Journal of Educational Technology & Online Learning
Volume 4 | Issue 3 | 2021
http://dergipark.org.tr/jetol

Pre-service teachers' decoding skills in information and communication technologies and critical thinking dispositions**

Hakan Akgül [a *], Özden Şahin İzmirli [b]

[a] Canakkale Onsekiz Mart University, Turkey.
[b] Çanakkale Onsekiz Mart University, Turkey.

Suggested citation: Akgül, H. & Şahin İzmirli, Ö. (2021). Pre-service teachers' decoding skills in information and communication technologies and critical thinking dispositions. *Journal of Educational Technology & Online Learning*, *4*(3), 516-530.

Article Info

Keywords:

Critical thinking dispositions
Decoding skills in ICT
Information and communication technologies
Pre-service teachers

Research Article

Abstract

This research aims to examine the relationship between the critical thinking dispositions of preservice teachers and their decoding skills in information and communication technologies (decoding skills-ICT). As a research method, survey and correlational research models from quantitative research approaches were used. Research universe is a Faculty of Education at a state university in Turkey. With the use of the convenience sampling method, 262 preservice teachers who voluntarily participated in the online survey constitute the sample of the research. The research data were obtained using the Marmara Critical Thinking Dispositions Scale (MCTDS) and the Decoding Skills in Information and Communication Technologies (decoding skills-ICT) Scale in the 2020-2021 academic year. Among the significant findings of the study are that the average scores of preservice teachers for decoding skills-ICT are at an average level and the average scores for critical thinking dispositions are high. Finally, it has been found in the study that there is a moderately positive relationship between critical thinking dispositions and decoding skills-ICT. According to regression analysis, decoding skills-ICT explains 17.8% of the variance of critical thinking dispositions. This study also aimed to investigate the relationship between decoding skills-ICT and different higher-level thinking skills and to examine the impact of attitudes, dispositions, and skills of different groups of participants on decoding skills-ICT.

1. Introduction

Human is a thinking being. However, individuals may not always exhibit consistent behaviour with their thoughts (Parra et al., 2021). Due to some incomplete information and prejudices, people may think incorrectly, ignoring some facts, evidence, and reasoning (Parra et al., 2021). However, when thinking, it is necessary to question what is true to conclude by combining available clues. In contrast, individuals do not prefer systematic thinking with the convenience of easy and effortless access to ready-to-use information (Tishman et al., 1993). For this reason, it will not be enough to think only when making decisions, believing in a situation or phenomenon. The act of thinking needs to be systematically transformed into quality thinking (Parra et al., 2021; Paul and Elder, 2006). For this purpose, individuals must access the information provided by the source with the use of exploratory methods, rather than getting

* Corresponding author: Hakan Akgül, Computer Education and Instructional Technology, Çanakkale Onsekiz Mart University, Turkey.
** This study was produced from Hakan Akgül's MA thesis entitled "Examining the Relationship between Critical Thinking and Decoding Skills-ICT" conducted under the consultancy of Assoc. Prof. Dr. Özden Şahin İzmirli.
** This study is supported by Çanakkale Onsekiz Mart University, Scientific Research Projects Coordination Unit.
Project Number: SYL-2021-3413
E-mail addresses: hakanakgul34@gmail.com, osahinizmirli@gmail.com

Doi: http://doi.org/10.31681/jetol.945411
Received 31 May 2021; Revised 14 Sep 2021; Accepted 29 Sep 2021

as it is (Paul and Elder, 2006). One of the methods mentioned in this framework is critical thinking (Fadel, 2008; Partnership for 21st Century Skills., 2019).

Critical thinking is defined as a purposeful and self-controlling process of judgment that allows individuals to find a way to interpret, analyse, evaluate, infer, explain, and combine details, making a judgment (Facione, 1990; S. Özdemir, 2005; Solmaz, 2014). Organisation for Economic Co-operation and Development [OECD] (2018) highlights cognitive and metacognitive that each individual is supposed to have through critical thinking, such as creative thinking, learning to learn and self-regulation to keep up with changing and evolving conditions. In the field of psychology, Cüceloğlu (2003, p.216) defines critical thinking as an active and organized mental process that aims to understand ourselves and the events around us through our own thought processes, taking into account the others' thought processes and applying what we have learned. Critical thinking is a skill that benefits from problem solving, requires a correct way of thinking and working, and allows us to be more accurate and specific in recognizing related situations (Saenab et al., 2021). Critical thinking is also the ability to apply reasoning and logic to new or unusual ideas, views, and situations (Broadbear and Keyser, 2000).

Today's field experts believe that critical thinking is an important output of higher education and that helping gain critical thinking dispositions is a fundamental part of learning (Bravo et al., 2020; Lou, 2018; Morales Carrero, 2020). For this reason, individuals need to be educated through educational processes by having critical thinking as a cognitive interrogation tool to establish the foundation of a rational and democratic society that provides consistent and useful information (Ennis, 1985; Facione, 1990; Scheffler, 1973). Cognitive and metacognitive strategies, which help individuals to use their prior knowledge or schemata, are known to have increased their participation in the learning process and thus raised more awareness regarding critical thinking (Salameh, Salameh, and Al-Emami, 2019). When considered from this point of view, it could be claimed that there is a link between cognitive schemata and critical thinking.

Piaget defines a scheme as "a coherent, repeatable sequence of actions with component actions that are tightly interconnected and regulated with a fundamental meaning" (Piaget, 1965). Schemata start as reflexes at birth (Piaget, 1965). Problems experienced throughout life are reshaped with new experiences (Bartlett, 1932) once they are solved (Mayer, 1983). It becomes more complex towards adulthood (Wadsworth, 1989). Besides, these are cognitive structures that serve to transfer new information to long-term memory and call to working memory when necessary (Gagne, 1986).

When an experience is encountered, the schemata and new situation are matched (Wadsworth, 1989). Equilibrium is achieved if matching could be done smoothly (McLeod, 2018). However, this is not always the case. It means that a problem that needs to be solved and a new disequilibrium that needs to be learned has emerged if schemata cannot match the new situation appropriately (McLeod, 2018; Phillips, 1975; Piaget, 1965; Wadsworth, 1989). Akgül (2021) mentions decoding skills, with which individuals can overcome disequilibrium with their self-awareness.

Decoding skills are based on the schemata approach. It is a mental and cyclic process that helps adapt to the new situation, integrating the existing information into a new event. In case of failure to provide such adaptation in this process, the sense-making, debugging, and problem-solving stages are used for the identification of the cause of the error and solve it (Akgül, 2021). The decoding process has a wide-ranging structure that can be used in reading, communication, neural activities, humour production, information and communication technologies. It needs to be "solved" to get an understandable result from the coded data. Therefore, awareness regarding decoding skills needs to be raised, learned, and used (Akgül, 2021). However, decoding skills, which are inherently associated with different disciplines, must be defined in a discipline-specific way in order to be measured and acquired in individuals (Akgül, 2021).

Based on this idea, Akgül (2021) proposes a structure that can use decoding skills based on information and communication technologies (ICT). Individuals' sense-making of the messages received through digital technology, inspecting the causes of errors encountered, obtaining good or bad results in the solution attempt of these problems reveals decoding skills in information and communication technologies (decoding skills-ICT) (Akgül, 2021). Sense-making in ICT is the association of schemata created with past ICT experiences with the new ICT experiences. Debugging in ICT is the cognitive identification of possible causes that cannot be understood in an ICT experience (Akgül, 2021). Problem-solving in ICT is a process that aims to solve the problems set in an ICT experiences. This process includes the stages of interpretation of the problem, planning the solution, implementing, and evaluating the result. At the end of the process, a new experience is gained, and cognitive schemata are formed (Akgül, 2021; Mayer, 1983). When consider from this point of view, the purpose of decoding in ICT is to understand an ICT experience based on past experiences. Failure to understand the experience is corrected by identifying the sources of the error and supporting with relevant problem-solving processes (Akgül, 2021). Overcoming biases in the decoding process and heading towards evidence/data (Abrami et al., 2008; Facione, 1990; Larsson, 2017; Williams, 2005) is thought to be related to critical thinking dispositions. This study is carried out as a strengthening study of the relationship between critical thinking and decoding skills.

At this point, preservice teachers who will educate new generations and who will guide the development and progress of society have to take big responsibility. Considering that preservice teachers use their pedagogical knowledge to transfer their cognitive skills as well as their content knowledge to new generations that will shape the future (Orhan-Göksun and Kurt, 2017), it is expected that they have a high level of cognitive skills at the last stage of their education life before they step into the teaching profession. Besides, it is suggested that decoding skills can be used to develop high-level cognitive skills. For this reason, this study aims to reveal the relationship between the critical thinking dispositions of preservice teachers and decoding skills in information and communication technologies (decoding skills-ICT).

This study aims to examine the relationship between the use of critical thinking dispositions and decoding skills in information and communication technologies (decoding skills-ICT) of preservice teachers studying at the Faculty of Education. For this purpose, the following research questions were developed in the study:

a. What is the decoding skills-ICT level of pre-services teachers?

b. What is the critical thinking disposition level of pre-services teachers?

c. What is the relationship between decoding skills-ICT and the critical thinking dispositions of preservice teachers?

d. Are pre-services teachers' decoding skills-ICT a meaningful part of their critical thinking dispositions?

2. Methodology

2.1. Research Model

This study was carried out using the survey and correlation research models. Survey model research often deals with the views of a large group of people on a particular topic (Fraenkel et al., 2012). However, the correlational survey model was used in the study to examine the relationship between critical thinking dispositions and decoding skills-ICT. The correlational survey model defines the degree to which two or more quantitative variables are related and uses a correlation coefficient to do this (Fraenkel et al., 2012). Such studies allow researchers to make inferences about the universe (Creswell, 2012).

2.2. Study Group

The universe of the research is a Faculty of Education of a state university in Turkey. The research universe of the study consists of the students at the same Faculty who are studying at the undergraduate level in the 2020-2021 academic year. The research universe consists of 3859 preservice teachers.

It was considered impossible to reach the entire universe, due to time, cost, and pandemic-related factors. For this reason, a sample that could represent the whole universe was determined. The sample was chosen by single-stage sampling and convenience sampling method. Regarding how to decide the number of samples, Fraenkel et al., (2012) stated that there is not any precise calculation method, and so suggested that the minimum number of participants should be 100 and 50 for a correlation study.

After receiving the relevant permissions, an email was sent to each of the 178 academics teaching at the Faculty of Education. In the email sent to academics, they were requested to share the scale link created via Google Forms with the students of the Faculty of Education through online platforms. Ethics committee approval and documents of data collection permission were attached to the sent e-mail. At the end of the data collection process, 331 participants who voluntarily participated in the survey were obtained. The responses were then examined. Through control items in the scale, 69 participants were found to have marked the items without reading them, and the data obtained through these items were excluded from the evaluation. In this way, 262 filled surveys were obtained, and the relevant descriptive details are given in Table 1.

Table 1.

Descriptive statistics regarding participants

		Female (f)	Female (%)	Male (f)	Male (%)	Total (f)	Total (%)
Gender	18	8	72.7%	3	27.3%	11	4.2%
	19	45	93.8%	3	6.3%	48	18.3%
	20	41	74.5%	14	25.5%	55	21%
	21	57	89.1%	7	10.9%	64	24.4%
	22	36	81.8%	8	18.2%	44	16.8%
	23	17	81%	4	19.0%	21	8.0%
	24	2	28.6%	5	71.4%	7	2.7%
	25+	9	75%	3	25.0%	12	4.6%
	TOTAL	**215**	**82.1%**	**47**	**17.9%**	**262**	**100%**
Class level	1	41	82%	9	18%	50	19.1%
	2	59	83.1%	12	16.9%	71	27.1%
	3	58	77.3%	17	22.7%	75	28.6%
	4	46	92%	4	8%	50	19.1%
	Preparatory	11	68.8%	5	31,3%	16	6.1%
	TOTAL	**215**	**82.1%**	**47**	**17,9%**	**262**	**100%**
I took "Computer" course at the primary school.	Yes	187	81.7%	42	18.3%	229	87.4%
	No	28	84.8%	5	15.2%	33	12.6%
	TOTAL	**215**	**82.1%**	**47**	**17.9%**	**262**	**100%**
I took "Information Technologies" course at the undergraduate Level	Yes	194	83.3%	39	16.7%	233	88.9%
	No	21	72.4%	8	27.6%	29	11.1%
	TOTAL	**215**	**82.1%**	**47**	**17.9%**	**262**	**100%**

When Table 1 was examined, there were 215 (82.1%) female and 47 (17.9%) male participants. The youngest of the participants was found to be 18 years old, and 9 participants were found to be aged 25 and above. According to class level, preparatory (N=16), first-year (N=50), second-year (n=71), Third-year (n=75) and fourth/last year (N=50) students took part in the study. On the other hand, according to the status of taking computer courses in primary education, 229 (87.4%) participants were found to have taken this course, while 33 (12.6%) of the participants did not. When the status of having taken Information Technologies course at the undergraduate level, 233 (88.9%) of the participants were found to have taken this course and 29 (11.1%) of them did not.

With the new regulation in the teacher education at the undergraduate program in 2018, the "Information Technology" course became a compulsory course. 16 of the pre-service teachers were found not to have taken this course as they were at the preparatory level. On the other hand, 3 of the preservice teachers who did not take the Information Technology course were found to be the first-year students of Japanese teaching. According to the Japanese teaching program, this course is given in the 3rd semester. Of the remaining 10 preservice teachers, 3 of them were in the 3rd grade and 7 of them were in the 4th grade. The fact that these preservice teachers stated that they did not take the compulsory Information Technology course could be explained with that they were taught with the curriculum implemented before 2018 because there was no course in the name of Information Technology before 2018. Instead, the Computer I and Computer II courses were compulsory in the 3rd and 4th semesters. For this reason, the responses “I did not take the Information Technology course" could be acceptable.

2.3. Data Collecting Tools

The “Marmara Critical Thinking Disposition” and “Decoding Skills in Information and Communication Technologies” (decoding skills-ICT) scales were used as data collection tools in the study.

Marmara Critical Thinking Disposition Scale (MCTDS)

The “Marmara critical thinking disposition scale” developed by Özgenel and Çetin (2018) was used to find out the critical thinking dispositions of preservice teachers. The scale consists of 28 items within a 5-point Likert type and a 6-Factor Structure, which are “reasoning”, “reaching judgment”, “searching for evidence”, “searching for the truth”, “open-mindedness”, “systematicity”. Validity and reliability studies of the original scale were conducted with the data collected from 410 teachers on active duty. It was decided that the target audience of our research was preservice teachers and that the CFA should be carried out as recommended by the scale developers.

CFA data was obtained from 1308 preservice teachers (out of the research universe and with similar demographics to the research universe) who participated voluntarily in the CFA research. With the CFA, which was performed without correction for the model consisting of 6 Factors and 28 items, the model fit indices were found to be as [$\chi2$=1322.240; df=335; $\chi2$/df=3.947 p<, 001; GFI=.929; AGFI=.914; CFI=.932; NFI=.912; NNFI(TLI)=.924; RMSEA= .047; RMR=.023; SRMR=.035] (Figure 1.)

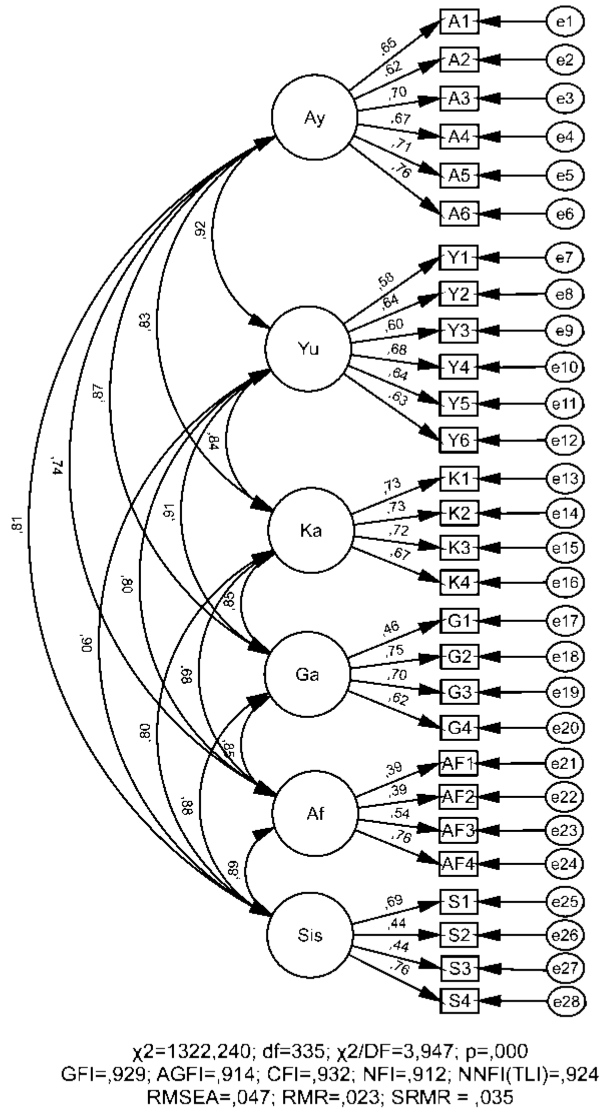

Figure 1. Findings of Confirmatory Factor Analysis (CFA)

Since increasing the sample size causes the value of $\chi 2$ to be higher and the value of p to be significant, it can be ignored in such studies (Çokluk et al., 2014). When the fit indices are considered, it is seen that RMSEA, RMR values are in the range of “goodness of fit indices” (Brown, 2006; Browne and Cudeck, 1992; Hu and Bentler, 1998; Schreiber et al., 2006). On the other hand, the $\chi 2$/sd, GFI, AGFI, CFI, NFI, NNFI values are in the range of "acceptable fit indices" (Forza and Filippini, 1998; Greenspoon and Saklofske, 1998; Hooper et al., 2008; Kline, 2016; Sümer, 2000; Tabachnick and Fidell, 2013). Based on these findings, it could be claimed that the model structure, consisting of 6 Factors and 28 items, is confirmed for preservice teachers. When internal consistency reliability was examined, Cronbach's alpha values were found to be α=84 for the dimension of reasoning, α=80 for the dimension of reaching judgment, α=.80 for the dimension of searching for the evidence, fact search size α=.70 for the dimension of searching for the truth, α=.62 for the dimension of open-mindedness, α=.93 for the dimension of systematicity α=.93 for the whole scale. According to the results, MCTDS has been adopted as a valid and reliable measurement tool for preservice teachers.

Decoding Skills in Information and Communication Technologies (Decoding skills-ICT) Scale

The scale developed by Akgül (2021) aims to determine the decoding skills-ICT of preservice teachers. The scale consists of 23 items in 5-point Likert type. It has a four-factor structure as “basic digital skills”, "advanced technical skills", "security and social skills in the digital environment", "coding skills". When internal consistency coefficients are examined, it was found to be α=.92 for basic digital skills, α=.93 for advanced technical skills, α=.79 for security and social skills in the digital environment, α=.95 for coding skills. The internal consistency coefficient for the whole scale was also found to be α=.94. In the interpretation of the total scores obtained from the scale, the range [23-53] is taken low, the range [54-84] is taken medium, the range [85-115] is taken high.

2.4. Data Analysis

As part of the research, the data obtained with MCTDS and the decoding skills-ICT scale were analysed through quantitative methods at the p<,05 significance level. Which of the analysis methods to use was determined by testing the assumption of normality. The fact that the skewness and kurtosis values are in the range of -1 and +1 indicates that the data is normally distributed (Hair et al., 2013; Tabachnick and Fidell, 2013). The skewness and kurtosis values of the data related to the measurement tools are given in Table 2.

Table 2: The skewness and kurtosis values of the measurement tool

Measurement Tool	Dimension	Skewness	Kurtosis
Decoding skills-ICT Scale	Whole Scale	-.092	-.514
	Basic Digital Skills	-.610	-.090
	Advanced Technical Skills	-.084	-.874
	Security and Social Skills in Digital Environment	-.579	-.281
	Decoding Skills	.965	-.062
MCTDS	Whole Scale	-.229	-.541
	Reasoning	-.352	-.648
	Reaching judgement	-.369	-.189
	Searching for the evidence	-.366	-.836
	Searching for the truth	-.273	-.490
	Open-mindedness	-.500	.147
	Systematicity	-.353	-.334

According to Table 2, it is seen that the skewness and kurtosis values in the whole scale and lower dimensions of the scale are in the range of -1 and +1 regarding the BIT-DS scale and MCTDS data. For both scales and all of their sub-dimensions, it can be said that the data is normally distributed and that the normality assumption is met (Hair et al., 2013). Therefore, parametric tests were used in the analysis of research data. Table 3 presents which analysis methods are used to obtain the results of research questions.

Table 3: Research question, data collection tool, matching data analysis method

Research question	Data collection tool	Data analysis technique
…of preservice teachers.		
1. What is the decoding skills-ICT level?	-Decoding skills-ICT Scale	Descriptive statistics
2.What is the critical thinking disposition level?	-MCTDS	Descriptive statistics
3. What is the relationship between decoding skills-ICT and the critical thinking dispositions?	- Decoding skills-ICT Scale and MCTDS	Pearson correlation coefficient
4. Are pre-services teachers' decoding skills-ICT a meaningful part of their critical thinking dispositions?	- Decoding skills-ICT Scale and MCTDS	Simple Linear Regression

3. Findings and Discussions

In this section, the findings regarding the relationship between the level of decoding skills-ICT, critical thinking dispositions of preservice teachers and decoding skills-ICT and critical thinking dispositions are given.

3.1. Findings regarding decoding skills-ICT level of preservice teachers

Findings regarding the decoding skills-ICT levels of preservice teachers were obtained using the decoding skills-ICT scale. Under this heading, the decoding skills-ICT levels of preservice teachers and their sense-making, debugging and problem-solving levels for decoding skills are presented in Table 4. The findings were then discussed in line with the relevant literature.

Table 4.

Descriptive statistics regarding the decoding skills-ICT levels of preservice teachers

Dimension	f	$\bar{X}$	Sd	S	Sd_S	D	Sd_D	PS	Sd_{PS}
Basic Digital Skills	262	3.80	.74	4.10	.70	3.65	.87	3.60	.87
Advanced Technical Skills		3.09	1.08	3.15	1.12	3.04	1.10	3.09	1.15
Security and social skills in the digital environment		4.02	.70	3.89	1.21	4.21	.71	3.95	.89
Decoding skills		2.00	1.11	2.09	1.18	1.98	1.15	1.92	1.12
Whole scale	262	3.44	.69	3.51	.71	3.40	.72	3.42	.72

Note 1: Sd: Standard deviation
Note 2: S: Average of sense-making, D: Average of debugging, PS: Average of problem-solving
Note 3: Average of the scores taken from the 5-point Likert type scale

According to Table 4, the analysis was conducted with the data obtained from a group of 262 preservice teachers. Averages that preservice teachers took from the decoding skills-ICT scale were found to be as follows; dimension of basic digital skills $\bar{X}$ =3.80, Sd=.74; dimension of advanced technical skills $\bar{X}$=3.09, Sd=1.08; dimension of security and social skills in digital environment $\bar{X}$=4.02, Sd=.70, dimension of encoding skills $\bar{X}$=2.00, Sd=1.11, and whole scale $\bar{X}$=3.44, Sd=.69. On the other hand, the averages of each dimension for decoding skills were taken. For the whole scale; sense-making ($\bar{X}$=3.51, Sd=.71), debugging ($\bar{X}$=3.40, Sd=.72), problem-solving ($\bar{X}$=3.42, Sd=.72); for basic digital skills; sense-making ($\bar{X}$=4.10, Sd=.70), debugging ($\bar{X}$=3.65, Sd=.87) and problem-solving ($\bar{X}$=3.60, Sd=.87). For advanced technical skills; sense-making ($\bar{X}$=3.15, Sd=.1.12), debugging ($\bar{X}$=3.04, Sd=1.10) and problem-solving ($\bar{X}$=3.09, Sd=1.15). For security and social skills in the digital environment; sense-making ($\bar{X}$=3.89, Sd=1.21), debugging ($\bar{X}$=4.21, Sd=.71) and problem-solving ($\bar{X}$=3.95, Sd=.89). For coding skills; sense-making ($\bar{X}$=2.09, Sd=1.18), debugging ($\bar{X}$=1.98, Sd=1.15) and problem solving ($\bar{X}$=1.92, Sd=1.12).

In other words, according to the average score received by preservice teachers, they were found to be *high* in the dimension of basic digital skills, *medium* in the dimension of advanced technical skills, *high* in the dimension of security and social skills in the digital environment, and *low* in the dimension of coding skills. In terms of overall scale, the decoding skills in information and communication technologies of preservice teachers were found to be at a *medium* level. Especially in the dimension of social and security skills, it is seen that the results are better compared to those of technical skills. These findings support Kaarakainen's (2018) claims that situations requiring more technical skills are more challenging.

On the other hand, for each dimension, averages of sense-making, debugging and problem-solving related to decoding skills were examined. Averages of preservice teachers according to decoding components for the whole scale were *medium* in the sense-making dimension, *medium* in the debugging dimension and *medium* in the problem-solving dimension. For basic digital skills, their averages were *high* in the sense-making dimension, *medium* in the debugging dimension and *medium* in the problem-solving dimension. For advanced technical skills, their averages were *medium* in the sense-making dimension, *medium* in the debugging dimension and *medium* in the problem-solving dimension. For security and social skills in the digital environment, their averages were found to be *high* in the sense-making dimension, *high* in the debugging dimension, *high* in the problem-solving dimension. For coding skills, their averages were found to be *low* in the sense-making dimension, *low* in the debugging dimension, *low* in the problem-solving dimension.

According to the results, preservice teachers have high and medium levels of sense-making in their decoding skills. This finding reveals that when a new experience is encountered, they can be successful in linking the new experience with the past experiences (Akın et al., 2007; Boyacıoğlu and Aktaş, 2018; Güven, 2004; Schraw and Dennison, 1994) and relate new knowledge to previous learning (Güven, 2004). On the other hand, preservice teachers with low coding skills were found to have low sense-making, debugging and problem-solving levels. Some studies claimed that those with high programming skills have low debugging skills, so debugging is a skill that should be taught separately (Ahmadzadeh et al., 2005; Masuck et al., 2008). This study found that, unlike the relevant literature, coding skill and debugging have consistent levels with each other. Böttcher et al., (2016) suggest that debugging does not only mean gaining technical skills in software or engineering but also means more than the technical meaning of debugging. When the debugging levels of preservice teachers are examined, the fact that the level of debugging in non-technical sub-dimensions is higher supports this view.

3.2. Findings Regarding Critical Thinking Dispositions of Preservice Teachers

Critical thinking dispositions of preservice teachers were obtained with MCTDS. Findings regarding the levels of critical thinking disposition obtained with MCTDS are given in Table 5.

Table 5.

Descriptive statistics regarding the level of critical thinking dispositions

Dimension	f	$\bar{X}$	Sd
Reasoning	262	4.25	.52
Reaching judgement		4.08	.54
Searching for the evidence		4.23	.55
Searching for the truth		4.01	.59
Open-mindedness		4.24	.49
Systematicity		4.21	.54
Whole scale	262	4.16	.41

According to Table 5, the analysis was conducted with the data obtained from a group of 262 preservice teachers. MCTDS averages of preservice teachers are as follows: the dimension of reasoning $\bar{X}$=4.25, Sd=.52; dimension of reaching judgement $\bar{X}$=4.08, Sd=.54; dimension of searching for the evidence $\bar{X}$=4.23, Sd=.55; dimension of searching for the truth $\bar{X}$=4.01, Sd=.59; dimension of open-mindedness $\bar{X}$=4.24, Sd=.49 and dimension of systematicity $\bar{X}$=4.21, Sd=.54. For the whole scale, the critical thinking dispositions of preservice teachers were found to be $\bar{X}$=4.16, Sd=0.41.

The fact that the average score of preservice teachers for critical thinking dispositions is 4 and above could be interpreted as having high critical thinking dispositions. In the studies conducted using a different measurement tool in the relevant field, there are a limited number of studies reporting a high level of critical thinking disposition (for example, Bayraktar and Yağan Güder, 2019; Kiriş Avaroğulları and Şaman, 2020). On the other hand, past research has mainly revealed that the critical thinking levels of preservice teachers are low (Açışlı, 2016; Alkın-Şahin et al., 2014; Can and Kaymakçı, 2015; Güven and Kürüm, 2007; Hayırsever and Oğuz, 2017; Yakar et al., 2010), or at average level (Alper, 2010; Bayat, 2014; Beşoluk and Önder, 2010; Korkmaz, 2009; Ocak et al., 2016; S. M. Özdemir, 2005; Saracaloğlu and Yılmaz, 2011; Sarıgöz, 2014; Semerci, 2010). The studies that claim a high level of critical thinking disposition seem to be more up to date. In this context, it is thought that developments in the education system have a positive effect on critical thinking dispositions.

3.3. The findings regarding the relationship between critical thinking dispositions and decoding skills-ICT

Findings regarding the relationship between critical thinking dispositions of preservice teachers and decoding skills in information and communication technologies are given under this heading. Pearson correlation multiplication coefficient was used to obtain the results. Results obtained from the analysis are given in Table 6.

Table 6: Relationship between critical thinking dispositions and decoding skills (decoding skills-ICT) of preservice teachers

Variable	n	X̄	Sd	Critical Thinking Dispositions	Decoding skills-ICT
Critical Thinking Dispositions	262	4.17	.41	.1	.422**
Decoding skills-ICT	262	3.44	.68	.422**	1

**p<0.01

As seen in Table 6, a positive and moderately significant relationship between the critical thinking dispositions of preservice teachers and decoding skills in information and communication technologies (r=.422, p=.000<.001) was found in the study. This indicates that the critical thinking dispositions of preservice teachers are closely related to ICT. This relationship reveals that developing the disposition to think critically can also improve decoding skills in information and communication technologies.

3.4. The findings of variance explained by ICT-skills towards critical thinking dispositions.

The findings regarding pre-service teachers' decoding skills-ICT explain how much of the variance towards critical thinking tendencies are given under this heading. Simple Linear Regression analysis was used to obtain the findings. The results obtained from the analysis are given in Table 7.

Table 7: Explanation of variance of critical thinking dispositions of decoding skills-ICT of pre services teachers.

Variable	B	Sh	β	t	p
Constant	3.29	.119			
Decoding skills-ICT	.255	.034	.422	7.502	.001
$R=.422$; $R^2=.178$; $F_{(1,260)}= 56.28$; $p<.001$					

Note: Average of Critical Thinking Trends as Independent Variable

As shown in Table 7, a significant regression model ($F_{(1,260)}= 56.27$, $p<.001$) was found with the analysis. It was also found that 17.8% ($R^2 = .178$) of the variance in critical thinking tendencies was explained by decoding skills-ICT. Accordingly, decoding skills-ICT positively and significantly exhaust critical thinking trends ($\beta=.422$, $t_{(260)}=7.502$, $p<.001$). Every 1-point increase in decoding skills-ICT leads to a .255 point increase in critical thinking dispositions (B=.255). Accordingly, the Y=a+bX regression equation, which fatigues the critical thinking trend score, is as follows:

Critical thinking dispositions = 3.29 + 0.255 x decoding skills-ICT.

Conclusion and Suggestions

This research examined the relationship between decoding skills in information and communication technologies and critical thinking dispositions through preservice teachers. The decoding skills-ICT of preservice teachers was found to be at the medium level. It was also found that as the need for technical knowledge increased, the decoding skills-ICT levels decreased accordingly. It is necessary to examine whether this shows similarities in the new research to be conducted with different working groups. In particular, it seems that preservice teachers received low scores in coding skills. Information and communication technologies within every part of life. For this reason, it is proposed to conduct educational studies to develop the coding skills of preservice teachers that will allow them to communicate through the used technologies. It has been observed that preservice teachers, especially in coding skills, are at a low level in debugging and problem-solving skills. In future research, it is recommended to design training and activities that support debugging and problem-solving processes to improve coding skills. On the other hand, this may also concern the content of Information Technology courses taught at universities. The contents of these courses can be restructured to support debugging and problem-solving skills in decoding skills.

The critical thinking dispositions of preservice teachers were found to be high. When the past research was examined, it is seen that more recent studies report a similarly high disposition regarding critical thinking

(Bayraktar and Yağan Güder, 2019; Kiriş Avaroğulları and Şaman, 2020). It is recommended to conduct meta-analysis studies that examine this in a more detailed way and observe the change in critical thinking dispositions of preservice teachers by year. Besides, it is recommended for researchers to conduct research that examines the critical thinking dispositions of preservice teachers through various measurement tools.

It has been found that ICT has a moderately positive relationship with critical thinking dispositions. This finding could be a new way to achieve critical thinking dispositions. In fact, ICT explains 17.8% of critical thinking tendencies. Therefore, it could be claimed to be a significant finding. There are studies that have concluded that decoding and critical processes should be combined in reading (Nascimento and Franco, 2017), the supporting role of decoding and critical thinking tendencies in reading (Kılıç et al., 2017), and that the meaning of reading improves other cognitive skills, including critical thinking (Lisitsina et al., 2020). Within the framework of the research results, decoding skills-ICT contributed to critical thinking trends. In this respect, it supports the relevant literature. On the contrary, Nascimento and Franco's (2017) finding suggesting that students read online without a scientific and critical perspective does not correspond to the research findings. However, it is necessary to examine whether or not this is confirmed by different participants. Besides, this relationship could be tested again using different measurement tools to determine critical thinking dispositions. In future research, it is recommended to investigate the relationship between decoding skills-ICT and different high-level thinking skills. Besides, the effect of attitudes, dispositions and skills of different research groups on decoding skills-ICT could be examined. Thus, different ways of achieving critical thinking dispositions can be used.

References

Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., and Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. Review of Educational Research, 78(4), 1102–1134. doi:10.3102/0034654308326084

Açışlı, S. (2016). Sınıf öğretmeni adaylarının öğrenme stilleri ile eleştirel düşünme eğilimlerinin incelenmesi. Elementary Education Online, 15(1), 273–285. doi:10.17051/io.2016.78596

Ahmadzadeh, M., Elliman, D., and Higgins, C. (2005). An analysis of patterns of debugging among novice computer science students. ACM SIGCSE Bulletin, 37(3), 84. doi:10.1145/1151954.1067472

Akgül, H. (2021). Eleştirel Düşünme ve BİT-Kod Çözme Becerileri Arasındaki İlişkinin İncelenmesi. (Unpublished master's thesis). Canakkale Onsekiz Mart University, Canakkale, Turkey.

Akın, A., Abacı, R., and Çetin, B. (2007). Bilişötesi Farklındalık Envanteri'nin Türkçe formunun geçerlik ve güvenirlik çalışması. Kuram ve Uygulamada Eğitim Bilimleri / Educational Sciences: Theory & Practice, 7(2), 655–680.

Alkın-Şahin, S., Tunca, N., and Ulubey, Ö. (2014). Öğretmen adaylarının eğitim inançları ile eleştirel düşünme eğilimleri arasındaki ilişki. Elementary Education Online, 13(4), 1473–1492. doi:10.17051/io.2014.56482

Alper, A. (2010). Öğretmen adaylarının eleştirel düşünme eğilimleri - Critical Thinking Disosition or Pre-Service Teachers. Egitim ve Bilim, 35(158).

Bartlett, F. C. (1932). Remembering: a Study in Experimental and Social Psychology. Combridge University Press.

Bayat, N. (2014). Öğretmen adaylarinin eleştirel düşünme düzeyleri ile akademik yazma başarıları arasındakı ilişki. Egitim ve Bilim, 39(173), 155–169.

Bayraktar, S., and Yağan Güder, S. (2019). Okul öncesi öğretmen adaylarının toplumsal cinsiyet rolüne ilişkin tutumları ile eleştirel düşünme eğilimleri ilişkisi. Anadolu Journal Of Educational Sciences International, 9(2), 640–665. doi:10.18039/ajesi.577713

Beşoluk, Ş., and Önder, İ. (2010). Öğretmen adaylarının öğrenme yaklaşımları, öğrenme stilleri ve eleştirel düşünme eğilimlerinin incelenmesi. Elementary Education Online, 9(2), 679–693. doi:10.17051/io.82991

Böttcher, A., Thurner, V., Schlierkamp, K., and Zehetmeier, D. (2016). Debugging students' debugging process. In Proceedings - Frontiers in Education Conference, FIE. Institute of Electrical and Electronics Engineers Inc. doi:10.1109/FIE.2016.7757447

Boyacıoğlu, İ., and Aktaş, Ç. (2018). Olayların Merkeziliği Ölçeği: geçerlik ve güvenirlik çalışması. Türk Psikoloji Yazıları, 21(41), 17–26.

Bravo, M. J., Galiana, L., Rodrigo, M. F., Navarro-Perez, J. J., and Oliver, A. (2020). An adaptation of the Critical Thinking Disposition Scale in Spanish youth. Thinking Skills and Creativity, 38. doi:10.1016/j.tsc.2020.100748

Broadbear, J. T., and Keyser, B. B. (2000). An approach to teaching for critical thinking in health education. Journal of School Health, 70(8), 322–326. doi:10.1111/j.1746-1561.2000.tb07266.x

Brown, T. A. (2006). Confirmatory factor analysis for applied research. Choice Reviews Online. New York, NY: Guilford Press. doi:10.5860/choice.44-2769

Browne, M. W., and Cudeck, R. (1992). Alternative Ways of Assessing Model Fit. Sociological Methods & Research, 21(2), 230–258. doi:10.1177/0049124192021002005

Can, Ş., and Kaymakçı, G. (2015). Öğretmen adaylarının eleştirel düşünme eğilimleri. NWSA-Education Sciences, 10(2), 66–83.

Çokluk, Ö., Şekercioğlu, G., and Büyüköztürk, Ş. (2014). Sosyal bilimler için çok değişkenli istatistik: SPSS ve LISREL uygulamaları (3. Baskı). Ankara: Pegem Akademi.

Creswell, J. W. (2012). Educational research: Planning, conducting and evaluating quantitative and qualitative research (4th ed.). Boston, MA: Pearson.

Cüceloğlu, D. (2003). İyi Düşün Doğru Karar Ver (37. Basım). Remzi Kitabevi.

Ennis, R. H. (1985). A logical basis for measuring critical thinking skills. Educational Leadership, 43(2), 44–48.

Facione, P. A. (1990). Critical thinking: a statement of expert consensus for purposes of educational assessment and instruction. The Delphi Report. Clifornia: California Academic Press. EBSCOST ERIC Document No: ED315423.

Fadel, C. (2008). How can you prepare students for the new Global Economy? In OECD/CERI.

Forza, C., and Filippini, R. (1998). TQM impact on quality conformance and customer satisfaction: A causal model. International Journal of Production Economics, 55(1), 1–20. doi:10.1016/S0925-5273(98)00007-3

Fraenkel, J. R., Wallen, N. E., and Hyun, H. H. (2012). How to design and evaluate research in education (8. baskı). New York: McGraw-Hill.

Gagne, R. M. (1986). Instructional technology: The research field. Journal of Instructional Development, 8(3), 7–14. doi:10.1007/BF02906263

Greenspoon, P. J., and Saklofske, D. H. (1998). Confirmatory factor analysis of the multidimensional Students' Life Satistaction Scale. Personality and Individual Differences, 25, 965–9771. doi:10.1016/S0191-8869(98)00115-9

Güven, M. (2004). Öğrenme Stilleri ile Öğrenme Stratejileri Arasındaki İlişki. (Yayımlanmamış doktora tezi). Anadolu Üniversitesi, Eğitim Bilimleri Enstitüsü, Eskişehir.

Güven, M., and Kürüm, D. (2007). Teacher candidates' learning styles and critical thinking dispositions. Elektronik Sosyal Bilimler Dergisi, 6(21), 60–90.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., and Tatham, R. L. (2013). Multivariate Data Analysis: Pearson New International Edition. Pearson Education Limited (UK).

Hayırsever, F., and Oğuz, E. (2017). Öğretmen adaylarının eğitim inançlarının eleştirel düşünme eğilimlerine etkisi. Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi, 17(2), 757–778.

Hooper, D., Coughlan, J., and Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. Electronic Journal of Business Research Methods, 6(1), 53–60. doi:10.21427/D79B73

Hu, L., and Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. Psychological Methods, 3(4), 424–453. doi:10.1037//1082-989x.3.4.424

Kaarakainen, M.-T. (2018). Measuring Ict Skills: Relationship of the Item Difficulty and Characteristics of Test Items. INTED2018 Proceedings, 1(March), 1354–1363. doi:10.21125/inted.2018.0023

Kılıç, İ., Yazıcı, T., and Topalak, S. I. (2017). Critical thinking disposition of music teacher. Eurasian Journal of Educational Research, 72, 185–202. doi:10.14689/ejer.2017.72.10

Kiriş Avaroğullari, A., and Şaman, B. (2020). Sosyal Bilgiler öğretmen adaylarının öğrenme stilleri ile eleştirel düşünme eğilimleri arasındaki ilişkinin incelenmesi. Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi, 53, 411–434. doi:10.21764/maeuefd.584183

Kline, R. B. (2016). Principles and practice of structural equation modeling (4. baskı). New York, NY: Guilford.

Korkmaz, Ö. (2009). Eğitim Fakültelerinin öğrencilerin eleştirel düşünme eğilim ve düzeylerine etkisi. Türk Eğitim Bilimleri Dergisi, 7(4), 879–902.

Larsson, K. (2017). Understanding and teaching critical thinking—A new approach. International Journal of Educational Research, 84, 32–42. doi:10.1016/j.ijer.2017.05.004

Lisitsina, T., Pastushkova, M., Putistina, O., and Lobovskaya, T. (2020). Online newspapers in teaching reading in the English classroom at high school. International Journal of Innovation and Learning, 28(1), 119–138. doi:10.1504/IJIL.2020.108470

Lou, J. (2018). Improvement in university students' critical thinking following a strategic thinking training program. NeuroQuantology, 16(5), 91–96. doi:10.14704/nq.2018.16.5.1310

Masuck, C., Alves-Foss, J., and Oman, P. (2008). Analysis of fault models for student use. ACM SIGCSE Bulletin, 40(2), 79–83. doi:10.1145/1383602.1383640

Mayer, R. E. (1983). Thinking, problem solving, cognition. New York, NY: W. H. Freeman and Company.

McLeod, S. (2018). Jean Piaget's Theory of Cognitive Development. Simply Psychology.

Morales Carrero, J. (2020). Lectura crítica: un proceso inherente a la educación universitaria competente y significativa. Revista Conrado, 16(73), 240–247. Retrieved from http://mpoc.org.my/malaysian-palm-oil-industry/

Nascimento, F. P., and Franco, S. A. P. (2017). Conhecimento de mundo por meio da leitura digital: um estudo com universitários. Revista Ibero-Americana de Estudos Em Educação, 12(n.esp.2), 1511–

1523. doi:10.21723/riaee.v12.n.esp.2.10306

Ocak, G., Eğmir, E., and Ocak, İ. (2016). Öğretmen adaylarının eleştirel düşünme eğilimlerinin çeşitli değişkenler açısından incelenmesi. Erzincan Üniversitesi Eğitim Fakültesi Dergisi, 18(1), 63–91. doi:10.17556/jef.27258

OECD. (2018). The Future of Education and Skills: Education 2030. OECD Education Working Papers.

Orhan-Göksün, D., and Kurt, A. A. (2017). Öğretmen adaylarının 21. yy. öğrenen becerileri kullanımları ve 21. yy. öğreten becerileri kullanımları arasındaki ilişki. Egitim ve Bilim, 42(190), 107–130. doi:DOI: 10.15390/EB.2017.7089

Özdemir, S. (2005). Web ortamında bireysel ve işbirlikli problem temelli öğrenmenin eleştirel düşünme becerisi, akademik başarı ve internet kullanımına yönelik tutuma etkileri. (Yayınlanmamış Doktora Tezi). Ankara: Gazi Üniversitesi.

Özdemir, S. M. (2005). Üniversite öğrencilerinin eleştirel düşünme becerilerinin çeşitli değişkenler açısından değerlendirilmesi. Türk Eğitim Bilimleri Dergisi, 3(3), 297–316.

Özgenel, M., and Çetin, M. (2018). Development of the Marmara critical thinking dispositions scale: Validity and reliability analysis. International Journal of Eurasia Social Sciences, 9(32), 991–1015.

Parra, Y. J. F., Barriga, A. M., Díaz, R. A. L., and Cuesta, J. A. G. (2021). Teacher education and critical thinking: Systematizing theoretical perspectives and formative experiences in Latin America. Revista de Investigacion Educativa, 39(1), 149–167. doi:10.6018/RIE.416271

Partnership for 21st Century Skills. (2019). Framework for 21st Century Learning. Battelle for Kids. Retrieved from http://static.battelleforkids.org/documents/p21/P21_Framework_Brief.pdf

Paul, R., and Elder, L. (2006). The Miniature Guide to Critical Thinking Concepts and Tools - Fourth Edition. The Foundation for Critical Thinking.

Phillips, J. L. (1975). The origins of intellect: Piaget's theory (2. baskı). San Francisco: W. H. Freeman and Company.

Piaget, J. (1965). The origins of intelligence in children. International Universities Press (3. baskı). New York, NY: International University Press.

Saenab, S., Zubaidah, S., Mahanal, S., and Lestari, S. R. (2021). Recode to re-code: An instructional model to accelerate students' critical thinking skills. Education Sciences, 11(1), 1–14. doi:10.3390/EDUCSCI11010002

Salameh, L. A., Salameh, Z. A., and Al-Emami, A. H. (2019). Measuring the Effect of Cognitive and Metacognitive Questioning Strategies on EFL Learners' Reading Comprehension in Understanding, Critical Thinking and the Quality of Schema at the University of Hail-KSA. International Journal of English Linguistics, 9(5), 12–28. doi:10.5539/ijel.v9n5p12

Saracaloğlu, A. S., and Yılmaz, S. (2011). Öğretmen adaylarının eleştirel düşünme tutumları ile denetim odaklarının incelenmesi. İlköğretim Online, 10(2), 468–478.

Sarıgöz, O. (2014). Öğretmen adaylarının eleştirel düşünme becerileri hakkındaki görüşlerinin değerlendirilmesi. Akademik Bakış Uluslararası Hakemli Sosyal Bilimler Dergisi, (41).

Scheffler, I. (1973). Reason and teaching. Indianapolis: Bobbs-Merrill.

Schraw, G., and Dennison, R. S. (1994). Assessing metacognitive awareness. Contemporary Educational Psychology. doi:10.1006/ceps.1994.1033

Schreiber, J. B., Stage, F. K., King, J., Nora, A., and Barlow, E. A. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. Journal of Educational Research, 99(6), 323–338. doi:10.3200/JOER.99.6.323-338

Semerci, N. (2010). Türkiye'nin Doğu Anadolu Bölgesi üniversitelerinde okuyan öğretmen adaylarının eleştirel düşünme eğilimleri. E-Journal of New World Sciences Academy, 5(3), 858–567.

Solmaz, E. (2014). Programlama dili öğretiminde Alice yazılımının ders başarısı, eleştirel düşünme ve problem çözme becerileri ile üstbilişsel farkındalık düzeyine etkisi. (Yayımlanmamış Doktora Tezi). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Sümer, N. (2000). Yapısal Eşitlik Modelleri: Temel kavramlar ve örnek uygulamalar. Türk Psikoloji Yazıları, 3(6), 49–74.

Tabachnick, B. G., and Fidell, L. S. (2013). Using Multivariate Statistics (6th Ed.). New Jersey: Pearson.

Tishman, S., Jay, E., and Perkins, D. N. (1993). Teaching thinking dispositions: From transmission to enculturation. Theory Into Practice. doi:10.1080/00405849309543590

Wadsworth, B. J. (1989). Piaget's theory of cognitive and affective development (4. baskı). New York, NY: Longman Inc.

Williams, R. L. (2005). Targeting critical thinking within teacher education: The potential impact on society. The Teacher Educator, 40(3), 163–187. doi:DOI: 10.1080/08878730509555359

Yakar, Z., Altındağ, C., and Kaya, F. (2010). Fen bilgisi öğretmen adaylarının ve sınıf öğretmeni adaylarının eleştirel düşünme eğilimlerinin karşılaştırılması. E-Journal of New World Sciences Academy, 5(3), 720–728. doi:10.1558/jsrnc.v4il.24