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Investigating “The Old Stereotype” about Boys/Girls and Mathematics: Gender Differences in Implicit Theory of Intelligence and Mathematics Self-Efficacy Beliefs

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Abstract

The implicit theory of intelligence postulates that an individual’s main beliefs about the fixed or malleable nature of intelligence have the power to determine the ways she or he acts in school settings and engages in learning. Some individuals tend to believe that a person is born with a certain fixed amount of intelligence that is uncontrollable and cannot be changed through effort (an entity theory). Others view intelligence as a malleable and controllable quality that can be developed through learning and study (an incremental theory). Research has found that the one’s dominant implicit theory of intelligence has important consequences for goal orientation, attributions, affect and behavior in school context. Perceived self-efficacy is defined as people’s beliefs about their capabilities to obtain an expected level of performance. In school, self-efficacy beliefs determine how students feel, think, motivate themselves and behave. Several studies have shown significant differences between male and female students in mathematics self-efficacy. The aims of this study are: 1. to investigate a possible relation between students’ implicit theories of intelligence and their mathematics self-efficacy beliefs; 2. to investigate gender differences in implicit theories of intelligence and mathematics self-efficacy beliefs. The participants were 108 college students aged 14 to 18 years, 63 females and 45 males. The assessment instruments were: The Implicit Theory of Intelligence Scale (ITIS; Abd-El Fattah & Yates, 2005); The Mathematics-Oriented Implicit Theory of Intelligence Scale (MOITIS); The Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) (May, 2009). The overall results showed significant gender differences in both constructs (dominant implicit theory of intelligence and mathematics self-efficacy beliefs). Significant correlations between implicit theories of intelligence and mathematics self-efficacy beliefs were observed. The results are discussed in a cultural, social and educational context. Implications for learning are also discussed.

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1. Introduction

Empirical studies conducted by Dweck et al. over several decades (Dweck, 1999; Dweck & Leggett, 1988; Dweck, Chiu & Hong, 1995; Dweck & Molden, 2005) have led to the conclusion that peoples’ beliefs and theories about themselves (self-theories) shape their goal orientation, thoughts, feelings, and academic behavior, performance, and the whole personality. Culture and society have decisive roles in the construction of peoples’ self-theories. Human attributes like intelligence or personality are viewed by some people as being, to a large extent, fixed and innate while they are viewed by others as being changeable with appropriate motivation, personal effort, social, and educational opportunities.

The implicit theories of intelligence are sets of personal beliefs about the nature of intelligence. Dweck and her colleagues (Dweck, 1986; Dweck & Leggett, 1988; Dweck & Master, 2008) have identified two contrasting patterns of conceptualizing intelligence, structured around two opposite core beliefs: intelligence is either viewed as a fixed entity genetically inherited, or it is viewed as a malleable and developing attribute. More concretely, some people tend to believe that a person is born with a certain fixed amount of intelligence that is uncontrollable and cannot be changed through effort (an entity theory). Others view intelligence as a malleable and controllable quality that can be developed through learning and study (an incremental theory). According to Dweck and Master (2008) both types of theories tend to be equally popular in children and young people from North American and European cultures, since statistical data indicate that approximately 40% of those populations endorse an entity theory of intelligence, about 40% endorse an incremental theory and the rest of 20% are undecided. These general statistical data raise multiple questions regarding the personal and contextual factors—such as learning experiences or sociocultural variables—that might exert determinant influences in favour of the crystallisation of an entity or an incremental view about intelligence. The same authors (Dweck & Master, 2008) agree that, in general, the implicit theory of intelligence an individual endorses tends to be relatively stable over time. However, this implicit theory can be challenged with targeted educational interventions (e.g. Niiya, Crocker & Bartmess, 2004; after Dweck & Master, 2008). People can hold different types of implicit self-theories for different domains of life or personal attributes. For example, a person could believe that logical or mathematical intelligence is innate and stable over time (an entity theory) but verbal or kinaesthetic/athletic aptitudes are malleable and can be considerably improved by guided practice (an incremental theory) (Dweck, Chiu & Hong, 1995; Dweck & Master, 2008). From their early studies on this topic, Dweck et al. (Dweck, 1986; Dweck & Leggett, 1988, Dweck & Sorich, 1999) have used the opposite constructs of entity versus incremental theory of intelligence to explain the different attitudes about learning observed in students with comparable levels of aptitudes, competences and performances.

In the last decades convincing empirical data have been gathered that attest the existence of statistically significant correlations between students’ dominant implicit theory of intelligence and their academic performances, motivation, goal orientation, attributions for success or failure, determination to cope with academic difficulties, learning strategies, performance anxiety, self-esteem, personal implication and autonomy in learning (Leonardi & Gialamas, 2002; Robins & Pals, 2002; Dahl, Bals & Turi, 2005; Dupeyrat & Marine, 2005; Cury, Elliot, Da Fonseca, & Moller, 2006; Blackwell, Trzesniewski & Dweck, 2007; Dweck & Master, 2008; Mango, 2012; Ilhan & Cetin, 2013). Research has found that students who hold an entity theory of intelligence are performance-oriented in learning, they tend to compare with their colleagues and use social comparisons as a criterion for success, they prefer to engage in tasks that can be completed fast and in an easy way, giving them the opportunity to show their competence and efficacy to the others. They prefer to adopt routines and well-know strategies in problem solving; they are self-defeating and less creative. They tend to avoid new, difficult or challenging tasks. In a case of failure they question their own abilities and competences and believe that their lack of intelligence caused the undesirable result. They are prone to fail into patterns of helplessness placing themselves at risk for underachievement. By contrast, students that hold an incremental theory of intelligence are oriented towards mastery-goals in learning and they are motivated to improve their abilities and competencies. They are willing to engage in solving new and difficult tasks and view them as opportunities to learn and gain competences. In a case of failure they actively try to manage the situation, to reconsider their methods and strategies, they are willing to struggle for success and feel less anxiety of performance compared with their counterparts. They are more autonomous and self-directed in learning, they are ready for sustained effort in order to obtain a desired result and they are more creative (Dweck & Master, 2008; Dweck, 1986; Dweck & Leggett, 1988; Ilhan & Cetin, 2013).

Several authors argue that, in mathematics, students as well as teachers tend to adopt the entity theory of intelligence more often compared with the incremental theory (Beach & Dovemark, 2007; Jonsson, Beach, Korp &
Gender differences in implicit theories of intelligence were highlighted in some studies (Hendricks, 2012). For example, in an illustrative study conducted by Henderson and Dweck (1990), eighth-grade boys with high academic performances were more likely to have an incremental theory of intelligence while girls with similar ages and academic performances were more likely to have an entity view of intelligence (after Hendricks, 2012).

Perceived self-efficacy is defined as peoples’ beliefs about their capabilities to obtain an expected level of performance (Bandura, 1994, Schunk, 1991; Pajares & Graham, 1999). In the school/academic context, perceived self-efficacy influences the way the students learn, engage in learning and in classroom activities, motivate themselves, make decisions, feel and behave (Hacket & Betz, 1989). According to Zimmerman (2000) students with a strong sense of self-efficacy “participate more readily, work harder, persist longer, and have fewer adverse emotional reactions when they encounter difficulties than do those who doubt their capabilities”. Gender differences in mathematics self-efficacy were documented in a number of studies (Pajares, 1997; Louis & Mistele, 2012).

2. Aims

The aims of this study were: 1). to investigate a possible relation between students’ implicit theories of intelligence (general and domain-specific) and their mathematics self-efficacy beliefs; 2). to investigate gender differences in implicit theories of intelligence (general and domain-specific) and mathematics self-efficacy beliefs.

3. Method

3.1. Participants

A total number of 108 high school students were included in this study; 63 were girls and 45 were boys, aged between 14 and 18 years. They were selected from a technical high school in Alba Iulia, Romania.

3.2. Instruments

The students’ general implicit theories of intelligence were investigated with the Implicit Theory of Intelligence Scale (ITIS). The ITIS was developed by Abd-El-Fattah and Yates (2005) to measure individuals’ implicit theories of intelligence. The scale consists of 14 items, 7 of them reflecting the entity theory while the other 7 reflecting the incremental theory. Participants rate their agreement or disagreement with each item/statement on a 4-point Likert type scale that ranges from 1 (Strongly Disagree) to 4 (Strongly Agree). Sample statements are “You have a certain amount of intelligence and you cannot do much to change it” for entity theory or “You can develop your intelligence if your really try” for incremental theory.

The domain-specific/mathematics-oriented implicit theories of intelligence were investigated with the Mathematics-Oriented Implicit Theory of Intelligence Scale (MOITIS). The MOITIS was developed by Ilhan and Cetin (1995) on the basis of the Implicit Theory of Intelligence Scale, originally developed by Dweck, Chiu & Hong (1995). The scale consists of 11 items, 6 items representing the entity theory while 5 items represent the incremental theory. Participants rate their agreement or disagreement with each item/statement on a 5-point Likert type scale that ranges from 1 (I definitely disagree) to 5 (I definitely agree). Sample statements are “You can learn new things in mathematics, but cannot change your mathematical intelligence” for entity theory or “One who is unsuccessful when solving a mathematics problem should continue believing in his/her mathematical intelligence” for incremental theory.

The Mathematics Self-Efficacy beliefs were investigated with an adapted version the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEQ). The MSEQ was developed by May (2009) as a reliable psychometric instrument designed to assess high school students’ mathematics self-efficacy and mathematics anxiety. The questionnaire consists of 29 items, 14 items assessing mathematics self-efficacy and 15 items assessing mathematics anxiety. Participants rate their agreement/disagreement with each statement or they rate how frequently each item/statement describes their state (feelings or beliefs) on a 5-point Likert type scale that ranges from 1 (Never) to 5 (Usually). Sample statements are “I believe I can do well on a mathematics test” for the mathematics self-efficacy
subscale or “I worry that I will not be able to get a good grade in my mathematics class” for the mathematics anxiety subscale.

4. Results

For each variable I investigated in the study sample, i.e., 1) Implicit theories of intelligence; 2) Mathematics-oriented implicit theories of intelligence; 3) Mathematics self-efficacy and 4) Mathematics anxiety, I analyzed gender differences. SPSS was used for processing the empirical data. The gender differences for the above mentioned variables were tested using the Student t-test for independent groups. The results are presented in Table 1.

Table 1. Differences in general and domain-specific implicit theories of intelligence as well as in Mathematics’ self-efficacy and Mathematics’ anxiety between high school girls and boys

<table>
<thead>
<tr>
<th></th>
<th>Female students</th>
<th>Male students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implicit Theories of Intelligence (ITIS)</td>
<td>Mean = 6.74; SD = 2.34</td>
<td>Mean = 4.60; SD = 1.77</td>
</tr>
<tr>
<td>t = 2.91, p &lt; .07</td>
<td></td>
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<tr>
<td>Mathematics-Oriented Implicit Theory of Intelligence (MOITIS)</td>
<td>Mean = 8.79; SD = 2.08</td>
<td>Mean = 6.98; SD = 3.14</td>
</tr>
<tr>
<td>t = 1.55, p &lt; .68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics Self-Efficacy (MSEAQ)</td>
<td>Mean = 26.66</td>
<td>Mean = 43.11</td>
</tr>
<tr>
<td>t = 1.89, p &lt; .061</td>
<td></td>
<td></td>
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<tr>
<td>Mathematics Anxiety (MSEAQ)</td>
<td>Mean = 31.36</td>
<td>Mean = 16.82</td>
</tr>
<tr>
<td>t = 1.87, p &lt; .064</td>
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</tbody>
</table>

* Global scores have been obtained by adding up individual scores; the scores obtained at the incremental theory subscale are reverse coded; ** Global scores have been obtained by adding up individual scores

The Independent Samples t-test calculations indicate significant differences between male and female students in the mean scores obtained at the Implicit Theories of Intelligence Scale (ITIS, t = 2.91, p < .07), in the sense that female students seem more likely to adopt an entity theory and male students an incremental theory. For the Mathematics-Oriented Implicit Theories of Intelligence Scale (MOITIS) global scores are visibly higher, suggesting that students of both genders tend to hold an entity perspective. Perceived self-efficacy in mathematics is more pronounced in male students compared with the female ones (t = 1.89, p < .06) and mathematics anxiety is significantly higher in female students (t = 1.87, p < .06).

Table 2. Pearson correlations between the general and Mathematics-Oriented Implicit of Intelligence and Mathematics Self-Efficacy beliefs in high school students (N = 108)

<table>
<thead>
<tr>
<th></th>
<th>Implicit Theories of Intelligence (ITIS scores)</th>
<th>Mathematics-Oriented Implicit Theory of Intelligence (MOITIS scores)</th>
<th>Mathematics Self-Efficacy (MSEAQ scores)</th>
<th>Mathematics Anxiety (MSEAQ scores)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implicit Theories of Intelligence</td>
<td>1</td>
<td>p = 0.267</td>
<td>p = 0.219</td>
<td>p = 0.094</td>
</tr>
<tr>
<td>t = .005**</td>
<td></td>
<td>t = .023*</td>
<td>t = .334</td>
<td>t = .334</td>
</tr>
<tr>
<td>Mathematics-Oriented</td>
<td>p = 0.267</td>
<td>1</td>
<td>p = 0.193</td>
<td>p = 0.149</td>
</tr>
<tr>
<td>Implicit Theory of Intelligence</td>
<td>t = .005**</td>
<td>t = .046*</td>
<td>t = .123</td>
<td>t = .001**</td>
</tr>
<tr>
<td>Mathematics Self-Efficiency</td>
<td>p = 0.219</td>
<td>p = 0.193</td>
<td>1</td>
<td>p = 0.334</td>
</tr>
<tr>
<td>t = .023*</td>
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</tr>
<tr>
<td>Mathematics Anxiety</td>
<td>p = 0.094</td>
<td>p = 0.149</td>
<td>p = 0.334</td>
<td>1</td>
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</tbody>
</table>

5. Conclusions

The overall results show significant gender differences in the students’ general implicit theories of intelligence and mathematics self-efficacy beliefs. Girls tend to hold an entity theory of intelligence and, compared with the boys, they feel less efficacious and competent in mathematics. Significant correlations between the implicit theories of
intelligence and mathematics self-efficacy beliefs have been observed, in a sense that students’ with strong self-efficacy beliefs tend to hold an incremental perspective about intelligence.

References