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The Investigation of Preservice Science Teachers' Critical Thinking Dispositions in the Context of Personal and Social Factors

A. AKGUN[*], U. DURUK[†]

ABSTRACT: One of the most important attribute for being scientifically literate in the context of science education requires individuals do research, inquiry and develop scientific attitudes toward facts brought about around them. In addition, it is often stated in the literature that individuals who are scientifically literate can also think critically and possess certain skills of critical thinking. According to previous research, the frequency of using critical thinking skills is interconnected to tendency of using critical thinking dispositions. Critical thinking dispositions are developed and changed on the basis of social environments and the relationship between these environments. The purpose of this study is twofold. The first one is to determine the critical thinking dispositions of preservice science teachers and the second one is to examine the possible effects of some variables including personal and social factors. The study included 346 preservice science teachers from three universities located in the distinct parts of Turkey. The study was designed in accordance with descriptive survey method. Data were collected through California Critical Thinking Disposition Inventory (CCTDI). ANOVA, independent samples t-test and tukey test are used in the analysis of the data. The results of the study revealed that preservice science teachers' critical thinking dispositions is low. In addition, there is not a significant difference between preservice science teachers' critical thinking dispositions scores by gender, grade, school and authority at home variables whereas there is by other variables such as decision making independently and receiving academic guidance.

KEY WORDS: Critical thinking dispositions, Scientific literacy, Preservice science teachers

INTRODUCTION

Science is a highly complex endeavour in which practitioners, educational researchers and even policymakers need to look forward, reflect back and

[*] (Corresponding Author) University of Adıyaman, Science Education Program, Faculty of Education, Turkey. Email: aakgun@adiyaman.edu.tr
[†] University of Adıyaman, Science Education Program, Faculty of Education, Turkey. Email: uduruk@adiyaman.edu.tr

pass on their experiences to keep up with the latest trends. All these stakeholders somehow need to feel themselves to be integrated into the educational settings so that they can achieve all these aims mentioned above. Initially, the main expectation is giving importance to social norms and values as well as making individuals to produce scientific knowledge, transfer of knowledge into other disciplines and think critically (Argon & Selvi, 2011). Over the past decades, as Stupnisky, Renaud, Daniels, Haynes & Perry (2008) indicate in putting forward the slogan of "knowledge workers", rapid developments and expansion of information at higher levels all around the world has increased the need for the provision of individuals to think critically. Some researchers think that critical thinking consists of particular skills such as thinking about reasons and finding relevant evidence, while others argue that critical thinking needs a critical disposition to ask questions, or attributes regarding individuals' character (Mason, 2007). To perform critical thinking, one should possess certain skills such as analysing, reasoning, problem solving, decision making and evaluating (APA, 1990). On the other hand, the initial requirement for using critical thinking skills is to prompt critical thinking dispositions. Critical thinking skills and dispositions toward critical thinking show also the current position of achievement to what extent individuals possess required skills as problem solvers (Ernst & Monroe, 2004).

As Facione, Facione & Giancarlo (2000) state, acquiring only information or skills cannot solely ensure the expected achievement from students. Students also need to be able to use what they learn. A major purpose of science education is to provide students to learn about the concepts and processes take place in science and interrelate them to society. New trends in science education focus on understanding and verifing any information with valid and reliable evidence, instead of memorization of huge data (Gunn, Grigg & Pohamac, 2008). At this point, verifying information as true or reliable can refer to critical thinking skills. Students who possess higher critical thinking skills are more likely to criticize information and bring together accurate descriptions and explanations for this. However, critical thinking skills are not easy for students to acquire. Because of its vital importance, many science education curricula consider critical thinking as the primary component in order to ensure both general and specific outcomes (Gunn et al. 2008). To develop in students critical thinking skills, science teachers have a crucial responsibility for the next generation and need to encourage students both to improve their critical thinking skills and facilitate critical thinking dispositions. To achieve this, both science teachers and preservice science teachers need to improve themselves in terms of critical thinking and critical thinking dispositions. In other words, science education should provide preservice teachers to be able to make analysis, interpretation, evaluation and to perform such skills

in order to ensure reasonable judgment about a given situation (Facione, Giancarlo, Facione & Gainen, 1995).

LITERATURE REVIEW

With an increase in interest on critical thinking since 1980s, the promotion of critical thinking has been one of the most remarkable issue in science education (Vieira, Tenreiro-Vieira & Martins, 2011). Besides, the literature about critical thinking is vast. Over the past decades, many researchers have studied critical thinking skills and dispositions (e.g. Facione et al. 1995; Ernst & Monroe, 2004; Çubukcu, 2006; Akbıyık & Seferoğlu, 2006; Stupnisky et al, 2008; Tümkaya & Aybek, 2008; Bataineh & Alazzi, 2009, Korkmaz, 2009; McBride, Xiang & Wittenburg, 2010; Gök & Erdoğan, 2011; Leach, 2011; Emir, 2012; Kartal, 2012; Stedman & Adams, 2012; Toy & Ok, 2012). Korkmaz (2009) investigated teachers' critical thinking dispositions by using CCTDI and found it low. In addition, no significant difference was found by gender. Ekinci & Aybek (2010) found no statistical difference both by gender and by grade. The study carried out by Tümkaya & Aybek (2008) showed that there is significant difference between university students' critical thinking dispositions by perceived parental attitudes. According to the study, university students whose parents behave more democratic have significantly higher critical thinking dispositions than those have conservative parents.

Generally speaking, studies based on social factors are generally rare, whereas researchers predominantly put emphasis on personal factors such as gender, socio-economic status and so on. Prior research has stated that social factors, besides genetic factors, have influence on preservice teachers' critical thinking skills.

Each society has distinctive traditions, customs or social norms and teachers have lived in these diverse cultures in which they have grown up forming their characteristics. Therefore, critical thinking skills and dispositions are likely to be shaped or dictated by families, societies as well as school atmosphere (Tümkaya & Aybek, 2008). Having more informed critical thinking dispositions requires preservice science teachers be more qualified and active in the process of taking guidance regarding their future as a teacher (Stupnisky et al. 2008).

This study, seeks to explore preservice science teachers' critical thinking dispositions in terms of certain social factors, including perception of authority, decision making independently and receiving academic guidance, in addition to personal factors including gender, grade and school.

METHODOLOGY

Research Model

This descriptive study is designed in accordance with survey methodology, in which a sample group is randomly selected in the case of failing to reach the whole population and skills, attitudes, beliefs and content knowledge are described in this way (Fraenkel, Wallen & Hyun, 2012).

Sampling

The sample consisted of 346 preservice science teachers selected through convenience sampling from three universities located in distinct parts of Turkey.

Data Collection

Data were collected during the fall semester of 2012-2013 from three universities through CCTDI developed by Facione and Facione (1992) and adapted into Turkish by Kökdemir (2003). The instrument has totally 51 items (22 of them negative). In the study, the value of Cronbach's alpha was found to be 0.82. As scores lower than 240 can be coded as "low", between 240-300 as "intermediary" and over 300 as "high", the preservice science teachers having more than 300 are said to possess high level critical thinking dispositions.

Data Analysis

CCTDI served as the data collection scale for the study. Personal factors such as gender, grade, school and social factors, such as perceptions of authority at home, decision making independently and receiving academic guidance, are investigated in the study. ANOVA, independent samples t-test and tukey test are used in the analysis of the data.

RESULTS

Descriptive statistics and data obtained from t test, ANOVA and tukey test with regard to preservice science teachers' critical thinking dispositions were given respectively under the title of findings. Table 1 gives data regarding the variable of gender.

Table 1 shows that there is no statistical difference between girls and boys in terms of their gender ($t=.873$, $p>.05$). However, girls' mean score is higher than that for boys. Data regarding the variable of grade are given in Table 2 and Table 3.

Table 1 Independent sample t-test results of preservice science teachers' critical thinking dispositions level by gender

Gender	N	X	Ss	sd	t	p
Girls	273	212.18	21.81	344	.873	.383
Boys	73	209.66	22.24			

Data in table 2 shows that percentages are almost equal and over 20% from each grades. The total mean score is 211,64 and lower than the previously mentioned categorization of critical thinking dispositions put forward by Faccione, Faccione & Giancarlo (1998).

Table 2 Preservice science teachers' critical thinking dispositions' level by grade

Grade Level	N	X	Ss
First grade	82	215.09	21.45
Second grade	90	209.06	20.90
Third grade	101	208.67	22.88
Fourth grade	73	215.08	21.58
Total	346	211.64	21.90

Table 3 The results of ANOVA analyzing preservice science teachers' critical thinking dispositions' level by grade

	Sum of squares	df	Mean square	F	p
Between groups	3328.425	3	1109.475	2.342	.073
Within groups	162000.849	342	473.687		
Total	165329.275	345			

ANOVA indicated no statistical difference between groups (F:2.342; p>.05). In other words, there is no significant difference between the grades. However, the highest scores are seen in the first and fourth years. Data regarding the variable of school were given in Table 4 and Table 5.

Table 4 The distribution of preservice science teachers by school

School	N	X	Ss
A	56	213.91	24.21
B	143	212.97	21.83
C	147	209.49	20.97

As seen in Table 4, participants from school A have the highest mean score while participants from school C the lowest.

Table 5 The results of ANOVA test analyzing preservice science teachers' critical thinking dispositions' level by school

	Sum of squares	df	Mean square	F	p
Between groups	1222.100	2	611.049	1.277	.280
Within groups	164107.176	343	478.447		
Total	165329.275	345			

As shown in Table 5, there is no statistically difference between groups (F:1.277; p>.05).

In the study, perception of authority at home, decision making independently and receiving academic guidance were taken as social factors that possible affect critical thinkıng dispositions. The distribution of preservice science teachers' perceptions of authority and mean scores are given in Table 6 and Table 7.

Table 6 The distribution of preservice science teachers according to perceptions of authority at home

Perception of authority	N	X	Ss
Mother dominated	90	210.69	23.02
Father dominated	245	211.89	21.46
Children dominated	11	214.09	23.68
Total	346	211.64	21.89

As seen in table 6, most preservice science teachers live in father dominated social environments. This excessive rate of father dominated families shows that their characteristics are more likely to be shaped by father's dominance and this can result in low critical thinking dispositions.

Table 7 The results of ANOVA test analyzing preservice science teachers' critical thinking dispositions' level by perception of authority at home

	Sum of squares	df	Mean square	F	p
Between groups	162.277	2	81.138	.168	.845
Within groups	165166.998	343	481.536		
Total	165329.275	345			

From analyzing Table 7, it can be seen that there is no statistical difference between groups (F:0.168; p>.05). This finding suggests the perception of authority at home as having no statistically effect on preservice science teachers' critical thinking dispositions.

The distribution of preservice science teachers' perceptions according to independent decision making and critical thinking dispositions' level are given in Table 8 and Table 9.

Table 8 The distribution of preservice science teachers according to independent decision making

Independent decision making	N	X	Ss
1. Criticize without any rationale	96	209.78	23.42
2. Consider as a democratic right	143	215.49	21.90
3. Father consent required	101	209.66	19.20
4. Pay no attention	6	183.17	10.44
Total	346	211.64	21.89

Preservice science teachers encounter all responses in their daily lives as given in Table 8. When preservice science teachers make a decision independently, most of the parents consider it as a democratic right or father consent is required, others criticize or pay no attention, instead.

Table 9 The results of ANOVA test analyzing preservice science teachers' critical thinking dispositions' level by independent decision making

	Sum of squares	df	Mean square	F	p
Between groups	7709.746	3	2569.915	5.576	.001*
Within groups	157619.528	342	460.876		
Total	165329.275	345			

In Table 9, there is a statistically significant difference between groups (F:5.576; p<.05). The Tukey test is used in order to understand in which groups this significant difference exist. According to the Tukey test, the significant difference is between the fourth group coded as "4" (pay no attention) and other groups 1, 2 and 3. Additionally, the ANOVA test used here ensures the determining of any significant difference without showing effect size. The effect size (η^2) was found to be 0.046 for this analysis.

The distribution of preservice science teachers' receiving academic guidance and mean squares are given in Table 10 and Table 11.

Table 10 The distribution of preservice science teachers according to receiving academic guidance

Receiving academic guidance	N	X	Ss
1. Receiving academic guidance	251	213.53	21.40
2. Receiving no response by academicians	63	208.83	23.72
3. Academicians to be disturbed	32	202.44	19.55
Total	346	211.64	21.89

Preservice science teachers (251) state that they receive guidance from academicians in their universities about their professional careers in the near future. Unfortunately, 32 of them think that academicians get disturbed when they are asked to give any opinion or advice as guidance (Table 10).

Table 11 The results of ANOVA test analyzing preservice science teachers' critical thinking dispositions' level by receiving academic guidance

	Sum of squares	df	Mean square	F	p	Significance
Between groups	4101.739	2	2050.869	4.363	.013*	1-3
Within groups	161227.536	343	470.051			
Total	165329.275	345				

Table 11 shows that there is a statistically significant difference between groups (F:4.363; p<.05). Viewing the Tukey test results, it is seen there is a significant difference between the first group coded as "1" (Receiving academic guidance) and the third group coded as "3" (Academicians to be disturbed). The effect size (η^2) is 0.024 for this analysis.

DISCUSSION

The main purpose of the study was to determine preservice science teachers' level of critical thinking dispositions. In addition, it was also investigated whether these dispositions were affected by personal and social factors. The results of the study revealed that total mean score of preservice science teachers' critical thinking dispositions was low (211,64; Table 2) and also lower than the previously mentioned categorization of critical thinking dispositions put forward by Faccione, Faccione & Giancarlo (1998). This result is also consistent with results in related literature (Beşoluk & Önder, 2010; Stedman & Adams, 2012; Tural & Seçgin, 2012;

Sağlam & Büyükuysal, 2013, Bakır, 2015). On the other hand, studies by Korkmaz (2009), Koc and Kuvac (2014) and Topuz (2014) resulted in decent levels of critical thinking dispositions.

The subsidiary purpose of the study was to determine whether critical thinking dispositions were affected by gender, grade and school variables. The present study showed that there is no statistical difference between girls and boys. Whereas Özdemir (2005), Korkmaz (2009), Emir (2012), Tural and Seçgin (2012) and Bakır (2015) found no statistical difference by gender, Çokluk-Bökeoğlu and Yılmaz (2005), Ay and Akgöl (2008), Leach & Good (2011) and Sağlam and Büyükuysal (2013) found statistically difference to some extent in their studies. Results from this studies revealed that it was not possible to generalize any superiority of gender categories.

Grade is also important for high level critical thinking dispositions. Normally, it is expected that critical thinking dispositions increased gradually over time as long as preservice teachers continue their studies. The present study shows there is no significant difference between grades (Table 3). Similarly, no statistical difference is found by Ekinci and Aybek (2010) and Bakır (2015). It can be stated that preservice science teachers fail to improve themselves with regard to critical thinking dispositions over time.

It could be generally stated that preservice science teachers from different universities had different experiences on the basis of educational settings. The universities in which they enrolled was a possible source of these different and various experiences. Therefore, it was investigated whether there was a significant difference between critical thinking dispositions of preservice science teachers coming from three universities located in different parts of the country. As seen in Table 5, there was no statistically difference between groups by school.

Social factors, on the other hand, could affect preservice teachers' critical thinking dispositions. Three variables were selected for the study at the beginning. These variables were coded as authority at home, decision making independently and receiving academic guidance, respectively. Results in the literature regarding these variables were rare. The present study showed that preservice science teachers' perception of authority at home had no statistically effect on preservice science teachers' critical thinking dispositions (Table 7). This indicated that perceived dominance in the family by father, mother or children did not make any significant difference in terms of critical thinking dispositions.

It was found that preservice science teachers, whose parents had more democratic behaviours allowing them to make decision independently were better than others paying no attention in terms of critical thinking dispositions. Tümkaya and Aybek (2008) reached similar results analysing university students' critical thinking dispositions. However, preservice science teachers who indicated they needed their father's consent or to be

criticized without any rationale when they make a decision also had a higher critical thinking disposition than others whose parents paid no attention. As ANOVA was a parametric test, and it is generally stated that ANOVA needed at least thirty or over thirty analysis unit for a healthy analysis, this conflicted result could stem from the number of participants in the fourth group (Table 8) against other groups.

Receiving academic guidance is one of the ways of learning from others. Preservice teachers need to be guided by academic staff in the universities, as well. Therefore, it is so vital for preservice teachers to receive constructive advice about their future planning during their undergraduate studies. The present study shows that most preservice science teachers think that they receive academic guidance (Table 10). Analysis of data given in Table 11 reveals that preservice science teachers who receive academic guidance have better critical thinking dispositions than those in the third group. This result makes it clear that it is a necessity for preservice teachers to receive academic guidance to possess higher critical thinking dispositions.

In conclusion, some suggestions based on the results in the present study can be offered to researchers studying in the same field. Initially, preservice science teachers' critical thinking dispositions scores obtained from the scale is low. This finding is supported by many studies in the literature. Moreover, qualitative studies are rare on this issue. This persisting problem requires more interpretative studies that investigate the problem from different and various perspectives. Grade is considered as an important variable in the study. But, it is seen that preservice science teachers do not improve themselves in terms of critical thinking dispositions over time. This finding is supported in the literature (Yenice, 2011; Bakır, 2015). Therefore, instruction in the universities needs to be enriched with the more specific aims of critical thinking. Promoting critical thinking needs be considered as vital in teacher education. Researchers need to investigate the reasons for failure by more narrative studies and criticize prevailing education programmes in the universities in terms of critical thinking. In terms of authority at home, decision making independently and receiving academic guidance, it can be stated that there is a lack of information about these variables' effect on critical thinking dispositions. In addition, these variables show social characteristics. Therefore, researchers who study these variables need to take into consideration the culture in which people live. It can be suggested finally that these variables need to be investigated separately rather than as an independent variable and investigated by more grounded approaches by using interpretative methods.

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