

Examining the Critical Thinking Dispositions and the Problem Solving Skills of Computer Engineering Students

Özcan Özyurt
Karadeniz Technical University, TURKEY

Received 19 September 2014; accepted 12 February 2015; published 25 March 2015

Problem solving is an indispensable part of engineering. Improving critical thinking dispositions for solving engineering problems is one of the objectives of engineering education. In this sense, knowing critical thinking and problem solving skills of engineering students is of importance for engineering education. This study aims to determine the critical thinking dispositions and the problem solving skills of computer engineering students as well as the relationship between them. The study was conducted in a university located in the north of Turkey at the beginning of the 2013-2014 spring semester. The research sample consisted of 186 students attending the faculty of engineering department of computer engineering. The California Critical Thinking Dispositions Inventory (CCTDI) and the Problem Solving Inventory (PSI) were used for data collection. The descriptive survey model was employed. The data obtained in the study were analyzed via the independent t-test, the Mann Whitney U-test, the Kruskal-Wallis test, and the Pearson's Correlation coefficient. The research results indicated that the students had high-level critical thinking dispositions and problem solving skills. Critical thinking disposition levels of the students did not vary statistically significantly by gender and grade. Similarly, no statistically significant variation was observed in the problem solving skill levels of the students by gender and grade. In addition, a statistically significant relationship was found between the critical thinking dispositions and the problem solving skills of students, but it was a low-level relationship.

Keywords: Thinking needs, Critical thinking disposition, Problem solving, Engineering education

INTRODUCTION

In today's world, critical thinking and problem solving are among the primary skills that need to be held by individuals. In this regard, one of the goals of modern education is to cultivate individuals who know what they learn and why they learn rather than being informed directly and construct their own knowledge. Cultivating individuals who can solve the problems

encountered, acquire new information by using the information s/he learnt, know and practice types of thinking such as critical thinking, creative thinking, and so on is also among the aforementioned goals. From this perspective, one of the most important functions of today's education system is to provide individuals with critical thinking and problem solving skills (Güven & Kürüm, 2008; Küçük & Uzun, 2013; Polat & Tümkaya, 2010; Tümkaya, Aybek, & Aldağ, 2009).

Critical thinking has been defined differently by various researchers. Critical thinking has been defined as logical and reflective thinking focusing on what is to be done and decision-making (Ten Dam & Volman, 2004) and as reaching a conclusion about a problem or a situation through reasoning on it (Akar & Kutlu, 2004). In consideration of these findings, critical thinking may

Correspondence to: Özcan Özyurt,
Department of Software Engineering, Faculty of
Technology, Karadeniz Technical University,
Of, Trabzon, Turkey.
E-mail: oozyurt@ktu.edu.tr
doi: 10.12973/eurasia.2015.1342a

State of the literature

- Critical thinking and problem solving are among the primary skills that need to be held by individuals.
- Research on engineering education emphasizes that engineers need to have high-level critical thinking dispositions and problem solving skills.
- The studies examining critical thinking dispositions and problem solving skills mainly focus on pre-service teachers from different branches and nursing students. There is almost no study examining the relationship between the critical thinking dispositions and the problem solving skills of students.

Contribution of this paper to the literature

- The present study was necessary and significant because there was almost no study of this kind on engineering education in Turkey.
- According to the results of the study, students generally have high-level critical thinking dispositions and problem solving skills. The critical thinking dispositions and the problem skills of the students do not vary by gender and grade. There is a low relationship between the critical thinking dispositions and the problem solving skills of the students.
- These kinds of studies should be carried out urgently to contribute to the development of engineering education.

be regarded as “an individual’s use of decision-making mechanism in view of any situation or phenomenon through subjecting his/her knowledge into a self-regulatory process by taking into consideration the thoughts of others”. Problem solving may be considered a product of critical thinking. Various researchers have made definitions of problem solving. Problem solving is defined by Heppner (1978) as directing cognitive and affective actions such as behavioral responses to a target in order to comply with internal/external requests or calls; by D’Zurilla (1988) as a cognitive-affective-behavioral process involving finding the effective ways of coping with daily-life problems; and by Altun (2003) as a response to an important and difficult situation requiring critical thinking for solution. Individuals need to have the problem solving skill in order to solve the problems they encounter (Berkant & Eren, 2013; Temur, 2012). According to Deniz (2004), individuals should have effective problem solving skills in order to overcome their problems. Way of thinking is important for the development of the problem solving skills (Altun, 2003; Cenkseven & Vural, 2006; Kanbay, Aslan, Işık, & Kılıç,

2013; Yeh, 2002). According to Braman (1999), the critical thinking skill is important not only in academic environments, but in any environment involving problem solving. As a matter of fact, critical thinking is generally associated with individuals who question, search, are flexible and open-minded, take different approaches to events, and make inductive and deductive inferences. Individuals having the above-mentioned characteristics are likely to succeed in problem-solving (Kanbay, et al., 2013).

In the literature, the studies about Critical Thinking Disposition (CTD) and Problem Solving Skill (PSS) can be divided into two categories. The first one includes the studies where CTD and PSS are examined in various educational environments as separate concepts (Allen, Rubenfeld, & Scheffer, 2004; Güven & Kürüm, 2008; Hamurcu, Günay, & Akamca, 2005; Jonassen, Strobel, & Lee, 2006; Kahyaoğlu, 2013; Kawashima & Shiomi, 2007). It is possible to come across many studies of this sort in the literature. The second one involves the studies focusing on the relationship between CTD and PSS (Beşer & Kıssal, 2009; Kanbay, et al., 2013; Polat & Tümkaya, 2010). As to the studies focusing on critical thinking and problem solving skills, it is clear that the latter are limited in number. On the other hand, the above-mentioned studies have mainly worked on two separate sample groups; 1) in-service and pre-service teachers from different branches (Berkant & Eren, 2013; Gök & Erdoğan, 2011; Kahyaoğlu, 2013; Küçük & Uzun, 2013; McBride, Xiang, & Wittenburg, 2002; Otacıoğlu, 2008; Schreglmann & Doğruluk, 2012; Serin, 2013; Yüksel, Uzun, & Dost, 2013); 2) students attending the department of nursing (Beşer & Kıssal, 2009; Drennan, 2010; Kanbay, et al., 2013; Kawashima & Shiomi, 2007; Shin, Lee, Ha, & Kim, 2006; Şahiner, Açıkgöz, & Açıkel, 2013). As to the samples of the studies, it is seen that the studies conducted with pre-service teachers are many more than the others.

In addition to these studies, there are only a few studies conducted with engineering students in the international literature. These studies dealt with students’ critical thinking dispositions and problem solving skills. They only highlighted the importance of these concepts for engineering education. As is seen in the literature, problem solving and critical thinking have crucial roles in engineering. Modern engineers should be equipped with several kinds of knowledge and skills to manage the ambiguities and adapt their knowledge to new situations. Creative problem solving skill is the first in the list of that kind of knowledge. Thanks to creative problem solving skills, engineers can adapt their knowledge to similar situations and produce solutions for urgent technical cases (Huntzinger, Hutchins, Gierke, & Sutherland, 2007). Critical thinking is directly related to problem solving process. To Siller (2001), developing critical thinking skills for the solution of

engineering problems is one of the most important objectives of engineering education. Pawley (2009) conducted a study covering definitions of faculty members regarding engineering. It was decided in this study that one of the most important characteristics of engineers was problem solving. The study asserted, "Engineering means problem solving". McGettrick, Theys, Soldan, and Srimani (2003) deem computer engineers as firmly settled in the theories and principles of computing, mathematics, and engineering and assert that they employ these basic theoretical facts to design hardware, software, networks, and computerized equipment and instruments to overcome technical problems in varied application domains. Considering the definitions of both computer engineering and general engineering, the importance of problem solving and critical thinking for the profession of engineering is understood easily.

To Huntzinger et al., (2007), critical thinking skills of engineers as well as the skills to collect, assess, and apply the information are not satisfyingly high. As for Lee, McNeill, Douglas, Koro-Ljungberg, and Therriault, (2013), engineering training should focus not only on engineering information but also on cognitive, problem solving, and critical thinking skills to produce effective solutions to complex technical problems. To Douglas (2012), critical thinking is generally known as a crucial skill. He also believes that it should be the one of the objectives of higher education. Yet, literature on critical thinking has only a few studies aimed at engineers, which is surprising. This study is both necessary and important since there are only a few studies in the international literature conducted with engineering students, whereas there is a huge lack of such studies in the national literature. Knowing CTD and PSS potentials of engineering students as well as the relationships between them is of crucial importance for engineering education. As a matter of fact, the results of the study may provide important outputs for engineering educators to take steps to raise these skills up to their highest level. From this perspective, the results of the present study may make important contributions to the literature, engineering education in Turkey being in the first place. This study examined the critical thinking dispositions and the problem solving skills of computer engineering students as well as the relationship between them. In this context, the research questions can be listed as the following:

- 1) What are the CTD levels of computer engineering students?
 - Do such levels significantly vary by gender?
 - Do such levels significantly vary by grade?
- 2) What are the PSS levels of computer engineering students?
 - Do such levels significantly vary by gender?

- Do such levels significantly vary by grade?
- 3) Is there any relationship between the CTDs and the PSSs of computer engineering students?

METHODOLOGY

Participants

This study was carried out at the beginning of the 2013-2014 academic year in a university located in the north of Turkey. A total of 186 computer engineering students participated in the study. The gender distribution and the frequency of these students were as follows: female (n=76, f=40.86%); male (n=110, f=59.14%). The grade distribution and the frequency of these students were as follows: 1st grade (n=46, f=24.73%); 2nd grade (n=50, f=26.88%); 3rd grade (n=44, f=23.66%); and 4th grade (n=46, f=24.73%).

Data collection tools

The California Critical Thinking Dispositions Inventory and the Problem Solving Inventory were used for data collection. *The California Critical Thinking Dispositions Inventory (CCTDI)*: This scale was developed by Facione, Facione, and Giancarlo (1998) in order to determine the levels of CTD of individuals. It was adapted to Turkish by Kökdemir (2003). The factor, validity, and reliability analyses of the Turkish version of the scale were made by Kökdemir (2003). The final version of the scale consists of 51 items (29 positive items and 22 negative items). The items were rated on a 6-point Likert-type scale as follows: "I strongly disagree; I disagree; I partly disagree; I partly agree; I agree; I strongly agree". The positive items were rated as 1, 2, 3, 4, 5, and 6 respectively. The items, on the other hand, were subject to a reverse rating. The score range of the scale was 51 to 306. The highness of the score achieved in the scale demonstrates that the relevant individual has a high-level CTD. The reliability coefficient of the scale was 0.88.

The Problem Solving Inventory (PSI): This scale was developed by Heppner and Petersen (1982) in order to measure the levels of PSS of individuals. It was adapted to Turkish by Şahin, Şahin, and Heppner (1993). The final version of the scale consists of 35 items. 3 items (9, 22, 29) in the scale are used as filler items and are not included in scoring. Of the remaining 32 items, 18 are positive, and 14 are negative. The items were rated on a 6-point Likert-type scale as follows: "I always behave like that; I usually behave like that; I often behave like that; I sometimes behave like that; I rarely behave like that; I never behave like that". The positive items were rated as 1, 2, 3, 4, 5, and 6 respectively. The items, on the other hand, were subject to a reverse rating. The score range of the scale was 32 to 192. The highness of

the total score achieved in the scale demonstrates that the relevant individual perceives himself/herself as incompetent in problem solving. The reliability coefficient of the scale was 0.88.

Data analysis

The scores that might be obtained from the CCTDI and the PSI, which were employed in the present study, and the levels such scores correspond to are as indicated in figure 1 and figure 2 respectively (Facione, et al., 1998; Şahin, et al., 1993).

The descriptive survey model was employed in the present study. The data obtained in the study were analyzed based on the research questions. With reference to the first research question, the scores obtained by the students from the CCTDI were evaluated in the first place. Minimum, maximum, and average values of these scores were found. The distribution of the scores obtained by the students from this scale was obtained. Whether or not the CTD levels of the students varied by gender was analyzed. Since the data did not have a normal distribution by groups (gender), the Mann Whitney U-test was used for this analysis. In addition, whether or not the CTD levels of the students varied by grade was analyzed. Since the data did not have a normal distribution by groups (grade), the Kruskal-Wallis test was used for this analysis.

With regard to the second research question, the scores obtained by the students from the PSI were evaluated in the first place. Minimum, maximum, and average values of these scores were found. The

distribution of the scores obtained by the students from this scale was obtained. Whether or not the PSS levels of the students varied by gender was analyzed. Since the data had a normal distribution by groups (gender), the independent t-test was used for this analysis. In addition, whether or not the PSS levels of the students varied by grade was analyzed. Since the data did not have a normal distribution by groups (grade), the Kruskal-Wallis test was used for this analysis.

For the third research question, the relationship between the CTD and the PSS levels of the students was searched through the Pearson’s Correlation coefficient. A correlation coefficient of 1.00 indicates a perfect positive relationship, and a correlation coefficient of -1.00 represents a perfect negative relationship. An absolute value of correlation coefficient of 0.70 to 1.00 refers to a high relationship; that of 0.70 to 0.30 demonstrates a medium relationship; and that of 0.30 to 0.00 signs a low relationship (Büyüköztürk, 2007). SPSS 16.0 was used for data analysis.

FINDINGS

The obtained findings are presented within the context of the research questions below.

Findings Concerning the CTD Levels of the Computer Engineering Students and the Variation of Such Levels by Gender and Grade

The minimum score, the maximum score, and the average score achieved by the students in the CCTDI were 101, 281, and 215 respectively. Figure 3 presents

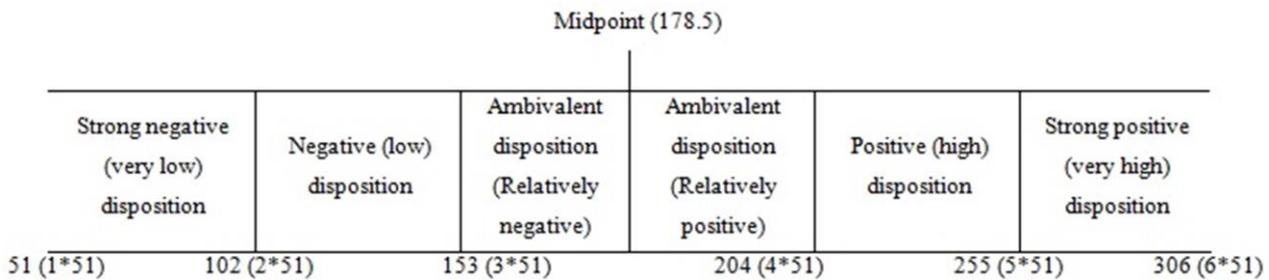


Figure 1. The scores that might be obtained from the CCTDI and the grading of such scores

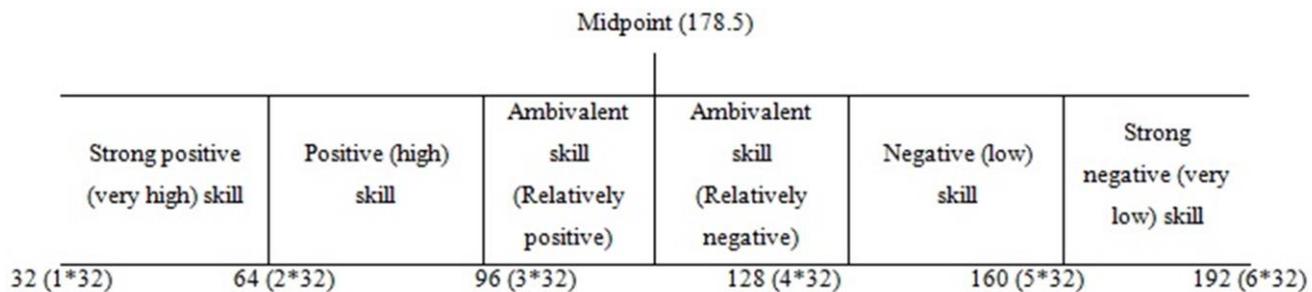


Figure 2. The scores that might be obtained from the PSI and the grading of such scores

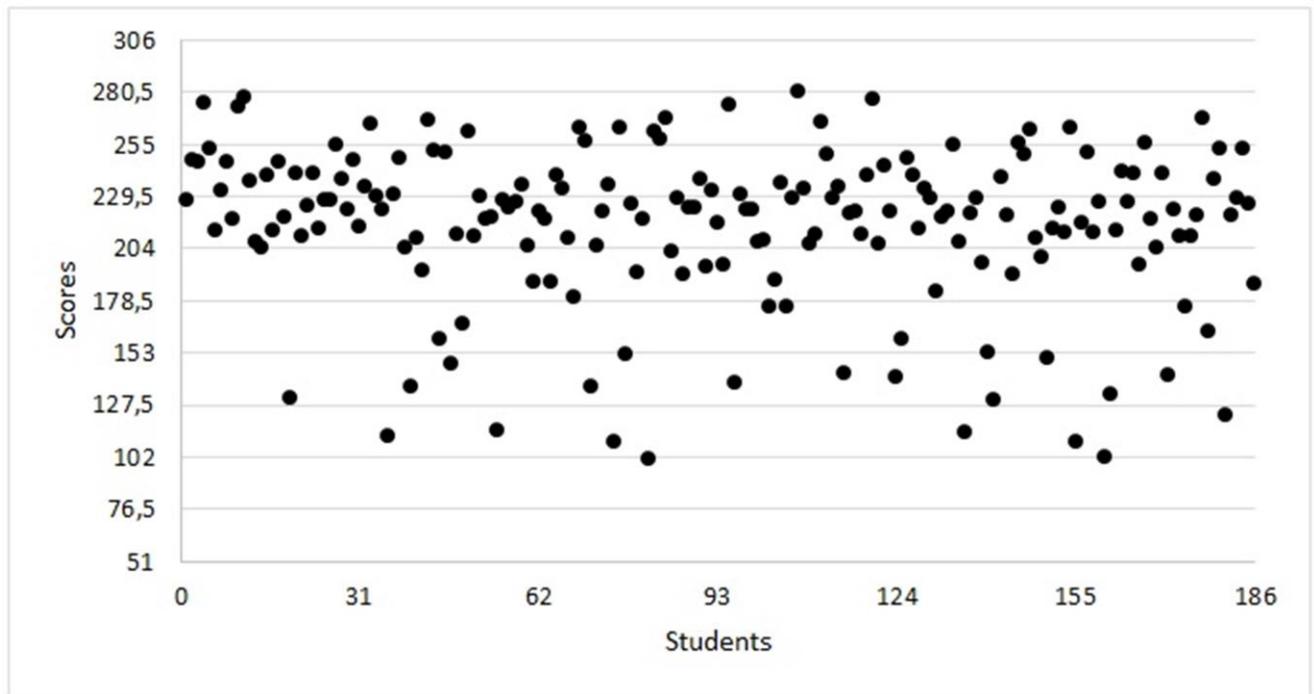


Figure 3. The distribution of the scores achieved by the students in the CCTDI

Table 1. The Mann Whitney U-test Result Showing Whether or not the CTD Levels of the Students Vary by Gender

Gender	N	Mean Rank	Sum of Ranks	U	p
Female	76	100.07	7605	3681	0.166
Male	110	88.96	9786		

p<0.05

Table 2. The Kruskal-Wallis Test Result Showing Whether or not the CTD Levels of the Students Vary by Grade

Grade	N	Mean Rank	df	X ²	p
1	46	100.29	3	3.646	0.302
2	50	100.68			
3	44	82.89			
4	46	89.05			

p<0.05

the distribution and the clustering tendencies of the scores achieved by the students in the CCTDI. As is seen in the figure 3, the scores achieved by the students in the CCTDI were mostly between 204 and 255. Based on the average value and the density in the graph, it can be said that the students generally had high-level CTDs.

Whether or not the CTD levels of the students varied statistically by gender was analyzed via the Mann Whitney U-test. The result of this analysis is given in table 1. According to the table 1, the CTD levels of the students did not vary statistically by gender (U=3681, p>0.05).

Whether or not the CTD levels of the students varied statistically by grade was analyzed via the Kruskal-Wallis test. The result of this analysis is given in table 2. According to the table 2, the CTD levels of the

students did not vary statistically by grade [X²(3) = 3.646, p>0.05].

Findings Concerning the PSS Levels of the Computer Engineering Students and the Variation of Such Levels by Gender and Grade

The minimum score, the maximum score, and the average score achieved by the students in the PSI were 53, 152, and 89.8 respectively. Figure 4 presents the distribution and the clustering tendencies of the scores achieved by the students in the PSI. As is seen in the figure 4, the scores achieved by the students in the PSI were mostly between 64 and 96. Based on the average value and the density in the graph, it can be said that the students generally had high-level PSSs.

Whether or not the PSS levels of the students varied statistically by gender was analyzed via the independent t-test. The result of this analysis is given in table 3. According to the table 3, the PSS levels of the students did not vary statistically by gender ($t(160) = 0.406, p > 0.05$).

Whether or not the PSS levels of the students varied statistically by grade was analyzed via the Kruskal-Wallis test. The result of this analysis is given in table 4. According to the table 4, the PSS levels of the students did not vary statistically by grade [$X^2(3) = 2.265, p > 0.05$].

Findings Concerning the Relationship between the CTD and the PSS Levels of the Computer Engineering Students

The relationship between the CTD and the PSS levels of the computer engineering students was searched via the Pearson’s Correlation coefficient.

Through this analysis, a negative low statistically significant relationship was found between the two variables ($r = -0.243, p < 0.01$). The negativity of this relationship resulted from the fact that the two scales were rated in two opposite directions.

DISCUSSION, CONCLUSION, AND IMPLICATIONS

The present study examined the CTD and the PSS levels of the computer engineering students and the relationship between these two variables. It was found out that the computer engineering students generally had high-level CTDs. The literature emphasizes that engineering requires high CTD levels as a profession (Jonassen, et al., 2006; Lee, et al., 2013; Rugarcia, et al., 2000). Findings of the study support this emphasis. Though there is no study in the literature analyzing CTD levels of engineering students, there are many studies conducted in other fields. While some of these

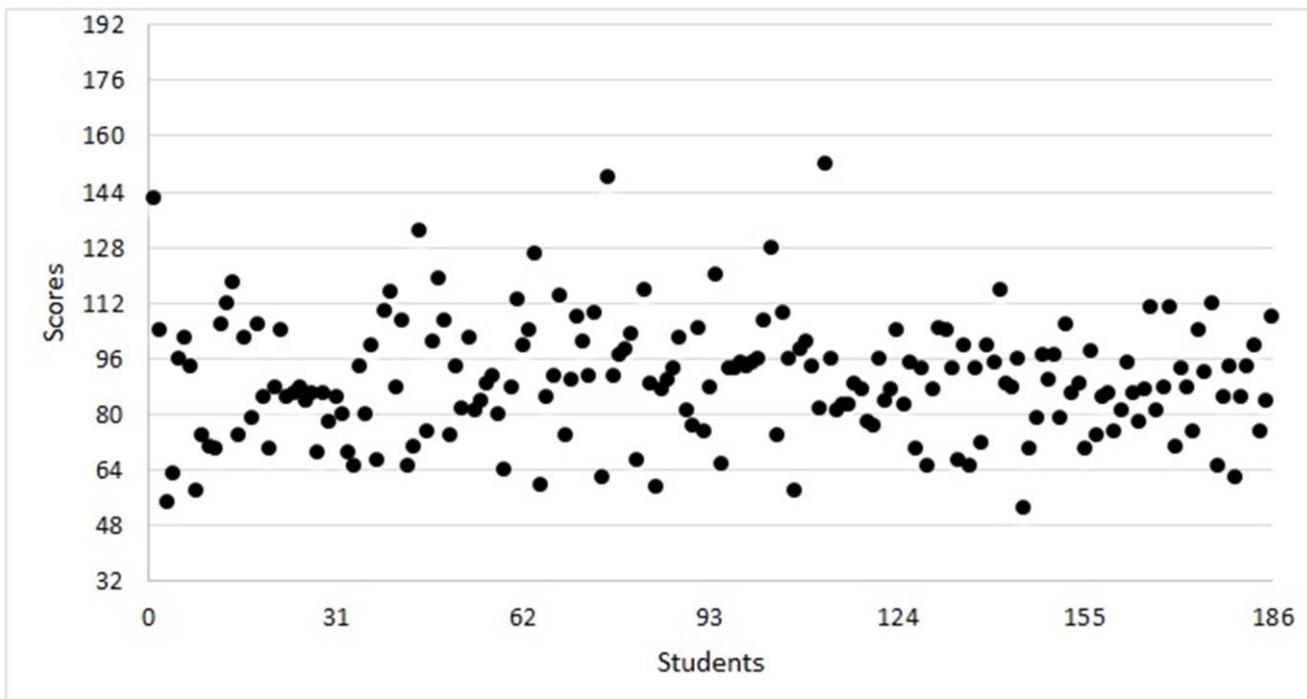


Figure 4. The distribution of the scores achieved by the students in the PSI

Table 3. The Independent t-Test Result Showing Whether or not the PSS Levels of the Students Vary by Gender

Gender	N	\bar{X}	Sd	df	t	p
Female	76	90.4	19.48	184	0.406	0.685
Male	110	89.37	15.22			

$p < 0.05$

Table 4. The Kruskal-Wallis Test Result Showing Whether or not the PSS Levels of the Students Vary by Grade

Grade	N	Mean Rank	df	X^2	p
1	46	100.71	3	2.265	0.519
2	50	86.53			
3	44	89.19			
4	46	97.99			

$p < 0.05$

studies have reported that students generally have low-level CTDs (Çetinkaya, 2011; Genç, 2008; Yüksel, et al., 2013), most of them have concluded that students have medium-level CTDs (Alper, 2010; Beşer & Kıssal, 2009; Güleç, 2010; Küçük & Uzun, 2013; Shin, et al., 2006; Serin, 2013). Few studies have determined that students have high-level CTDs (McBride, et al., 2002). Although the results of the present study are generally different from the results of those included in the literature, they are parallel with the results of a few studies.

It was seen that the CTD levels of the students did not vary statistically significantly by gender and grade. Though the number of studies reporting that the CTD levels of students vary by gender is few (Çetinkaya, 2011; Kökdemir, 2003), there are many studies concluding that gender does not have any effect on CTD (Gök & Erdoğan, 2009; Kawashima & Shiomi, 2007; Korkmaz, 2009; Küçük & Uzun, 2013, Şen, 2009; Yüksel, et al., 2013). The result obtained from the present study supports the result of many studies in the literature that gender does not have any effect on CTD levels. Non-variation of the CTD levels of students by gender may result from the fact that the CTD levels of those students who receive the same education are affected evenly, as emphasized in the literature. Similarly, while some studies report that the CTD levels of students vary by grade (Beşer & Kıssal, 2009; Çetinkaya, 2011; Shin, et al., 2006), some others have concluded that grade does not have any effect on CTD levels (Kanbay, et al., 2013; Kawashima & Shiomi, 2007; Küçük & Uzun, 2009; Korkmaz, 2009). The results obtained from the present study show parallelism with those of the studies in the literature reporting that grade does not have any impact on the CTD levels of students (Küçük & Uzun, 2009). The studies reporting that there is no variation by grade include the opinion that the education provided fails to improve the CTDs of students as the grade rises. Non-variation by grade found in the present study may result from the fact that the curriculum does not contain courses to improve the CTDs of students as the grade rises, and/or the existing courses do not involve practices aimed at improving CTDs.

Another result of the present study was that the computer engineering students had generally high-level PSSs. It is possible to find studies in the literature which define engineering as problem solving (Pawley, 2009). Besides, there are studies claiming that engineering requires problem solving, and engineers have to have high problem solving skills (Huntzinger, et al., 2007; Jonassen, et al., 2006; Mills & Treagust, 2003). Findings of the study support this result. Though there is no study in the literature analyzing the PSS levels of engineering students, there are many studies conducted in other fields. The literature contains studies concluding that students have low-level PSSs (Şirin &

Güzel, 2006), medium-level PSSs (Beşer & Kıssal, 2009; Kahyaoğlu, 2013), and high-level PSSs (Berkant & Eren, 2013; Polat & Tümkaya, 2010; Schreglmann & Doğruluk, 2012; Şahiner, et al., 2013). The results of the present study show parallelism with those of the studies in the literature concluding that PSS levels are high.

It was determined in the present study that the PSS levels of the students did not vary statistically significantly by gender and grade. While some studies in the literature have reported that PSS levels vary by gender (Cenkseven & Vural, 2006; Kahyaoğlu, 2013; Otacioğlu, 2008; Polat & Tümkaya, 2010), some others have concluded that gender does not have any effect on PSS levels (Berkant & Eren, 2013; Kanbay, et al., 2013; Schreglmann & Doğruluk, 2012; Tümkaya et al., 2009). The result obtained from the present study on this subject is similar to the result of many studies in the literature that gender does not have any effect on PSS. Non-variation of the PSS levels of students by gender confirms the opinion emphasized in the literature that students who receive the same education and are at almost the same level may have PSS levels close to one another. Although there are some studies concluding that the PSS levels of students vary by grade (Beşer & Kıssal, 2009; Polat & Tümkaya, 2010), many studies report that grade does not have any effect on PSS (Berkant & Eren, 2013; Kanbay, et al., 2013; Schreglmann & Doğruluk, 2012; Şahiner, et al., 2013). The result obtained from the present study on this subject shows parallelism with the results of the studies in the literature concluding that grade does not have any effect on the PSS levels of students. Non-influence of grade on the PSS levels of students may result from the fact that the number of courses provided for improving the PSS levels of students is not adequate, and/or the existing courses do not involve practices aimed at improving such skills.

Finally, a negative low statistically significant relationship was found between the CTD and the PSS levels of the students. Negative relationship was the result of reverse scoring of the scales. The literature contains a limited number of studies dealing with the relationship between the CTD and the PSS levels of the students. While two studies (Beşer & Kıssal, 2009; Tümkaya et al., 2009) found a strong relationship between the CTD and the PSS levels of the students, one study (Kanbay, et al., 2013) determined a poor relationship between the two. The result obtained from the present study is similar to the result of Kanbay, et al., (2013).

In consideration of the research findings, it may be recommended to include courses improving the CTD and the PSS levels of prospective computer engineers in the curriculum and to carry out activities/practices aimed at enhancing the CTD and the PSS levels of prospective computer engineers in the existing courses.

In addition, studies may be conducted with larger study groups and prospective engineers from different fields. Such studies may investigate the relationship between the CTD and the PSS levels of prospective engineers and thinking requirements, learning styles, creativity, communication skill, etc. Furthermore, experimental studies may be carried out in order to examine the effects of the education provided in the departments of engineering on the CTDs and the PSSs of students. Finally, future qualitative studies may dwell on the reasons why students have such levels.

REFERENCES

- Akar, V. R. & Kutlu, O. (2004). Eleştirel düşünme araçlarının incelenmesi ve bir güvenilirlik çalışması [Examining critical thinking tools and a reliability study]. *Journal of Çukurova University Institute of Social Sciences*, 13(2), 189-199.
- Allen, D. G., Rubenfeld, M. G., & Scheffer, B. K. (2004). Reliability of assessment of critical thinking. *Journal of Professional Nursing*, 20(1), 15-22.
- Alper, A. (2010). Critical thinking disposition of pre-service teachers. *Education and Science*, 35(158), 14-27.
- Altun, I. (2003). The perceived problem solving ability and values of student nurses and midwives. *Nurse Education Today*, 23, 575-584.
- Berkant, H.G. & Eren, I. (2013). Investigating problem solving skills of students of primary school math teaching department in terms of some variables. *International Journal of Social Science*, 6(3), 1021-1041.
- Beşer, A. & Kissal, A. (2009). Critical thinking dispositions and problem solving skills among nursing students. *Electronic Journal of Dokuş Eylül University School of Nursing*, 2(3), 88-94.
- Braman, O. R. (1999). Teaching peace to adults: Using critical thinking to improve conflict resolution. *Adult Learning*, 10(2), 30-32.
- Büyükoztürk, Ş. (2007). Sosyal bilimler için veri analizi el kitabı [A handbook of data analysis in social sciences], PegemA Yayıncılık.
- Cenkseven, F. & Vural, R. A. (2006). Comparing adolescents' perceived problem solving skills according to need for cognition and gender. *Eurasian Journal of Educational Research*, 25, 45-53.
- Çetinkaya, Z. (2011). Determination of Turkish education teacher candidates' views related to critical thinking. *Journal of Kırsehir Education Faculty*, 12(3), 93-108.
- Deniz, M. E. (2004). Investigation of the relation between decision making self-esteem, decision making style and problem solving skills of university students. *Eurasian Journal of Educational Research*, 15, 23-35.
- Douglas, E. P. (2012). Defining and measuring critical thinking in engineering. *Procedia-Social and Behavioral Sciences*, 56, 153-159.
- Drennan, J. (2010). Critical thinking as an outcome of a Master's degree in nursing programme. *Journal of Advanced Nursing*, 66(2), 422- 431.
- D'Zurilla, T. J. (1988). Problem solving therapies. In K.S. Dobson (Ed.). *Handbook of Cognitive-Behavioural Therapies*, Guilford Publications Inc. 85-135.
- Facione, P. A., Facione, N. C., & Giancarlo, C. A. F. (1998). *The California critical thinking dispositions inventory*. Millbrae, CA: California Academic Press.
- Genç, S. Z. (2008). Critical thinking tendencies among teacher candidates. *Educational Sciences: Theory and Practice*, 8(1), 107-116.
- Gök, B. & Erdoğan, T. (2011). The investigation of the creative thinking levels and the critical thinking disposition of pre-service elementary teachers. *Ankara University, Journal of Faculty of Educational Sciences*, 44(2), 19-51.
- Güleç, H. Ç. (2010). Evaluation of prospective primary and pre-school teachers' critical thinking level. *Education and Science*, 35(157), 3-14.
- Güven, M. & Kürüm, D. (2008). The relationship between teacher candidates' learning styles and critical thinking dispositions. *Elementary Education Online*, 7(1), 53-70.
- Hamurcu, H., Günay, Y., & Akamca, G. Ö. (2005). Profiles of critical thinking dispositions of science and class teacher candidates. *Eurasian Journal of Educational Research*, 20, 47-157.
- Heppner, P. P. (1978). A review of the problem solving literature and it's relationship to the counseling process. *Journal of Counseling Psychology*, 25, 366-375.
- Heppner, P. P. & Petersen, C. H. (1982). The development and implications of a personal problem solving inventory. *Journal of Counseling Psychology*, 29, 66-75.
- Huntzinger, D. N., Hutchins, M. J., Gierke, J. S., & Sutherland, J. W. (2007). Enabling sustainable thinking in undergraduate engineering education. *International Journal of Engineering Education*, 23(2), 218-230.
- Jonassen, D., Strobel, J., & Lee, C.B. (2006). Everyday problem solving in engineering: Lessons for engineering educators. *Journal of Engineering Education*, 95(2), 139-151.
- Kanbay, Y., Aslan, Ö., Işık, E., & Kılıç, N. (2013). Problem solving and critical thinking skills of undergraduate nursing students. *Journal of Higher Education and Science*, 3(3), 244-251.
- Kahyaoglu, M. (2013). The relationship between elementary teacher candidates' attitudes towards problem based learning and problem solving skills. *The Online Journal of New Horizons in Education*, 3(1), 62-67.
- Kawashima, N., & Shiomi, K. (2007). Factors of the thinking disposition of Japanese high school students. *Social Behavior and Personality*, 35(2), 187-194.
- Korkmaz, Ö. (2009). The influence of education faculties on students' critical thinking level and disposition. *Journal of Turkish Educational Sciences*, 7(4), 879-902.
- Kökdemir, D. (2003). Belirsizlik durumlarında karar verme ve problem çözüme [Decision making and problem solving under uncertainty]. Unpublished doctoral dissertation, Ankara University, Institute of Social Sciences, Ankara.
- Küçük, D. P & Uzun, Y. B. (2013). Critical thinking tendencies of music teacher candidates. *Journal of Kırsehir Education Faculty*, 14(1), 327-345.
- Lee, C. S., McNeill, N. J., Douglas, E. P., Koro-Ljungberg, M. E., & Therriault, D. J. (2013). Indispensable resource? A phenomenological study of textbook use in engineering

- problem solving. *Journal of Engineering Education*, 102(2), 269-288.
- McBride, R.E., Xiang, P., & Wittenburg, D. (2002). Dispositions toward critical thinking: The preservice teacher's perspective. *Teachers and Teaching: Theory and Practice*, 8(1), 29-40.
- McGettrick, A., Theys, M. D., Soldan, D. L., & Srimani, P. K. (2003). Computer engineering curriculum in the new millennium. *IEEE Transactions on Education*, 46(4), 456-462.
- Mills, J. E. & Treagust, D. F. (2003). Engineering education-is problem-based or project-based learning the answer? *Australasian Journal of Engineering Education*, 3, 2-16.
- Otacıoğlu, S. G. (2008). Prospective teachers' problem solving skills and self-confidence levels. *Educational Sciences: Theory & Practice*, 8(3), 915-923.
- Pawley, A. L. (2009). Universalized narratives: Patterns in how faculty members define "engineering". *Journal of Engineering Education*, 98(4), 309-319.
- Polat, R. H. & Tümkaya, S. (2010). An investigation of the students of primary school problem solving abilities depending on need for cognition. *Elementary Education Online*, 9(1), 346-360.
- Rugarcia, A., Felder, R. M., Woods, D. R., & Stice, J. E. (2000). The future of engineering education I.A vision for a new century. *Chemical Engineering Education*, 34(1), 16-25.
- Schreglmann, S. & Doğruluk, S. (2012). Investigation of problem solving skills of prospective information technologies teachers in terms of different variables. *Amasya Education Journal*, 1(2), 143-150
- Serin, O. (2013). The critical thinking skills of teacher candidates Turkish Republic of Northern Cyprus sampling. *Eurasian Journal of Educational Research*, 53, 231-248.
- Siller, T. J. (2001). Sustainability and critical thinking in civil engineering curriculum. *Journal of Professional Issues in Engineering Education and Practice*, 127, 104-108
- Shin, K. R., Lee, J. H., Ha, J. Y., & Kim, K. H. (2006). Critical thinking dispositions in baccalaureate nursing students. *Journal of Advanced Nursing*, 56(2), 182-189.
- Şahin, N., Şahin, N. H., & Heppner, P. P. (1993). Psychometric properties of the Problem Solving Inventory in a group of Turkish university students. *Cognitive Therapy and Research*, 17(4), 379-396.
- Şahiner, G., Açıksöz, S., & Açıkel, C. (2013). Student nurses' perceptions of their problem-solving ability. *TAF Preventive Medicine Bulletin*, 12(6), 673-680.
- Şen, Ü. (2009). An evaluation about Turkish teacher candidates' critical thinking attitude's in terms of difference variable. *Journal of World of Turks*, 1(2), 2009.
- Şirin, A. & Güzel, A. (2006). The relationship between learning styles and problem solving skills among college students. *Educational Sciences: Theory & Practice*, 6(1), 255-264.
- Ten Dam, G. & Volman, M. (2004). Critical thinking as a citizenship competence: Teaching strategies. *Learning and Instruction*, 14(4), 359-379.
- Temur, O. D. (2012). Analysis of prospective classroom teachers' teaching of mathematical modeling and problem solving. *Eurasia Journal of Mathematics, Science & Technology Education*, 8(2), 83-93.
- Tümkaya S., Aybek, B., & Aldağ, H. (2009). An investigation of university students' critical thinking disposition and perceived problem solving skills. *Eğitim Araştırmaları-Eurasian Journal of Educational Research*, 36, 57-74.
- Yeh, M. (2002). Assessing the reliability and validity of the Chinese version of the California Critical Thinking Disposition Inventory. *International Journal of Nursing Studies*, 39, 123-132.
- Yüksel, N. Z., Uzun, M. S., & Dost, Ş. (2013). Critical thinking tendencies of prospective mathematics teachers. *Hacettepe University Faculty of Education Journal*, 28-1, 393-403.

