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# The Investigation of the Relationship Between Mathematical Connection Skills and Self-Efficacy Beliefs*

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**Abstract:** In this study, it is aimed to examine the relationship between mathematical connection skills and mathematical connection self-efficacy beliefs. The study group consists of 33 students who are in the 11th grade of a public high school in Ordu. The study is a relational study and data collection tools are Mathematical Connection Skill Test developed by the researchers and the Mathematical Connection Self-efficacy Scale developed by Özgen and Bindak (2018). The study of Mumcu (2018) was used for the theoretical framework of the Mathematical Connection Skill Test. In the analysis of the data, descriptive statistics and correlation analysis were used. As a result of the study, it has been found that there is a positive and significant relationship between the students' connection skills and self-efficacy beliefs. In addition, when the relations between the sub-dimensions of data collection tools are examined, it is seen that there is a low relationship between skills of mathematical connection with real life and self-efficacy of connection with real life, skill of connecting mathematics with different disciplines and self-efficacy of connecting with different disciplines than expected. Suggestions were made for the nature of teaching environments and different studies that could be done about this subject in the light of the results obtained from the work.

**Keywords:** mathematical connection skills, mathematical connection self-efficacy, high school students.

## INTRODUCTION

One of the general aims of teaching mathematics is to provide the mathematical knowledge that individuals need in their lives and the basic skills that enable them to use this knowledge in different areas of their life (Baki, 2014, p.34; Ministry of National Education [MoNE], 2013, p.1; National Council of Teachers of Mathematics [NCTM], 2000, p.4). In order to achieve this goal, students need to acquire basic mathematical skills such as being able to understand, interpret and

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use mathematical concepts and relationships among them, and to be able to connect mathematics with different fields and disciplines (Ball, 1990; Kinach, 2002; NCTM, 2000; Skemp, 1978; Vale, McAndrew & Krishnan, 2011; Van de Walle, 2013). In this context, skills of connection is clearly emphasized as one of the most important skills of learning and doing mathematics processes in current mathematics education program or standard documents (Chapman, 2012; MoNE, 2013).

Self-efficacy is a concept of judgments about how well individuals can perform the actions needed to cope with possible situations (Bandura, 1977). In many studies (Akbaş & Çelikkaleli, 2006, Cannon & Scharmann, 1996, Eggen & Kauchak, 1999, Gibson & Dembo, 1984, Guskey & Passaro, 1994; Riggs & Enochs, 1990, Savran and Çakıroğlu, 2001, Soodak & Podel, 1993; Woolfolk, Rosoff and Hoy, 1990), there is a positive relationship between self-efficacy beliefs and academic achievement. In case of connection skills, it is expected to be a positive relationship between self-efficacy beliefs of mathematical connection and the subject skills. From this point of view, it is aimed to investigate the relationship between the self-efficacy beliefs and the subject skills of the secondary school students in this study. The research questions of the study are as follows.

- What are the levels of students' mathematical connection skills?
- What are the levels of students' mathematical connection self-efficacy beliefs?
- Is there any significant relationship between students' connection skills and self-efficacy beliefs?
- Are there significant relationships between the subscales of connection skills and self-efficacy beliefs?

## METHOD

This is a relational study and convenience sampling from purposeful sampling methods were used in the study. The grade levels which the *function* concept is included in the curriculum and the selected students should be volunteered for the study were considered for determining the study group.

### Study Group

#### *The characteristics of the study group*

The study group consists of 33 secondary students who are in the 11th grade of a public school in Ordu. The number of girls and boys are 17 and 16 respectively.

### Data Collection Tools

*Mathematical Connection Skill Test* (CST) developed by the researchers and the *Mathematical Connection Self-efficacy Scale* (CSB) developed by Özgen and Bindak (2018) were used as data collection tools.

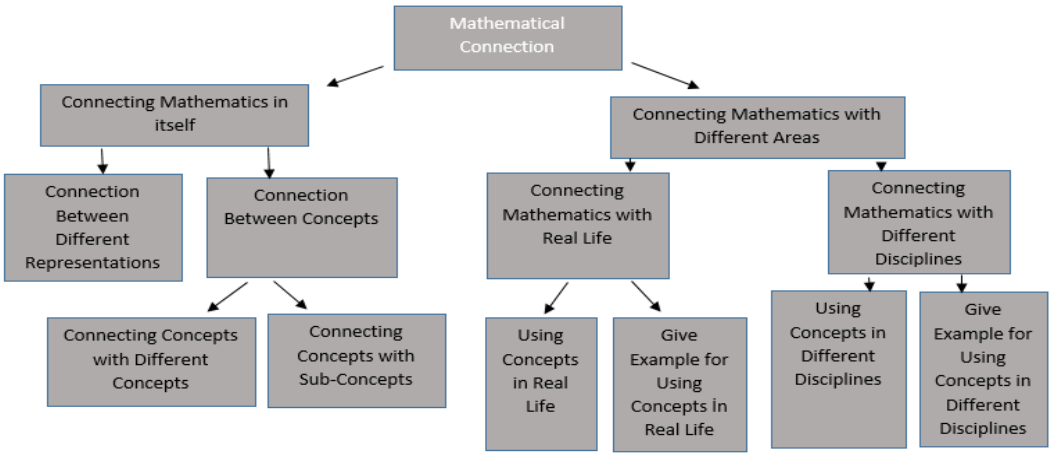
#### *Mathematical connection skill test (CST)*

CST, developed by the researchers, consists of four sub-dimensions and 11 questions in total. In developing these questions, the concept of function was chosen in particular. This is because of the close relation of the function concept with real life and many other mathematical ideas. However, it is suggested that the concept of function is used as a unifying and integrative way of

thinking in the field of mathematics education (NCTM, 1989, Altun, 1999; Brieske, 1973, Sajka, 2003, Selden and Selden, 1992).

The theoretical framework developed by Mumcu (2018) was used for the sub-dimensions of CST (Figure 1).

**Figure 1: Sub-Dimensions of Mathematical Connection**




According to this framework, sub-dimensions of mathematical connection skill are, *Connection Between Different Representation (CBDR)*, *Connection Between Concepts* (CBC), *Connection with Real Life (CwRL)* and *Connection with Different Disciplines (CwDD)*. In addition, the data in Table 1 are used in relation to the content of the questions in CST.

**Table 1: Content of CST**

| Dimensions of CST | Sub-Dimensions of CST | Content/Aim of the Questions | Number of Questions | Total Number of Questions |
|---|---|---|---|---|
| **CBDR** | | To be able to make connections between tables, diagrams, graphs and algebraic representations of functions. | 3 | **3** |
| **CBC** | Connecting with Sub-Conceps | Ability to select functions from given relationships<br>To be able to relate composite operation with function concept. | 2 | **3** |
| | Connecting with Different Concepts | To be able to use the concept of function in relation to the concept of arithmetic mean. | 1 | |
| **CwRL** | Using Mathematical Concepts in Real Life Situations | To be able to use function concept in real life situations. | 2 | **3** |
| | Give Example for Using Mathematical Concepts in Real Life Situations | To be able to give example for using function concept in real life situations | 1 | |
| **CwDD** | Using Mathematical Concepts in Different Disciplines | To be able to use function concept in different disciplines | 1 | **2** |
| | Give Example for Using Mathematical Concepts in Different Disciplines | To be able to give example for using function concept in different disciplines | 1 | |
| **General** | | | 11 | **11** |

***Mathematical connection self-efficacy belief scale (CSB)***

Developed by Ozgen and Bindak (2018), the CSB consists of five sub-dimensions and 22 items and is in the form of a five-point likert type scale. The sub-dimensions of the CSB can be expressed as *Difficulty* (D), *Using Mathematics* (UM), *Connecting Mathematics in Itself* (CII), *Connecting Mathematics with Real Life* (CwRL) and *Connecting Mathematics with Different Disciplines* (CwDD). Sub-dimensions include 6,5,5,3 and 3 items respectively.

## Data Analysis

The data obtained from the CST were evaluated as 1/0 for true / false answers and the data from the CSB were evaluated *for all times-most of the times-sometimes-rarely-never* as 5-4-3-2-1 respectively. The arithmetic mean reference interval (Kan, 2009, p. 407) was used for CST and CSB levels (low-intermediate-high). Correlation values between CST and CSB and their sub-factor were calculated and interpreted in accordance with the sub-problems of the study.

For the validity of the CST, two experts were consulted, and some expressions of some questions were changed accordingly. Equivalent half-way method was used for the reliability of the CST and the Spearman Brown reliability coefficient was calculated as 0.53 for half of the test and 0.70 for the general. The Cronbach alpha internal consistency coefficient of the CSB is 0.85 in the original study; and was calculated as 0.75 in this study.

## FINDINGS

### *Findings Obtained from CST*

Findings obtained from CST are given in Table 2.

**Table 2: Findings Obtained from CST**

| Sub-Dimensions of CST | Low | | Intermediate | | High | |
|---|---|---|---|---|---|---|
| | f | % | f | % | f | % |
| CBDR | 8 | 24,24 | 15 | 45,45 | 10 | 30,30 |
| CBC | 23 | 69,69 | 9 | 27,27 | 1 | 3,03 |
| CwRL | 26 | 78,78 | 6 | 18,18 | 1 | 3,03 |
| CwDD | 21 | 63,63 | 9 | 27,27 | 3 | 9,09 |
| CST General | 21 | 63,63 | 12 | 36,36 | - | - |

According to Table 2, most of the students (about 70%) were found to be at a moderate level in the CBC, CwRL, CwDD sub-dimensions and in CST general, and near half of them in the CBDR dimension.

### *Findings Obtained from CSB*

Findings obtained from CSB are given in Table 3.

**Table 3: Findings Obtained from CSB**

| Sub-Dimensions of CSB | Low | | Intermediate | | High | |
|---|---|---|---|---|---|---|
| | f | % | f | % | f | % |
| D | 2 | 6,06 | 21 | 63,63 | 10 | 30,30 |
| UM | 1 | 3,03 | 28 | 84,84 | 4 | 12,12 |
| CII | 3 | 9,09 | 24 | 72,72 | 6 | 18,18 |
| CwRL | 2 | 6,06 | 25 | 75,75 | 6 | 18,18 |
| CwDD | 4 | 12,12 | 27 | 81,81 | 2 | 6,06 |
| **CSB General** | **2** | **6,06** | **25** | **75,75** | **6** | **18,18** |

According to the data obtained from the CSB, most of the students were found to be moderately involved in the CSB and its sub-dimensions.

***Findings on the Relationship Between CST and CSB***

The results of the correlation analysis performed on the relationship between CST and CSB are given in Table 4.

**Table 4: The Correlation Analysis Results Between CST and CSB**

| | | BSB | CST |
|---|---|---|---|
| CSB | Pearson Correlation | 1 | .404* |
| | Sig. (2-tailed) | | .020 |
| | N | 33 | 33 |
| CST | Pearson Correlation | .404* | 1 |
| | Sig. (2-tailed) | .020 | |
| | N | 33 | 33 |
| *Correlation is significant at the 0.05 level (2-tailed). | | | |

According to the data in Table 4, there is a positive correlation between students' connection skills and self-efficacy beliefs (r = 0.04*, p <0,05). Accordingly, it can be said that the mathematical connection self-efficacy belief explains 16% of the subject performance.

***Findings on the Relationship Between Sub-Dimensions***

The results obtained from the correlation analysis between the sub-dimensions of CST and CSB were presented in Table 5.

**Table 5: Coefficients of Correlation Between Sub-Dimensions of CSB and CSB**

| | D | UM | CII | CwRL | CwDD | CSB General |
|---|---|---|---|---|---|---|
| CBDR | 0.058 | 0.252 | 0.348* | 0.200 | 0.155 | 0.309 |
| CBC | 0.211 | 0.296 | 0.337 | 0.064 | 0.327 | 0.410* |
| CwRL | 0.118 | 0.132 | 0.096 | 0.267 | 0.164 | 0.095 |
| CwDD | 0.294 | 0.117 | 0.197 | 0.387* | 0.177 | 0.193 |
| **CST General** | **0.103** | **0.324** | **0.402*** | **0.406*** | **0.331** | **0.404*** |

When the data in Table 5 were examined, positive and significant correlations were found between CBDR and CII self-efficacy, CwDD skill and CwRL self-efficacy, CST General and CII, CST General and CwRL, CST General and CSB General. On the other hand, there is a low relationship between skills of mathematical connection with real life and self-efficacy of connecting to real life, skills of connecting mathematics to different disciplines and self-efficacy of connecting to different disciplines than expected (r <0.30).

## DISCUSSION AND CONCLUSION

As a result of the study, it has been found that most of the students have difficulty using mathematical connection skills, especially in connecting the concept of function with different concepts and real life. This result is parallel to the results of different studies in the literature. The studies show that students and the prospective teachers have difficulties for using mathematical connection skills (Businskas, 2008; Dilberoğlu, 2015, Eli, 2009, Gülten, Ilgar and Gülten, 2009, Kızıloğlu and Konyalıoğlu, 2002, Leikin & Levav-Waynberg, 2007, Mumcu, 2018, Özgen, 2013a, 2013b; Taşdan, Uğurel and Koyunkaya, 2017).

However, it has been determined that students' conceptual knowledge about functions is restricted and they have misconceptions about this concept, which has a particularly important place in students' understanding of mathematics and relating with real life. In different studies, it is stated that students understand the concept of function very simply and primitively and have rooted

misconceptions (Davis, 1984; Narlı and Başer, 2008; Tall & Vinner, 1981). For overcoming these difficulties, it is important the curriculum has content which provides and evaluates the ways of students' functional thinking. In addition, it is suggested that the teachers adapt the function concept in real life situations and related nature events to the teaching environments with appropriate mathematical models in order to ensure that the students understand the function concept. Moreover, it is suggested that teachers show not only the operational but also the structural side, and the connections between different representations (such as algebraic, graphical or tables) of the concept (Ural, 2006).

At the end of the study, results were obtained which support the hypothesis which is the basis for this study. Accordingly, there was a positive relationship between the mathematical connection skills and the mathematical connection self-efficacy beliefs of the 11th grade students. Parallel to this result, PISA (2003; 2012) results are the most comprehensive studies carried out on this subject. In these studies, there are high and mid-level relation between self-efficacy beliefs towards mathematics and mathematics literacy levels of students in Turkey. In addition, it was found that the mathematical self-efficacy beliefs have an effect on mathematical performances at the rate of 26% and 19% respectively (OECD, 2004, MoNE, 2015). Similarly, in different studies (Eshel, Yohanan, Kohavi & Revital, 2003, Desoete, 2001, Mayer, 1998, Bouffard-Bounchard, Parent & Larivee, 1991, Pajares & Graham, 1999, Malpass, O'Neil, Harold & Hocevar, 1999; Üredi and Üredi, 2005) it is concluded that there was a high correlation between mathematics self-efficacy and mathematical achievements.

In order to improve students' mathematical connection performances, firstly they must learn mathematics meaningfully. For this reason, in mathematics learning environments, teachers should focus on the conceptual meanings and try to make meaningful learnings by connecting concepts with real life and different disciplines besides mathematics. As a result of this study, mathematical connection self-efficacy belief was found to express 16% of the connection performance. It is suggested for different studies in this subject, it is necessary to investigate the other factors which are effective in this performance and to determine the elements to support the development of these factors.

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