is considered to be a highly sufficient number. Hair, Anderson, Tatham and Grablowsky (1979) recommend that the number of participants should be 20 times as many as the number of scale items in factor analysis. For factor analysis studies, Gorsuch (1983) recommends having at least 5 participants for each item and at least 100 participants (Cramer, 2003). Crowley and Lee (1992) find 100 to be unsatisfactory, 200 as average, 300 as good, and 500 as very good and 1000 as perfect (Akbulut, 2010) for factor analysis. Ferguson and Cox (1993) state that the number of 100 participants should be the minimum criterion for factor analysis. As for Kline (1994), he believes 200 is generally satisfactory to obtain reliable results from factor analysis, but in cases where the factor structure is clear and small, this can be reduced to 100 but working with large samples is more appropriate. In estimates of appropriate sample sizes for factor analysis, meeting at least two of the criteria in the literature is recommended (Cokluk, Sekercioglu & Buyukozturk, 2012). According to these criteria, the number of participants in the present study is satisfactory for factor analysis. In order to understand whether the data are appropriate for factor analysis, Kaiser-Mayer-Olkin (KMO) and Barlett's tests can also be used. KMO can take values ranging between 0 and 1. According to Kaiser (1974), KMO values over 0.5 are acceptable (Field, 2009). It is generally accepted that KMO values ranging between 0.5 and 0.7 are medium, 0.8-0.9 are very good and over 0.9 are perfect (Hutcheson & Sofroniou, 1999; Sharma, 1996). In the present study, the KMO value was found to be .791 and the Bartlett's test was found to be significant (X^2=808.909, SD=55). Thus, it could be argued that the data are appropriate for factor analysis. Following this, in EFA as a result of basic components method and direct oblimin rotation, a two-factor structure explaining 48.30% of the total variance was obtained. In general implicit theory of intelligence scales, the fact that scale dimensions are interrelated (Abd-El-Fattah & Yates, 2006) led us to think that there may be a relationship among scale factors in MOITIS, too. Due to this prediction that scale factors might be interrelated, oblique rotation technique was used in EFA. As a result of EFA, the item contents and theoretical construct were taken into consideration and the first factor was named Entity Theory while the second factor was named Incremental Theory. Entity theory subscale comprises 6 items and explains 30.71% of the total variance. The pattern coefficients of the items in this subscale vary between .54 and .84 and structure coefficients vary between .55 and .82. The Incremental Theory subscale comprises 5 items and explains 17.60% of the total variance. The pattern coefficients of the items in this subscale range between .62 and .79 and the structure coefficients vary between .62 and .77. Structure coefficients reflect an item's relationship with its factor (Everitt & Hothorn, 2011; Afifi & Clark, 1996). As for pattern coefficients, while controlling for the item's relationship with other dimensions, they show the correlation between the item and its factor (Brown, 2006; Kahn, 2006). When there is no relationship among factors, the pattern and structure coefficients are equal to each other (Field, 2009) and when there is a relationship among factors, there is a difference between pattern and structure coefficients (Pedhazur, 1997).

In measurement instruments in which factors are interrelated, the fact that pattern coefficients are different from structure coefficients arises the question as to which of these coefficients should be interpreted (Meyers, Gamst & Guarino, 2006). In the naming of factors emerging in factor analysis, referring to structure coefficients (Kahn, 2006) is recommended while the use of pattern coefficients is recommended for the interpretation of factor loads (Brown, 2006; Costello & Osborne, 2005; Ho, 2006). In this respect, pattern coefficients were taken into consideration in the interpretation of factor loads in MOITIS items. When interpreting pattern coefficients, items with factor loads of .40 and over should be included in the scale and those with a load less than .40 should be excluded, which is considered as a good criterion (Stevens, 2009). Besides, in some cases, exclusion of an item whose factor loads are lower than .40 might harm the content validity of the scale and the construct to be measured may be incomplete. In such cases, taking .30 value as a criterion for factor load is recommended (Bordens & Abbott, 2011; Martin & Newell, 2004; Pallant, 2005; Schriesheim & Eisenbach, 1995; Stangor, 2010; Tavsancıl, 2010). In cases where there are more than one item measuring the same feature, .50 value can be taken as a criterion in order to measure the factors more precisely (Kahn, 2006) and contribute to the practicality of the scale (DeVellis, 2003; Kahn, 2006; Leech, Barlett & Morgan, 2005) On the basis of factor load criteria, it was not deemed necessary to exclude any items from MOITIS. The *common variance values related to the measured variable* (Communalities, h^2), which were found as a result of the factor analysis confirm that there is no need to exclude any item from the scale. The common variance value of the measured variable is the degree of common variance shared with other variables (Hair, Black, Babin & Anderson, 2010). In factor analysis, it is recommended that items with low common variance should be excluded from the instrument (Kalaycı, 2010). When interpreting common variance values, it is generally agreed that the value of .50 should be taken as a criterion (Thompson, 2004). However, in social sciences it is sometimes not possible to obtain high common variance values. Therefore, Costello and Osborne (2005) argue that taking the value of .40 as a criterion is a better choice. As for Tabachnick and Fidell (2001), they explain that items with common variance of .20 and lower point to heterogeneity among items (Cokluk, Sekercioglu & Buyukozturk, 2012). In this view, the criterion related to common factor variance should be set as .20 (Sencan, 2005). The factor variance values of the items in MOITIS vary between .31 and .68. Since the values related to items' common variance are over .20, it was not necessary to exclude any items from the scale. Findings of the EFA are presented in Table 1.

Table 1. MOITIS EFA Results

Item No.	Factor 1: Entity Theory PC	SC	Factor 2: Incremental Theory PC	SC	h^2
ITEM1	**.643**	.641	.007	-.165	.412
ITEM2	**.770**	.761	.033	-.173	.580
ITEM3	**.837**	.823	.053	-.172	.680
ITEM4	**.553**	.582	-.111	-.259	.351
ITEM5	**.542**	.554	-.043	-.188	.308
ITEM6	**.534**	.623	-.042	-.129	.390
ITEM7	-.108	-.307	**.744**	.773	.608
ITEM8	-.004	-.197	**.720**	.721	.520
ITEM9	.134	-.077	**.790**	.754	.585
ITEM10	-.014	-.179	**.615**	.619	.383
ITEM11	-.051	-.236	**.690**	.703	.497
Total Variance Explained 48.30%	30.71%		17.60%		

PC=Pattern coefficients, SC=Structure coefficients, h^2= Common variance related to the measured variables

Confirmatory Factor Analysis (CFA): CFA was performed in order to determine whether the 11 items obtained in EFA and the two-factor structure has satisfactory goodness of fit indices and to obtain additional evidence for the structure validity of MOITIS. A lot of goodness of fit indices have been used for examining the efficiency of the model tested in CFA. In the present study, Chi-Square Goodness, Goodness of Fit Index (GFI), Adjustment Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), Non-Normed Fit Index (NNFI), Relative Fit Index (RFI), Incremental Fit Index (IFI),Root Mean Square Error of Approximation

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(RMSEA), Standardized Root Mean Square Residual (SRMR), Parsimony Normed Fit Index (PNFI) and Parsimony Goodness of Fit Index (PGFI) were examined for DFA. As in sample size, the criteria for goodness of fit indices is a much debated issue (Wetson & Gore, 2006). As such, generally .90 is considered to refer to acceptable fit and .95 refers to perfect fit for the indices of GFI, CFI, NFI, NNFI, RFI and IFI (Bentler, 1980; Bentler & Bonett, 1980; Marsh, Hau, Artelt, Baumert & Peschar, 2006). With regard to AGFI, the value of .85 refers to acceptable fit and .90 refers to perfect fit (Schermelleh-Engel & Moosbrugger, 2003). As for RMSEA, the value of .08 is considered to refer to acceptable fit, while .05 refers to perfect fit (Brown & Cudeck, 1993; Byrne & Campbell, 1999). With regard to SRMR, the value of .05 refers to perfect fit and .10 refers to acceptable fit (Hu & Bentler, 1999; Kline, 2011). PNFI and PGFI goodness of fit indices over .50 refer to acceptable fit (Meyers, Gamst & Guarino, 2006) and .95 and over refer to perfect fit (Meydan & Sesen, 2011). In CFA, the goodness of fit indices were examined and the minimum value of χ^2 (χ^2=90.59, N=304, p=.00) was found to be significant. As for the goodness of fit index values, they were found to be GFI=.95, AGFI=.92, CFI=.96, NFI=.93, NNFI=95, RFI=.91, IFI=.96, RMSEA=.060, SRMR=.057, PNFI=.73, PGFI=.62. The acceptable and perfect values for the goodness of fit indices, goodness of fit index values obtained in CFA and the related results are presented in Table 2.

Table 2. The Acceptable and Perfect Goodness of Fit Index Values and the Goodness of Fit Indices from CFA

Examined Goodness of Fit Indices	Perfect Fit Criteria	Acceptable Fit Criteria	Findings of CFA	Result
X^2/sd	$0 \leq X^2/sd \leq 2$	$2 \leq X^2/sd \leq 3$	2.11	Acceptable Goodness of Fit
GFI	.95 ≤ GFI ≤ 1.00	.90 ≤ GFI ≤ 95	.95	Perfect Goodness of Fit
AGFI	.90 ≤ AGFI ≤ 1.00	.85 ≤ AGFI ≤ .90	.92	Perfect Goodness of Fit
CFI	.95 ≤ CFI ≤ 1.00	.90 ≤ CFI ≤ .95	.96	Perfect Goodness of Fit
NFI	.95 ≤ NFI ≤ 1.00	.90 ≤ NFI ≤ .95	.93	Acceptable Goodness of Fit
NNFI	.95 ≤ NNFI ≤ 1.00	.90 ≤ NNFI ≤ .95	.95	Perfect Goodness of Fit
RFI	.95 ≤ RFI ≤ 1.00	.90 ≤ RFI ≤ .95	.91	Acceptable Goodness of Fit
IFI	.95 ≤ IFI ≤ 1.00	.90 ≤ IFI ≤ .95	.96	Perfect Goodness of Fit
RMSEA	.00 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .08	.060	Acceptable Goodness of Fit
SRMR	.00 ≤ SRMR ≤ .05	.05 ≤ SRMR ≤ .10	.057	Acceptable Goodness of Fit
PNFI	.95 ≤ PNFI ≤ 1.00	.50 ≤ PNFI ≤ .95	.73	Acceptable Goodness of Fit
PGFI	.95 ≤ PGFI ≤ 1.00	.50 ≤ PGFI ≤ .95	.62	Acceptable Goodness of Fit

The perfect and acceptable goodness of fit criteria in Table 2 demonstrate that the two-factor model has satisfactory goodness of fit. The factor loads related to the two-dimensional model are presented in Figure 2. As can be seen in Figure 2, the factor loads range between .39 and .86 for the Entity Theory subdimension and between .49 and .75 for the Incremental Theory subdimension.

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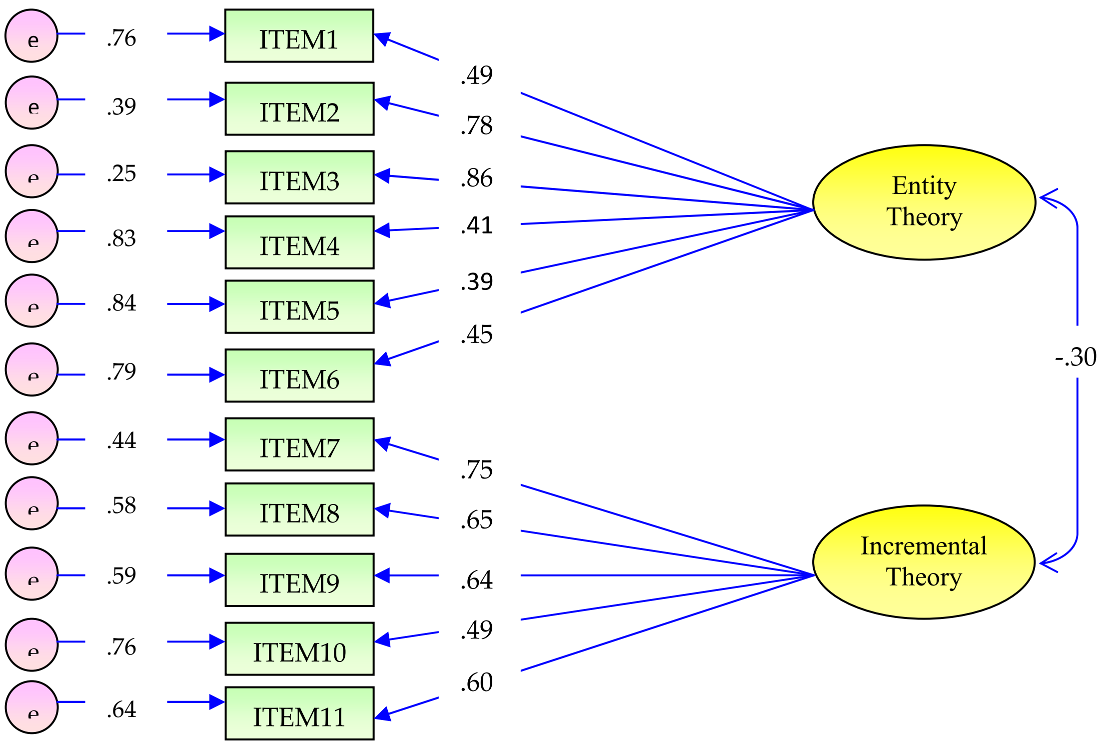

Figure 1. MOITIS Path Diagram and Factor Loads

The standard error, t and R^2 values related to the two-factor model obtained as a result of CFA are presented in Table 3.

Table 3. Standard Error, t, and R^2 Values related to MOITIS

ITEMS		SE	t	R^2
Factor 1: Entity Theory				
ITEM1	You have a certain level of mathematical intelligence and there is no way to change this.	.077	8.39**	.24
ITEM2	You can learn new things in mathematics, but cannot change your mathematical intelligence.	.067	14.52**	.61
ITEM3	People are born with fixed mathematical intelligence and cannot change this intelligence level throughout their lives.	.066	16.54**	.65
ITEM4	Your mathematical intelligence determines your achievement in maths.	.067	6.84**	.17
ITEM5	The fact that you make a lot of effort for solving a mathematics problem indicates that your mathematical intelligence is unsatisfactory.	.071	6.58**	.16
ITEM6	An individual who is unsuccessful in mathematics should question his/her mathematical intelligence.	.068	7.85**	.21
Factor 2: Incremental Theory				
ITEM7	You can improve your mathematical intelligence by studying.	.071	13.16**	.56
ITEM8	Novel knowledge that you learn in mathematics can contribute to the development of your mathematical intelligence.	.071	11.07**	.42
ITEM9	Completing a mathematics assignment with success may contribute to developing your mathematical intelligence.	.069	11.01**	.41
ITEM10	Making good preparation before making a mathematics assignment is a way of improving your intelligence.	.072	8.02**	.24
ITEM11	One who is unsuccessful when solving a mathematics problem should continue believing in his/her mathematical intelligence.	.077	10.15**	.36

SE=Standard Error, **p<.001

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Analysis of Table 3 reveals that the t values range between 6.58 and 16.54 for the Entity Theory subscale and between 8.02 and 13.16 in the Incremental Theory subscale, which are significant for all items in the scale. Insignificant t values imply that the related items should be excluded from the model or the number of participants is unsatisfactory for factor analysis (Byrne, 2010). Therefore, the t values obtained as a result of CFA confirm that the number of participants is satisfactory for the factor analysis and it is not necessary to exclude any item from the model.

Criterion-Related Validity

A look at the literature on implicit theory of intelligence demonstrates that there is a negative relationship between entity theory and academic success while there is a positive relationship between incremental theory and academic success (Carr & Dweck 2011). On the basis of this, within the scope of MOITIS' criterion-related validity, a correlation was found between students' subscale scores and mathematics achievement. Students' mathematics grades belonging to the previous term (2012 Fall) were taken as their mathematics achievement grades. The hypothesis that there is a negative relationship between entity theory and mathematics achievement and that there is a positive relationship between incremental theory and mathematics achievement was tested. As a result of the correlation analysis, a negative relationship was found between entity theory [$n=304$, $r=-.36$, $p<.001$] and mathematics achievement and a positive relationship was found between incremental theory and mathematics achievement [$n=304$, $r=-.45$ $p<.001$]. These findings can be evaluated as proof for the criterion-related validity of MOITIS.

Reliability

The reliability of MOITIS was calculated by means of internal consistency and test-retest reliability methods. The internal consistency coefficients were found to be .75 for the Entity Theory subscale and .76 for the Incremental Theory subscale. In order to determine the scale's test-retest reliability, two sessions were administered to 91 students with an interval of two weeks. In order to maintain reliability between the first and second administration, the correlation between the scores of the two administrations was calculated. The test-retest reliability coefficient was .96 for the Entity Theory subscale and .93 for the Incremental Theory subscale. Considering the fact that scales with a reliability coefficient of .70 and over are considered to be reliable (Domino & Domino, 2006; Fraenkel, Wallend & Hyun, 2012; Leech, Barlett & Morgan, 2005; Pallant, 2005; Tezbasaran, 1997; Urbina, 2004) it could be argued that the obtained reliability coefficients are satisfactory. Results of the reliability analysis are presented in Table 4.

Table 4. MOITIS Reliability Coefficients calculated by means of Internal Consistency, Test Retest Methods

Subscales	Internal Consistency (Cronbach's Alpha)	Test Retest Test
Entity Theory	.75	.96
Incremental Theory	.76	.93

Item Analysis

In order to determine the discriminatory power of the MOITIS items and the predictive power of the total score, corrected item total correlation was calculated and the upper and lower 27% groups were compared. Pearson Moments Product Correlation was used in the calculation of corrected item total correlation. In the 27% upper and lower group comparisons, independent samples t test was used. Findings of the item analysis and the arithmetic mean and standard deviation values related to the items are presented in Table 5.

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Table 5. MOITIS Item Analysis Results

Subdimension	Item No.	Mean	SD	Scale's Alpha with Excluded Item	Corrected Item Total Correlation	t	
Entity Theory N=304 Cronbach's Alpha=.75	ITEM1	2.61	1.324	.727	.460	15.88**	df=167 $^{**}p$<.001
	ITEM2	2.44	1.252	.695	.567	15.43**	
	ITEM3	2.43	1.262	.669	.656	20.83**	
	ITEM4	1.90	1.130	.732	.432	15.77**	
	ITEM5	2.26	1.189	.741	.396	12.74**	
	ITEM6	2.82	1.160	.729	.444	11.47**	
Incremental Theory N=304 Cronbach's Alpha=.76	ITEM7	4.08	1.254	.692	.603	16.27**	df=171 $^{**}p$<.001
	ITEM8	3.77	1.224	.718	.532	12.89**	
	ITEM9	3.63	1.183	.708	.563	12.97**	
	ITEM10	3.90	1.175	.751	.433	11.04**	
	ITEM11	3.94	1.308	.722	.522	13.77**	

Table 5 shows that the t values related to the upper and lower 27% groups range between 11.47 and 15.88 in the Entity Theory subscale (sd=167, p<.001) and between 11.04 and 16.27 in the Incremental Theory subscale (sd=171, p<.001). In addition, according to Table 5, the results of item total correlation range between .40 and .66 for the Entity Theory subscale and between .43 and .60 for the Incremental Theory subscale. The fact that the item total correlation is .30 and over (Akbulut, 2010; Buyukozturk, 2010; Field, 2009; Nunnally &Bernstein, 1994) in addition to the significant t values related to the upper-lower group differences can be regarded as evidence for the item's discriminatory (Erkus, 2012; Tezbasaran, 1996). According to these criteria, it could be argued that all of the items in the scale are discriminatory.

Evaluation of the MOITIS scores

There are 11 items in MOITIS. A five-point Likert type scale grading was used where (5) refers to "Definitely disagree" and *(1) refers to "Definitely agree"* The scale has two dimensions: Entity Theory and Incremental Theory. Since there are 6 items in the entity theory subscale, the highest score to be obtained is 30 and the lowest score is 6. Since there are 5 items in the Incremental Theory subscale, the highest score to be obtained is 25 and the lowest score is 5. The increase in the subdimensions of MOITIS implies that students have higher level beliefs in the related subdimension.

Discussion and Conclusion

The present study aims to develop MOITIS which can measure students' beliefs of mathematical intelligence in a reliable and valid way. In the development of MOITIS, the entity and incremental implicit intelligence theories were taken into consideration. There were 11 items, 6 reflecting the Entity Theory dimension and 5 reflecting the Incremental Theory dimension. Experts were consulted in order to obtain information on content and face validity. In line with the experts' opinions, it was not deemed necessary to exclude or add any items to the scale. The 11 items in the scale were graded in five-point Likert type scale where (1) referred to I definitely agree and (5) referred to I definitely disagree.

EFA and CFA were applied in order to maintain the construct validity of MOITIS. As a result of EFA, a two-factor structure explaining 48.30% of the total variance was obtained. Considering the content of the items in the factors and the theoretical structure, the first factor was named Entity Theory while the second factor was named Incremental Theory. In order to understand whether the two-factor structure gives sufficient goodness of fit indices, and to obtain additional evidence for the construct validity of MOITIS, CFA was applied. CFA findings revealed

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that the goodness of fit indices were sufficient for the two-factor structure of MOITIS. Considering that values of 30% and over are the criteria for the explained variance rates in EFA (Bayram, 2009; Buyukozturk, 2010) and the scale items' factor loads meet the lower limit of .30 (Buyukozturk, 2010; Costello & Osborne, 2005; Foster, 2002; Pallant, 2005; Schriesheim & Eisenbach, 1995) and the goodness of fit indices obtained in CFA are within acceptable borders, it could be argued that MOITIS has satisfactory construct validity.

For the criterion related validity of MOITIS, the correlation between students' subscale scores and mathematics achievement was calculated. Students' mathematics grades from the previous semester were regarded as their mathematics achievement scores. The correlation analyses showed that the relationship between students' beliefs of mathematical intelligence and mathematics achievement is in line with the implicit intelligence theory literature. The fact that criterion-related validity findings support implicit theory of intelligence can be regarded as additional evidence for the criterion-related validity of MOITIS.

The reliability of MOITIS was examined by means of internal consistency and test-retest methods. The internal consistency coefficients were .75 for the Entity Theory and .76 for the Incremental Theory. As for the test-retest reliability coefficients, they were found to be .96 for the Entity Theory subscale and .93 for the Incremental Theory subscale. Scales with a reliability coefficient of .70 and over are regarded to be reliable (Anastasi, 1982; Muijs, 2004; Nunnaly & Bernstein, 1994; Sipahi, Yurtkoru & Cinko, 2010; Stangor, 2010); therefore, the calculated internal consistency and test-retest values can be considered as evidence for the reliability of the scale. An analysis of MOITIS' reliability coefficient reveals that the scale's test-retest coefficients are higher than internal consistency coefficients. The fact that beliefs are structures which are shaped over a long period of time and resist change (Nespor, 1987) might explain why MOITIS' test-retest reliability coefficients are higher than that of the internal consistency coefficients.

An item analysis was conducted in order to determine MOITIS items' predictive and discriminatory power. Item total correlation was analyzed in the item analysis and the 27% upper and lower level groups were compared. As the end of the analysis, item total correlations ranged between .40 and .66 in the Entity Theory subscale and between .43 and 60 in the Incremental Theory subscale and the t values related to the 27% upper and lower group differences were found to be significant These findings point to the discriminatory power of all MOITIS items.

The findings from the statistical analyses performed in order to examine the psychometric characteristics of MOITIS reveal that it is a valid and reliable instrument for determining students' beliefs of mathematical intelligence. To conclude, the present study aimed to contribute to the literature with the two-factor structure MOITIS, which is line with the theoretical framework of implicit intelligence theory and thus a satisfactory measurement instrument was devised for measuring students' beliefs of mathematical intelligence.

Suggestions

The literature shows that the measurement instrument used for measuring mathematics-oriented implicit theory of intelligence has a one-factor structure rather than a two-dimensional theoretical framework. In the present study a two-factor MOITIS was developed which is in line with entity and incremental theories; therefore, this study is highly significant and it is believed that it will fill the gap in the literature. However, the fact that the research is limited to high school students necessitates analysis of the scale's factor structure with other student groups. In this respect, different samples should be analyzed so that the scale's reliability and validity can be maintained.

In the present study, within the scope of the criterion-related validity analysis of MOITIS, the relationship between students' MOITIS scores and mathematics achievement was examined. Analysis of the literature related to implicit theory of intelligence demonstrates that individuals' beliefs of intelligence influence their achievement goal orientations (Cury, Elliot, Da Fonseca & Moller, 2006; Knee, 1998; Robins & Pals, 2002), learning approaches (Dahl, Bals & Turi, 2005; Stipek & Gralinski, 1996; Vermetten, Lodewijks & Vermunt, 2005), exam anxiety (Cury, Elliot,

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Da Fonseca, & Moller, 2006; Dweck & Sorich, 1999; Stipek & Gralinski, 1996), sources of motivation (Carr & Dweck 2011; Dweck, 1986) and risk-taking behaviours (Dweck & Leggett, 1988). On the basis of this, more studies are needed for investigating the relationship between learning approaches, exam anxiety, motivation and academic risk-taking behaviour in order to obtain additional evidence on the scale's criterion-related validity. Further studies on MOITIS will contribute to the measurement power of the scale.

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