Journal of Learning and Teaching in Digital Age, 2017, ***2***(1), 11-19

Examination of the Computational Thinking Skills of Students

Agah Tugrul Korucu
Konya Necmettin Erbakan University
agahkorucu@gmail.com

Abdullah Tarık Gencturk
Konya Necmettin Erbakan University
tarikgencturk@gmail.com

Mustafa Mucahit Gundogdu
Konya Necmettin Erbakan University
mmucahitgundogdu@gmail.com

ABSTRACT

Computational thinking is generally considered as a kind of analytical way of thinking. According to Wings (2008) it shares with mathematical thinking, engineering thinking and scientific thinking in the general ways in which we may use for solving a problem, designing and evaluating complex systems or understanding computability and intelligence as well as the mind and human behaviour. It is generally accepted important that like high order thinking skills the analytical way of thinking should be taught to the children at very early ages. The aim of this study is to investigate the computational thinking skills of secondary school students in terms of different variables. The study group of the research is 160 secondary school students who continue their education at different levels in Konya. The "Computational Thinking Skills Scale" which has been developed by Korkmaz, Çakır and Özden (2015) used for data collection. The scale includes 22 items and it is a 5 point likert type scale. The Cronbach Alpha reliability of the scale has been calculated as 0.80 and it has been found to be valid to measure the computational skills levels of the secondary school students as a result of the analysis. As a result of this research, the computational thinking skill levels of participants differ meaningfully in terms of their class levels, do not differ meaningfully in terms of their genders, do not differ meaningfully in terms of their weekly internet usage durations, do not differ meaningfully in terms of their mobile device usage competence situations, differ meaningfully in terms of their mobile Technologies possession durations.

Keywords: *computational thinking, algorithmic thinking, secondary school students, thinking skills, analytical thinking*

INTRODUCTION

In order that the development level advances in today's communities, progression in science and technology should be made (Karasar, 2004). Communities are affected by technological development and thus they shall comply with the development occurring in technology. Communities complying with these developments will take their place among developed communities since they will play role in the process of information generation (Akkoyunlu, Soylu & Çağlar, 2010). Technology is defined usually as scientific information and products involving scientific information (Aksoy, 2003). Computer technology is continuously advancing day by day. These developments affect all fields of life. Progression made in technology leads to particular changes in educational processes. The goals in educational environments are the easy accession of learners to information and the reintegration of individuals complying with technological developments (Seferoğlu, 2009). Developments occurring in information technologies lead communities to change their systems and to use technology in all fields of their lives (Sadi et al., 2008). It is observed that different dimensions of technology enter into the lives of communities (Erdem & Akkoyunlu, 2002). Involvement of technology in education environments began in the 19th century (Ritz and Martin, 2013). The usage of

Correspondence to: *Agah Tugrul Korucu, Assistant Professor, Department of Computer Education and Instructional Technology, Ahmet Kelesoglu Faculty of Education, Necmettin Erbakan University, agahkorucu@gmail.com*

technology in educational environments lowers the cost of education and increases the quality of the education (Yiğit, Zayim & Yıldırım, 2002). While instructors who demonstrate positive attitude towards technology usage in education environments, comfortably use technology in education, individuals find the opportunity to improve themselves professionally and individually (Avcı & Seferoğlu, 2011). Positive developments are experienced in educational processes with the widespread usage of technology in education (Jones, Buntting & Vries, 2011). Today's needs and conditions change day by day and people encounter with different problems. These changes increase particularly in social, scientific and technological fields (Özkök, 2005). The goals of the education delivered in some communities for the usage of technology are to improve students' skills through various activities in order to increase their self-confidence and to promote them to create the products they made in different ways. Students can control the products they made with technological products again with the help of technology (Autio, Soobik, Thorteinsson & Olafsson, 2015). The information instructors own in the field of technology has an important role in the attitudes of students towards technology (Rohaan, Taconis & Jochems, 2012).

Computational thinking is involved in analytical thinking (Wing, 2008). Computational thinking has become a widespread context in computer sciences (Rong-sheng, 2009). It is expected that computational thinking will be a fundamental skill to be used by all individuals within 21st century (Wing, 2006). Researches made on computational thinking defined this concept in the best way and revealed that this concept is used in a wide range (Kazımoğlu, Kiernan, Bacon & Mackinnon, 2012). According to Bundy (2007), computational thinking has an effective role on researches in all disciplines. Researchers use computational metaphors in order to enrich the theories in various problems. In today's world, nearly everyone has a personal computer. Individuals generally use their computers for mailing, using web browsers and programmes such as office and for playing games. However, with the emergence of computational thinking, it began to create a change in thinking system by going deeper and provided a new language for the definition of theories within the concept of computer. As a description, computational thinking is the whole of knowledge, skills and attitudes which individuals should own for the solution of daily problems and is defined as the interpretation of behaviours which problem-solving, system design and computer sciences demand to earn to (Korkmaz, Çakır & Özden, 2015). Computational thinking recently demonstrates a conspicuous development (Brennan & Resnick, 2012). The attitude which is developed by using computational thinking should be improved in order to analyse systematic approaches, interactions and interwoven complex relationships (Qiu, 2009). It is observed that computational thinking is started to be integrated in educational environments by 21st century (Morelli et al., 2011). Applications such as social networks and cooperative Technologies, digital world, e-state, e-science can be demonstrated as samples of computational thinking (Güney & Çelik, 2009). Developments are being made on computational thinking by analysing computer sciences and computer technologies methodologies (Tian-long, 2009). Computational thinking is considered a term not only valid for computer engineers but also all individuals and it requires analytical thinking skills (Moursund, 2006). Computational thinking involves all fundamental concepts and applications within the computer science. Also, applications including simulations are included in this context. The fact that this concept benefits from experiences which are obtained by scientific and mathematical sciences for applications within the computational thinking concept has an important role in the development of it (Sengupta, Kinnebrew, Basu, Biswas & Clark, 2013).

When analysing the studies conducted in computational thinking skills field, Korkmaz, Çakır, Özden, Oluk & Sarıoğlu (2015) have reached to 1306 individuals in their studies. As a result of the research, they found that regarding the perceptions of the individuals regarding computational thinking skills, the perceptions of 653 individuals are high and that of 653 individuals are medium-level. They stated that programs applied in Technology Faculty and Institute have meaningful effects on computational thinking skills of individuals. They also stated that computational thinking skills of individuals in departments of mathematics, science and technology have more meaningful correlation as compared to other individuals.

In the study of Seiter and Foreman (2013), the goal is the determination of differences between computational thinking skills of students of different ages. As a result of the research, they concluded that research-based syllabus appropriate for the ages of the students should be prepared for first-graders and that academic programs should be prepared towards cognitive development stages for all levels of education. To determine level of computational thinking of elementary students so that a curriculum addressing these skills could be developed. Within this context, the goal of this research is the determination of computational thinking skills of elementary students in terms of various variables. Within the framework of this general goal, the answers to the following questions are sought;

1. Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their class levels?
2. Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their Gender?
3. Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their weekly internet usage situations?
4. Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their mobile device usage competence situations?
5. Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their mobile technologies possession durations?

METHOD

Research Model and Study Group

This study, performed with quantitative research, is conducted according to the survey model. The study group consists of 160 elementary students receiving education in different classrooms in an elementary state school in the province of Konya. Table 1 includes the demographical data belonging to elementary students of the study group.

Table 1. Demographical Data of Participants

		N	%
Gender	Female	75	46,9
	Male	85	53,1
	Total	160	100,0
Learning on the class level	5th grade	32	20,0
	6th grade	38	23,8
	7th grade	49	30,6
	8th grade	41	25,6
	Total	160	100,0

As it is clear in Table 1, among 160 students, 85 (53,1%) are male and 75 (46,9%) are female.

Among 160 students, 32 (20,0%), are in 5th grade, 38 (23,8%)are in 6th grade, 49 (30,6%)are in 7th grade and 41 (25,6%) are in 8th grade.

Data Collection Tools

As data collection tools, personal information form in which demographical data is collected prepared by researchers and the "Computational Thinking Skills Levels Scale" developed by Korkmaz, Çakır and Özden (2015) are used. The scale comprises of 22 items and it is 5-point Likert type. Each of the items are scaled as; never (1), rarely (2), occasionally (3), usually (4) and always (5). The Cronbach- alpha reliability co-efficient of the scale is 0.80. the scale comprises of 22 items which can be collected in five factors; Creativity, Algorithmic Thinking, Collaboration, Analytical Thinking, Problem Solving. Levels corresponding to points obtained from factors are as follows; 20-51: Low Level; 52-67: Medium Level; 68-100: High Level.

The Analysis of Data

The data obtained in scope of the research is analysed with SPSS (The Statistical Package for The Social Sciences) package program and all hypotheses are tested in 0.95 reliability level ($p = 0.05$). Since the obtained data correspond to parametric test assumptions ($N=160$) and show normality of the data parametric tests are used in the analysis of data. Within this concept, tests used for each sub-goal are explained below.

Demographical data collected from the participants is explained with descriptive statistic methods. In order to determine whether the participants demonstrate meaningful differences in terms of their Gender, t-test for independent samples is used. Furthermore, in order to determine whether the grades of participants demonstrate meaningful differences in terms of their classroom types, weekly internet usage durations, mobile device usage competence levels and mobile device possession durations, single-factor variance analysis (ANOVA) for independent samples is used.

FINDINGS AND INTERPRETATIONS

Findings regarding the first research question (Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their educational levels?)

Table 2 includes the findings acquired by single-factor variance analysis regarding whether the points obtained by participants from computational thinking skill levels scale differ meaningfully or not in terms of their educational levels variable.

Table 2. Results in terms of their Educational Level Variable

Learning on the class level	**N**	$\overline{X}$	**S**
5th grade	32	76,03	10,79
6th grade*	38	80,00	11,89
7th grade	49	70,22	13,41
8th grade	41	76,73	11,28
Total	160	75,37	12,48

	Source of variance	Sum of Squares	sd	Mean Square	F	p	Difference
Learning on the class level	Between Groups	2201,95	3	733,98	5,071	,002	7 with 5, 6, 8 and 6 with 5, 8
	Within Groups	22581,54	156	144,75			
	Total	24783,50	159				

As it is clear in Table 2, according to the findings obtained with single-factor variance analysis (ANOVA) for unrelated samples, there is a meaningful difference among the points of participants obtained from the scale in terms of their class levels [F(3-156)= 5,071, p<.05]. In other words, the computational thinking skill levels of participants differ meaningfully in terms of their class levels. As a result of LSD test which is performed in order to determine the source groups of this difference, it is found that the 7th graders are significantly different from all other students. In addition, there is a significant difference between 5th and 8th graders in favor of 6th graders.

Findings regarding the second research question (Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their Gender?)

Table 3 includes the findings acquired by t-test for independent samples regarding whether the points obtained by participants from computational thinking skill levels scale differ meaningfully or not in terms of their gender.

Table 3. Results in Terms of Their Gender

Groups	N	$\overline{X}$	S	Sd	t	p
Female	75	76,50	12,88	158	1,078	.283
Male	85	74,37	12,10			

*p<0.05

As it is clear in Table 3, the result is not meaningful because it is .283 > .05 for *p<.05 relevance level. The averages (=74,37 for males; =76,50 for females) of points of participants obtained in the scale are near to each-other, therefore the result is .283 > .05 for *p<.05 relevance level and is not meaningful. In other words, the computational thinking skill levels of participants do not differ meaningfully in terms of their genders.

Findings regarding the third research question (Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their weekly internet usage situations?)

Table 4 includes the findings acquired by single-factor variance analysis regarding whether the points obtained by participants from computational thinking skill levels scale differ meaningfully or not in terms of their weekly internet usage durations.

Table 4. Results in Terms of Weekly Internet Usage Durations

Weekly Internet Usage Durations	N	$\overline{X}$	S
0-3 hours	115	75,81	11,79
3-6 hours	27	71,74	14,80
6-9 hours	8	74,00	16,57
9 hours and over	10	81,20	8,02
Total	160	75,37	12,48

	Source of variance	Sum of Squares	sd	Mean Square	F	p	Difference
Weekly Internet Usage Durations	Between Groups	733,55	3	244,51	1,586	,195	
	Within Groups	24049,95	156	154,16			-----
	Total	24783,50	159				

As it is clear in Table 4, according to the findings obtained with single-factor variance analysis (ANOVA) for unrelated samples, there isn't any meaningful difference among the points of participants obtained from the scale in terms of their weekly internet usage durations [F(3-156)= 1,586, p>.05]. In other words, the computational thinking skill levels of participants do not differ meaningfully in terms of their weekly internet usage durations.

Findings regarding the fourth research question (Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their mobile device usage competence situations?)

Table 5 includes the findings acquired by single-factor variance analysis regarding whether the points obtained by participants from computational thinking skill levels scale differ meaningfully or not in terms of their mobile device usage competence situations.

Table 5. Results in Terms of Mobile Device Usage Competence Situations

Mobile Device Usage Competence Situations	**N**	$\overline{X}$	**S**
1. Very Poor	8	72,37	12,63
2. Insufficient	10	72,40	20,26
3.Adequate Intermediate	50	75,76	12,57
4. Adequate	55	75,92	12,75
5. Very Adequate	37	75,48	9,50
Total	160	75,37	12,48

	Source of variance	Sum of Squares	sd	Mean Square	F	p	Difference
Mobile Device Usage Competence Situations	Between Groups	185,15	4	46,28	,292	,883	-----
	Within Groups	24598,34	155	158,69			
	Total	24783,50	159				

As it is clear in Table 5, according to the findings obtained with single-factor variance analysis (ANOVA) for unrelated samples, there isn't any meaningful difference among the points of participants obtained from the scale in terms of their mobile device usage competence situations [F(4-155)= ,292, p>.05]. In other words, the computational thinking skill levels of participants do not differ meaningfully in terms of their mobile device usage competence situations.

Findings regarding the fifth research question (Do levels of computational thinking skill levels of elementary students differ meaningfully in terms of their mobile technologies possession durations?)

Table 6 includes the findings acquired by single-factor variance analysis regarding whether the points obtained by participants from computational thinking skill levels scale differ meaningfully or not in terms of their mobile technologies possession durations.

Table 6. Results in terms of Mobile Technologies Possession Durations

Year of having Mobile Technologies	**N**	$\overline{X}$	**S**
1. 0-2 years	112	77,03	11,98
2. 2-4 years	26	71,19	15,62
3. 4-6 years	22	71,86	8,99
Total	160	75,37	12,48

	Source of variance	Sum of Squares	sd	Mean Square	F	p	Difference
Mobile Technologies Possession Durations	Between Groups	1035,01	2	517,50	3,421	,035	1 with 2 and 2 with 1
	Within Groups	23748,48	157	151,26			
	Total	24783,50	159				

As it is clear in Table 6, according to the findings obtained with single-factor variance analysis (ANOVA) for unrelated samples, there is a meaningful difference among the points of participants obtained from the scale in terms of their mobile Technologies possession durations [$F(2\text{-}157)= 3,421$, $p<.05$]. In other words, the computational thinking skill levels of participants differ meaningfully in terms of their mobile Technologies possession durations.

As a result of LSD test which is performed in order to determine the source groups of this difference, it is found that the difference is between; 1 with 2 and 2 with 1.

CONCLUSION AND SUGGESTIONS

Computational thinking which includes various abilities of 21st century such as problem solving, analytical thinking and creative thinking develops competencies of; development and facilitation of individuals' problem-solving skills with the help of technology and setting the developing technology into work. Problem-solving skills and technology usage which are of big importance in order that individuals reach literacy level in academic area, should become efficient processes in educational environments. As a result of this, individuals will be able to access information without difficulties and to reach further high levels in the process of information production in their daily lives (Mertoğlu & Öztuna, 2004). The computational thinking of individuals is to use different algorithms to solve problems and to provide problem-solving success by using different solution methods. According to Tor and Erden (2004), individuals' usage rates of technological tools increase with the development of technology. The earlier students use technology, the more qualified information they learn in their progressive education. It is important to develop computational thinking skills and problem-solving skills at a young age. Computational thinking shows its effects in all fields of life. Particularly, it provides a new educational system for younger individuals (Wing, 2008). From this point of view, the following findings are reached as a result of this research which is realized with the participation of 160 elementary students (of which 75 are female (46,9%) and 85 are male (53,1%)) and by which the computational thinking skill levels of students are analysed; the computational thinking skill levels of elementary students differ in terms of their educational levels and as a result of LSD test which is performed in order to determine the source groups of this difference, it is found that the difference is between; 5th grade and 7th grade; 6th grade and 7th grade; 7th grade and 5th grade; 6th grade and 8th grade; 8th grade and 7th grade; computational thinking skill levels of elementary students do not differ meaningfully in terms of their genders; computational thinking skill levels of elementary students do not differ meaningfully in terms of their weekly internet usage situations; computational thinking skill levels of elementary students do not differ meaningfully in terms of their mobile device usage competence situations; computational thinking skill levels of elementary students differ meaningfully in terms of their mobile technologies possession durations and as a result of LSD test which is performed in order to determine the source groups of this difference, it is found that the difference is between; 1 with 2 and 2 with 1.

It is estimated that the information delivered regarding computational thinking skills will positively affect the usage of computer technologies by individuals in educational processes (Yadav, Zhou, Mayfield, Hambrusch & Korb, 2011). Furthermore, it is also considered that computational thinking skills affect teachers as well as students (Yadav, Mayfield, Zhou, Hambrusch & Korb, 2014). Brennan and Resnick (2012) stated that in order that Computational Thinking Skills to be in high-level, learning should be more supported, learning processes should be determined more clearly and precisely, different methods should be tried while accessing to information and individuals should have different attitudes towards events. It is suggested that activities regarding integration of problem-solving skills should be added into educational programs and deficient sides of individuals should be recovered by evaluating and grouping individuals' problem-solving skills since problem-solving skills are a cognitive feature (Saracaloğlu, Serin & Bozkurt, 2001). Considering that mobile device usage affects Computational Thinking Skills, it is estimated that the usage of these technologies will be increased with the solutions of problems experienced in technical support, infrastructure and cost fields of mobile technologies (Menzi, Önal & Çalışkan, 2012). In order to efficiently use mobile technologies. These devices should be used purposively in education environments, software of the devices should be up-to-date and trainings should be delivered for the effective usage of these devices in educational processes. (Çetinkaya & Keser, 2014). It is observed that computational thinking skill levels do not differ in terms of weekly internet usages. However, it is obvious that mobile technologies usage causes a difference. It is suggested that advantage can be provided by students possessing mobile devices in obtaining information every time everywhere by accessing internet through these devices (Yaşar, Sert, Demir & Yurdagül, 2013). It is important to investigate computer thinking skills with different studies. It is important to identify deficiencies in these studies and to propose solutions to eliminate these deficiencies. In the future, it is suggested to increase the computer thinking skill for the generation of the code writer.

REFERENCES

Akkoyunlu, B., Soylu, M.Y. & Caglar, M. (2010). A study on developing "digital empowerment scale" for university students. *H. U. Journal of Education, 39*, 10-19.

Aksoy, H. H. (2003). An analysis of concerning the use of technology and effects. *Education, Science and Society, 1*(4), 4-23.

Autio, O., Soobik, M., Thorsteinsson, G., & Olafsson, B. (2015). The development of craft and technology education curriculums and students' attitudes towards technology in Finland, Estonia and Iceland. *International Journal of Contemporary Educational Research, 2*(1), 22-34.

Avcı, U., & Seferoglu, S. S. (2011). Teackers' burnout in the information age: use of technology and possible actions in preventing burnout. *Mediterranean Journal of Educational Research, 9*, 13-26.

Brennan, K., & Resnick, M. (2012). New frameworks for studying and assessing the development of computational thinking. *In Proceedings of the 2012 annual meeting of the American Educational Research Association*, Vancouver, Canada (pp. 1-25).

Bundy, A. (2007). Computational thinking is pervasive. *Journal of Scientific and Practical Computing, 1*(2), 67-69.

Çetinkaya, L., & Keser, H. (2014). Problems faced by teachers and students in terms of using tablet pcs and suggested solutions related to these problems. *Anadolu Journal of Educational Sciences International, 4*(1), 13-34.

Erdem, M., & Akkoyunlu, B. (2002). A study of scope of primary school social studies project based learning with team carried with 5th grade students. *Elementary Education Online, 1*(1), 2-11.

Güney, C., & Çelik, R. N. (2009). Spatial informatics and spatial governance. 12. *Turkey Scientific and Technical Mapping Conference*, 11-15 May 2009, Ankara.

Jones, A., Buntting, C., & deVries, M. J. (2013). The developing field of technology education: A review to look forward. *International Journal of Technology and Design Education, 23*(2), 191-212.

Karasar, Ş. (2004). New communication technologies in education- internet and virtual higher education. *The Turkish Online Journal of Educational Technology–TOJET, 3*(4), 117-125.

Kazimoglu, C., Kiernan, M., Bacon, L., & MacKinnon, L. (2012). Learning programming at the computational thinking level via digital game-play. *Procedia Computer Science, 9*, 522-531.

Korkmaz, Ö., Çakır, R., Özden, M. Y., Oluk, A., & Sarıoğlu, S. (2015). Investigation of individuals' computational thinking skills in terms of different variables. *Ondokuz Mayis University Journal of Faculty of Education, 34*(2), 68-87.

Korkmaz, Ö., Çakır, R., & Özden, M. Y. (2015). Computational thinking levels scale (ctls) adaptation for secondary school level. *Gazi Journal of Education Sciences, 1*(2), 143-162.

Menzi, N., Önal, N., & Çalışkan, E. (2012). Investigating educational researchers' views of using mobile technologies for educational purposes based on technology acceptance model. *Ege Journal of Education, 13*(1), 40-55.

Mertoğlu, H., & Öztuna, A. (2004). Are there a relationship between the usage of technology by individuals and the problem solving skills?. *TOJET: The Turkish Online Journal of Educational Technology, 3*(1), 83-92.

Morelli, R., De Lanerolle, T., Lake, P., Limardo, N., Tamotsu, E., & Uche, C. (2011). Can android app inventor bring computational thinking to k-12. *In Proc. 42nd ACM Technical Symposium On Computer Science Education (SIGCSE'11)*, 1-6.

Moursund, D. G. (2006). *Computational thinking and math maturity: Improving math education in K-8 schools.* Eugene, OR: Information Age Education.

Özkök, A. (2005). Effects of interdisciplinary creative problem solving teaching program on creative problem solving skills. *Hacettepe University Journal of Education, 28*(28), 159-167.

Qiu, R. G. (2009). Computational thinking of service systems: Dynamics and adaptiveness modeling. *Service Science, 1*(1), 42-55.

Ritz, J. M., & Martin, G. (2013). Research needs for technology education: An international perspective. *International Journal of Technology and Design Education, 23*(3), 767-783.

Rohaan, E. J., Taconis, R., & Jochems, W. M. (2012). Analysing teacher knowledge for technology education in primary schools. International *Journal of Technology and Design Education, 22*(3), 271-280.

Rong-sheng, D. (2009). Computational thinking and introduction to computer science. *Computer Science, 4*, 015.

Sadi, S., Şekerci, A. R., Kurban, B., Topu, F. B., Demirel, T., Tosun, C., Demirci, T., & Göktaş, Y. (2008). Effective technology use in teacher education: the views of faculty members and preservice teachers. *International Journal of Informatics Technologies, 1*(3), 43-49.

Saracaloğlu, A. S., Serin, O., & Bozkurt, N. (2001). The relationship between the problem solving skills and the achievement of graduate students of the graduate school of educational sciences. *Marmara University Journal of Educational Sciences, 14*, 121-134.

Seferoğlu, S. S. (2009). Technology usage and managers perspectives in primary schools. *Academic Computing'09* – 11-13 February 2009 Harran University, Şanlıurfa.

Seiter, L., & Foreman, B. (2013). Modeling the learning progressions of computational thinking of primary grade students. *In Proceedings of the Ninth Annual İnternational ACM Conference On International Computing Education Research*, 59-66.

Sengupta, P., Kinnebrew, J. S., Basu, S., Biswas, G., & Clark, D. (2013). Integrating computational thinking with K-12 science education using agent-based computation: A theoretical framework. *Education and Information Technologies, 18*(2), 351-380.

Tian-long, D. (2009). Computational Thinking and Methodology of Computer Science and Technology. *Computer Science*, 1, 005.

Tor, H., & Erden, O. (2004). A research about primary school students level who takes advantage from information technology. *The Turkish Online Journal of Educational Technology, 3*(1), 120-130.

Wing, J. M. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33-35.

Wing, J. M. (2008). Computational thinking and thinking about computing. Philosophical Transactions of the Royal Society of London A: *Mathematical, Physical and Engineering Sciences, 366*(1881), 3717-3725.

Yadav, A., Zhou, N., Mayfield, C., Hambrusch, S., & Korb, J. T. (2011). Introducing computational thinking in education courses. *In Proceedings of the 42nd ACM Technical Symposium on Computer Science Education*, 465-470.

Yadav, A., Mayfield, C., Zhou, N., Hambrusch, S., & Korb, J. T. (2014). Computational thinking in elementary and secondary teacher education. *ACM Transactions on Computing Education (TOCE), 14(*1), 5.

Yaşar, S., Sert, G., Demir., Ö., & Yurdugül, H. (2013). *To investigate the correlation secondary schools and high schools students' attitudes towards the computer and self-learning with technology.* 1st International Instructional Technologies and Teacher Education Symposium, 152-161.

Yiğit, Y. G., Zayim, N., & Yıldırım, S. (2002). Administrative and instructional use of technology in higher education: a case study. *Education and Science, 27(*124), 42-51.