Investigating The Reflective Thinking Skills Of Students For Problem Solving

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Abstract
Being part of the German didactic tradition, reflective thinking was first coined by Wilhelm von Humboldt two-century ago. Reflective thinking helps individuals to develop strategies in order to overcome the problems that they encounter. Investigating the reflective thinking skills of students for problem solving is important to identify students that may need extra assistance to develop their reflective thinking skills. In this study, the reflective thinking skill level of secondary school students is investigated. The cross sectional survey design is used in this study. The data were collected from 297 middle school students who are in 6th, 7th and 8th grades in Zonguldak city center of Turkey. The scale measuring the reflective thinking skill towards problem solving was used for the data collection. The descriptive statistic, the one-way ANOVA and the Bivariate correlation were used for data analysis. Findings revealed that secondary school students' reflective thinking skill levels are above the average. However at the same time participating students' course grades for the math course and for the science and technology course were close to the maximum score. This shows that academically successful students' reflective thinking skill level tend to be high. Another significant finding of this study is that female students' reflective thinking skills are higher than male students' reflective thinking skills. The third finding of the study revealed that there is no correlation between the math course grades and the reflective thinking skills of the secondary school students. Similarly no correlation was found between the science and technology course grades and the reflective thinking skills of the secondary school students. However a statically significant relationship is found between the questioning skill level of the students and their course grades in the science and technology course. It is suggested that reflective thinking skill level should not be used as a predictor of the course grades for investigated courses for the study population. More research studies are needed to make generalizable conclusions about the relationship between the reflective thinking skills of the elementary school students and their academic achievement. The results of the study reveal that the reflective thinking skill of secondary school students are above the average but there is a room for improvement. It is also found that female students' reflective thinking skills are higher than the male students'. Moreover a statically significant relationship is found between the questioning skill level of the students and their course grades in the science and technology course. It is suggested that reflective thinking skill level should not be used as a predictor of the course grades for investigated courses.
Keywords: *Reflective thinking, problem solving skill, secondary education*

Introduction

Reflective thinking, one of the higher-order thinking skills, has been defined by Ünver (2003) as a way of thinking that aims to determine the factors that affect the learning level and methods of the individual, positively or negatively to solve the problems. Although it was Wilhelm von Humboldt, who spoke the concept of reflective thinking for the first time two centuries ago, John Dewey advocated that the concept of reflective thinking was developed in the early twentieth century by one of the primary priorities of the society, reflecting the knowledge that learners learned in school (Alp and Taşkın, 2008). Reflective thinking is a form of thinking that is associated with a progressive movement based on pragmatic philosophy and that is developing continuously. In 1933, Dewey defined reflective thinking as "any thought or knowledge, and an information structure that supports attainment of its intended results, in an effective coherent and careful way".

John Dewey stated that the reflective thinking process is made up of five stages without a specific order. These are the five stages:
1. Suggestions: Ideas and possibilities in the mind when an individual is confused with a complex situation. As proposals grow, the need to think more and more.
2. Problem: When an individual is confronted with a complex situation, he tries to see the big picture instead of small details.
3. Hypothesis formation: It is an effort to determine what is feasible by looking at the proposal. This phase ensures that you do not think more on information, purify the problem, the proposals are testable, measurable.
4. Reasoning: Information, ideas and experiences are intertwined to provide advice, hypothesis and testing.
5. Testing: A new problem may arise as well as existing probabilistic clarification (Kızılkaya & Aşkar, 2009).

Reflective thinking begins when a problem is recognized. It ends when the problem is resolved. In addition, there is

an aim to understand the problem well and solve it better in the process. Furthermore, the analysis and restructuring of the information in this way of thinking is the subject of question (Çubukçu, 2011). Identification of reflective thinking skills that will give pupils the opportunity to improve themselves after school and, if so, clarification of the development of these skills, will contribute to the solution of problems that students will encounter in real life.

The results of the studies in the literature about reflective thinking differ. When the results of the studies done in time are summarized chronologically; Özçallı (2007) conducted a study to investigate the relationship between teacher efficacy and reflective thinking. In the study it was also investigated whether an in-service education program change teachers' reflective thinking level. Quantitative and qualitative data were collected from 25 Turkish EFL teachers. Results of the study revealed that there is no relationship between the teacher efficacy and reflective thinking. It was also found that as a result of the in-service education program, teachers' reflective thinking did not change significantly.

In another study, Alp and Taşkın (2007) completed a study to determine the perspectives of primary school teachers about reflective thinking. Data related to the study were collected from 134 teachers working in primary education using a scale developed during the study. The results showed that the teachers did not know the concept of reflective thinking, but they were aware of the reflective thinking as part of the critical thinking and problem solving dimensions. In the study, the necessity of initiating in-service programs for teachers about reflective thinking was proposed.

Also, Baki, Güç and Özmen (2012) collected qualitative data from 10 pre-service teachers in order to determine the reflective thinking skills of primary school mathematics teacher candidates for problem solving. Qualitative data were obtained through observations. In order to reach the aim of the study, reflecting reflective thinking situations were determined by monitoring the teacher candidates participating in the activity. As a result of the study, it was found that the teacher candidates were focused on solving the given problem as soon as possible and the reflective thinking skills were found to be at a low level in the dimensions of questioning, reasoning and solution stages of the problem.

In the study, Baş (2013) collected data from 254 elementary school students by using the screening model to examine the relationship between the reflective thinking skills of the elementary school students for problem solving and their academic achievement in science and technology course using the structural equation model. The results of the study showed that the sub-dimensions of the questioning, reasoning and evaluation of the reflective thinking skills scale for problem solving were an important predictor of their academic achievement.

Kaplan, Doruk and Ozturk (2017) collected data from 31 gifted students using mixed research method to investigate the reflective thinking skills of gifted students for problem solving. At the end of the study, it was found that the reflective thinking skills of the gifted students towards problem solving were at a high level, but used relatively less than the skills of inquiry and evaluation.

Furthermore, Eğmir and Ocak (2018) examined the effect of the curriculum prepared for critical thinking skills on students' reflective thinking levels. In this study, the critical thinking skill levels of the students in the experimental and control groups were compared in two classes consisting of 5th grade students. The results of the study indicated that the reflective thinking skill levels of the students in the classroom who participated in the curriculum prepared for critical thinking skills were higher than the control group.

In the study conducted by (Bakar, 2018) the effect of technology usage on reflective thinking of students was investigated. The study was carried out with 109 12th grade students by using quasi-experimental method. The results of the study showed that the level of reflective thinking of the students was higher in experimental group which used technology for teaching than the control group.

Studies carried out up to date in the field of literature are inadequate in providing information about the current reflective thinking skills of secondary school students. An examination of reflective thinking skills that helps individuals develop strategies to overcome the challenges they face is important for identifying those students who need to develop these skills. Therefore this study was designed with the purpose of examining the reflective thinking skills of middle school students.

In order to achieve the study purpose, answers to following research questions are investigated;
- What are the reflective thinking skill level of secondary school students?
- Does the level of reflective thinking skill of secondary school students change by the gender?

- Is there a relationship between the math course grades and reflective thinking skills of students in secondary school?
- Is there a relationship between the science and technology course grades and reflective thinking skills of students in secondary school?

The Study

Research Design
Being one of the quantitative research methodology, the cross sectional survey design (Creswell & Creswell, 2017) is used in this study to collect data about the reflective thinking level of the middle school students and their course grades for the math course and for the science and technology course.

Setting and Participants
The data were collected from 297 middle school students who are in 6th, 7th and 8th grades in Zonguldak city center of Turkey. 5th grade students were excluded from the study because 5th grade is the first year of the middle school. Therefore the researcher cannot collect the data from students about their math course grades and their science and technology course grades through the use of the cross sectional survey.

The math course and the science and technology course were specifically selected in the study because middle school students attend to the nationwide administered test at the end of the middle school to make selection for their high school. Students' scores on the math course and the science and technology course are the major determinants for the calculation of the nationwide exam scores.

Measure
The data were collected using the scale measuring the reflective thinking skill towards problem solving (Kızılkaya & Aşkar, 2009). There are 14 items in the scale with response options ranging between always and never. The scale measure three dimensions of the reflective thinking. These are questioning, reasoning and evaluation. With the scale, also gender, previous year's math course grade and previous year's science and technology course grade were asked to the participants for data collection purposes.

Data Analysis
The data were analyzed using the descriptive statistic, the one-way ANOVA and the Bivariate correlation. SPSS (Statistical Package for the Social Sciences) were used for the data analysis. All statistical tests were conducted with a significant level of 0.05.

Findings
What are the reflective thinking skill level of secondary school students?
The first research question investigated the reflective thinking skill level of secondary school students. 297 students involved the study by completing the scale. The reflective thinking skill of the secondary schools students is presented at the Table-1.

Table 1: The reflective thinking skill of the secondary schools students

Scale Results	N	Min	Max	Mean	Std. Deviation
Questioning	297	5,00	25,00	17,72	3,94
Evaluation	297	7,00	25,00	17,92	3,77
Reasoning	297	5,00	20,00	14,95	3,22
Reflective Thinking Skill	297	21,00	70,00	50,59	9,24

The reflective thinking skill of the secondary school students is presented at the Table-1. Findings show that reflective thinking skill of the secondary school students are above the average. Also results indicate that for all sub-dimensions (questioning, reasoning and evaluating) of the reflective thinking skill are above the average for the secondary school students. Out of 297 secondary school students, 193 students completed and shared their math course grades and science and technology course grades for the study. The mean math course grades and the mean science and technology course grade of the secondary school students are close to the maximum grade of 100 (Table-2).

Table 2: The course grades of the secondary school students

Course Grades	N	Min	Max	Mean	Std. Deviation
Math Course Grade	193	48,00	100,00	88,89	10,75
Science and Technology Corse Grade	193	56,00	100,00	91,49	8,15

Does the level of reflective thinking skill of secondary school students change by the gender?

The second research question investigated whether the reflective thinking skill of secondary school students change by the gender. The results of the One-way ANOVA revealed that the reflective skills of secondary school students change by the gender ($F (1, 295) = 5.91$; $p < 0.05$) (Table 3). The female students' reflective thinking skills ($\bar{x} = 52.0$, SD=8.49) are higher than male students' reflective thinking skills ($\bar{x} = 49.4$, SD = 9.66). The One-way ANOVA results also revealed that reasoning dimension of the Reflective Thinking Skill is different for the gender ($F (1, 295) = 6.49$; $p < 0.05$) (Table 3). The female students' reasoning skills ($\bar{x} = 15.4$, SD = 2.8) are higher than male students' reasoning skills ($\bar{x} = 14.5$, SD = 3.4).

Table 3: The reflective thinking skill of students change by the gender

		Sum of Squares	df	Mean Square	F	Sig.
Questioning	Between Groups	61,01	1	61,01	3,96	,047
	Within Groups	4540,79	295	15,39		
	Total	4601,80	296			
Evaluation	Between Groups	40,09	1	40,09	2,84	,093
	Within Groups	4159,12	295	14,09		
	Total	4199,21	296			
Reasoning	Between Groups	66,18	1	66,183	6,491	,011*
	Within Groups	3008,05	295	10,197		
	Total	3074,24	296			
Reflective Thinking Skill	Between Groups	496,31	1	496,311	5,910	,016*
	Within Groups	24773,39	295	83,978		
	Total	25269,70	296			

* $p < 0.05$

Is there a relationship between the math course grades and reflective thinking skills of students in secondary school?

The third research question investigated whether there is a relationship between the math course grades and reflective thinking skills of students in secondary school. The results of the Pearson's correlation coefficient revealed that there is no correlation between the math course grades and the reflective thinking skills of the secondary school students (Table 4). No correlation is also found between the math course grades and the other sub-dimensions of the reflective thinking skills.

Table 4: The correlation between the reflective thinking skills and the math course grades

		Questioning	Evaluation	Reasoning	Reflective Thinking Skill	Math Course Grades
Questioning	PearsonCorrelation	1	,59*	,60*	,87*	,09
	Sig. (2-tailed)		,00	,00	,00	,17
	N		297	297	297	193
Evaluation	PearsonCorrelation		1	,51*	,83*	,01
	Sig. (2-tailed)			,00	,00	,87
	N			297	297	193
Reasoning	PearsonCorrelation			1	,81*	-,001
	Sig. (2-tailed)				,00	,99
	N				297	193
Reflective Thinking Skill	PearsonCorrelation				1	,04
	Sig. (2-tailed)					,52
	N					193
Math Course Grades	PearsonCorrelation					1
	Sig. (2-tailed)					
	N					193

* The correlation is significant at the 0.05 level.

Is there a relationship between the science and technology course grades and reflective thinking skills of students in secondary school?

The last research question investigated whether there is a relationship between the science and technology course grades and reflective thinking skills of students in secondary school. The results of the Pearson's correlation coefficient revealed that there is no correlation between the science and technology course grades and the reflective thinking skills of the secondary school students (Table 5). However statistically significant positive correlation is found between the science and technology course grades and questioning skills ($r = 0,14*$, $p < 0,05$). On the other hand for the reasoning skill and for the evaluation skills, statistically significant correlation is not found.

Table 5: The correlation between the reflective thinking skills and the science and technology course grades

		Questioning	Evaluation	Reasoning	Reflective Thinking Skill	Science and Technology Course Grades
Questioning	PearsonCorrelation	1	,59*	,60*	,87*	,14*
	Sig. (2-tailed)		,00	,00	,00	,04
	N		297	297	297	193
Evaluation	PearsonCorrelation		1	,51*	,83*	,09
	Sig. (2-tailed)			,00	,000	,19
	N			297	297	193
Reasoning	PearsonCorrelation			1	,81*	,01
	Sig. (2-tailed)				,00	,80
	N				297	193
Reflective Thinking Skill	PearsonCorrelation				1	,10
	Sig. (2-tailed)					,13
	N					19
Science and Technology Course Grades	PearsonCorrelation					1
	Sig. (2-tailed)					
	N					193

* Correlation is significant at the 0.05 level.

Conclusion
Findings revealed that secondary school students' reflective thinking skill levels are above the average. However at the same time participating students' course grades for the math course and for the science and technology course were close to the maximum score. This shows that academically successful students' reflective thinking skill level tend to be high. This finding can be used as a proclaim to support the conclusion of Baş (2013) that the reflective thinking skills are an important predictor of their academic achievement. In fact, Kaplan, Doruk and Ozturk (2017) also found that reflective thinking skills of the gifted students towards problem solving are at a high level. These findings support the idea that the relationship between the reflective thinking skill level and the academic achievement should be investigated. Another significant finding of this study is that female students' reflective thinking skills are higher than male students' reflective thinking skills. Bağçeci, Döş and Sarıca (2011) found that female students' metacognitive awareness level is higher than male students. Female students seem to be more successful in cognitive skills than males. The third finding of this study revealed that there is no correlation between the math course grades and the reflective thinking skills of the secondary school students. Similarly no correlation was found between the science and technology course grades and the reflective thinking skills of the secondary school students in this study. However a statically significant relationship is found between the questioning skill level of the students and their course grades in the science and technology course. It is suggested that reflective thinking skill level should not be used as a predictor of the course grades for investigated courses for the study population. However in a different study, Baş (2013) while investigating the relationship between the reflective thinking skills of the elementary school students for problem solving and their academic achievement in science and technology, it was found that the reflective thinking skills scale for problem solving were an important predictor of their academic achievement. Because of the contradiction between the results of this study and Bas (2013)'s finding, more research studies are needed to make generalizable conclusions about the relationship between the reflective thinking skills of the elementary school students and their academic achievement.

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