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Research Paper

Investigating the Effectiveness of Web 2.0-Based Critical Thinking Curriculum Developed for Secondary School Students: A Mixed-Methods Study

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ABSTRACT

It is crucial for students to develop their 21st-century skills such as technological literacy and critical thinking skills with various curricula to be updated in accordance with technology integration in education. Therefore, a critical thinking curriculum was designed, implemented and evaluated by using Web 2.0 tools for secondary school students. The research, adopting embedded mixed design [qual+Quan(qual)+qual] research model, was carried out with 21 secondary school students studying at 5th and 6th grades. Before the 8-week implementation process, a needs analysis was carried out, student journals during the implementation were analyzed with content analysis. A significant difference was found, in favor of the post-test, between the pre-tests/post-tests of "Critical Thinking Skills Test" and "Critical Thinking Disposition Instrument" as a result of Wilcoxon Signed Ranked Test analysis while there was no significant difference between the post-tests based on variables of grade and gender in the Mann Whitney-U analysis. In the content analysis of the student interviews carried out after the implementation, it is seen that students found the curriculum entertaining and gained awareness in utilizing critical thinking skills. In addition, students suggested activities embodying more verbal expressions and extracurricular assignments to be more active.

INTRODUCTION

Today, the rate of increase and change in information makes it difficult to access accurate and up-to-date information. Therefore, in this age, it is acknowledged as a crucial skill that individuals acquire accurate information by questioning rather than obtaining it as it is. (Conklin, 2011; Kivunja, 2014; P21, 2015; OECD, 2018; Semerci, 2003). In order for the individuals to reach the information on their own, to use the new information by evaluating it within the scope of cognitive processing skills, and to make inferences from the incoming information, it is necessary to develop thinking processes (Kuhn & Dean, 2004). Individuals can improve in problem-solving, creative thinking, decision-making, and interpretation of knowledge by using their cognitive skills through thinking (Güneş, 2012). One of these thinking skills, called higher-order thinking skills, is "critical thinking (CT)" (Dwyer, Hogan & Stewart, 2014; Fisher, 1985; Gündoğdu, 2009; Söylemez, 2018).

First expressed by Socrates as "seeking the truth", the current foundations of CT, which requires the search for evidence, the investigation of reasons, and the discussion of assumptions and inferences from a skeptical perspective, have been established with the views of Aristotle, Descartes, and Plato (Kazancı, 2014; Söylemez, 2018). In a study conducted in 1990 with American and Canadian theoreticians, the American Psychological Association (APA) defines CT as "an individual's making conscious judgments that are analytical and evaluative in order to decide what to do and what to believe and expressing these judgments" (Evancho, 2000). There are many definitions of CT in the literature. Most of these definitions evoke the term "reflective thinking" by John Dewey (1910), which is a careful consideration of the knowledge that is supported by evidence" (Gündoğdu, 2009; Önal, 2020; Yılmaz, 2019). In CT, newly encountered information is analyzed with a logical approach, and it is ensured that aspects that are not clearly specified are recognized and alternative considerations are generated (Facione, 1990; Nosich, 2018; Paul & Elder, 2008). CT is not perceiving the information as it is, but a process of perceiving it objectively through reasoning (Yılmaz, 2019). According to Beyer (1984), it is a set of skills that includes the analysis and the evaluation of information.

Individuals who have critical thinking skills (CTS) are open to change, think alternatively, are curious, make realistic decisions by establishing a cause-effect relationship based on evidence, and have the self-confidence to discuss the reasons for their decisions (Facione, 1990; Yılmaz, 2019). It is a necessity to enrich the curricula with up-to-date knowledge, skills, and technologies so that individuals in the developmental age can acquire CTS (Larson & Miller, 2011; Voogt & Roblin, 2010). Accordingly, teaching/learning methods and materials along with the subject content need to be updated with the innovations in accordance with the age of technology (Dede, 2010). By developing curricula, so that new knowledge and skills are acquired in the social structure through the technological literacy skills that emerged with the rapid progress in the information technologies in the 21st-century and

updating the existing curricula in parallel with the new skills constitute a vital place to overcome the shortcomings (Ananiadou & Claro, 2009; ISTE, 2008; Lewin & McNicol, 2015; P21, 2015; Voogt & Roblin, 2010).

The access to knowledge has become easier with the advances in the field of information technologies, and almost every area of life have been surrounded by the devices of information technologies (Parlak, 2017). Societies using the opportunities brought by the digital world effectively will be able to ensure the development of their countries, improve in the scientific field, maintain their existence in the global order, and live-in prosperity. Besides, the institutions bear the responsibility for providing learning opportunities both in the class and out of the class in order that individuals preparing for the future can acquire the skills they need (Dede, 2010). While preparing education programs within this responsibility, different interests, skills, and needs of students in the learning process and individual differences such as age, gender and cognitive characteristics should be taken into consideration (Ilgaz, 2018; Norwich, 2002). In addition, the classification of education programs applied in schools according to grade level can also be taken into account in the preparation of the programs. It is expected that considering the developmental levels and individual differences of the students in the education programs to be prepared for this purpose will increase the effectiveness of the program.

In the 21st-century, described as the age of information and technology, the opportunities for accessing technological applications are increasing day by day for the secondary educational level learners who are in the formal operational stage. Thus, educators are responsible for teaching by engaging these technologies that are intriguing due to rich visual and auditory elements (Gretter & Yadav, 2016; Pearlman, 2010). It is necessary for teachers to include the digital contents and Web 2.0 tools in the curriculum in the interest of learners to benefit from learning opportunities by means of digital technologies (Anderson, Van Weert & Duchâteau, 2002; ISTE, 2008).

Web 2.0 tools enable individuals to create and share collaborative products by promoting cooperation among interactive peer groups via the Internet (Anderson, 2007; Horzum, 2007). Thanks to this feature, it creates social learning networks among learners in distance education (Bozkurt, 2013). Learners can obtain CTS within the scope of 21st-century skills owing to the integration of technology into the curriculum (Ananiadou & Claro, 2009; ISTE, 2008; Uğur, 2019). As a consequence of integrating the dynamic and interactive content (Magnuson, 2012) and Web 2.0 tools, which are among the educational technology applications, into the "CT Training Curriculum", CTS of individuals can be developed in order to reach both technological literacy and accurate information (Kazancı, 2014; Pürbudak, 2020). Moreover, Web 2.0 tools that enable active participation and creation of knowledge through experience provides an opportunity for constructivist learning, which is at the center of today's educational programs, and it promotes multiple intelligence with collaborative activities and innovations in technology (Çelik, 2021; Horzum, 2007; Horzum, 2010). Therefore, it is possible to talk about a sufficient education and a fully equipped society that is ready for the future. Consequently, it would be appropriate to use Web 2.0 tools in a curriculum for the development of CTS. To that end, it is thought that it will contribute to the development and success of secondary school students in the short term while contributing to the welfare, peace, improvement, and development of society in the long term.

When the literature is reviewed, it is possible to find some studies that have been conducted regarding this subject. There are studies such as investigating of the impact of web 2.0 tools on CTS of secondary school students by Kazancı (2014) and Alp (2019), the investigation the effect of web 2.0 tools on cooperative learning and motivation by Gündoğdu (2019), and the development of a CT curriculum by Eğmir (2016). These studies, indicating a need for a web 2.0 assisted curriculum to enhance the CTS of secondary school learners, are both a justification and an inspiration for this very study. In addition, studies show that individuals' critical thinking processes are classified in terms of cognitive and effective aspects (Ennis, 1985; Facione, 1990; Paul et al., 1990). Thereupon, it is planned to measure students' affective critical thinking dispositions and cognitive critical thinking skills separately in the education program to be designed in the research.

In the light of this information, it is important to develop critical thinking disposition and skills, as one of the high-level thinking skills among students' 21st-century skills, with web 2.0 tools that are thought to help attract students' attention in the age of technology. In this study, it is aimed to design, implement, and evaluate a CT curriculum enriched with web 2.0 technological applications for secondary school students. In line with this purpose, the research question of the study is: "What is the effectiveness of the Web 2.0 Based Critical Thinking Curriculum Developed for Secondary School Learners?". The following research questions guided the study:

RQ1: What are the opinions of the learners about the Web 2.0 Based CT Curriculum developed for secondary school learners?
RQ2: Is there a significant difference between the CT Disposition Instrument pre-test and post-test scores of the experimental group?
- 2.1. Does the CT Disposition Instrument post-test scores of the experimental group differ according to their grade level?
- 2.2. Does the CT Disposition Instrument post-test scores of the experimental group differ according to their gender?

RQ3: Is there a significant difference between the CTS Test pre-test and post-test scores of the experimental group?
- 3.1. Does the CTS Test post-test scores of the experimental group differ according to their grade level?
- 3.2. Does the CTS Test post-test scores of the experimental group differ according to their gender?

THEORETICAL FRAMEWORK

Dimensions of Critical Thinking

CT is defined by Paul and Edler (2008) as the individual's ability to manage their cognitive processes and the process of developing a thinking system within the intellectual standards such as clarity, accuracy, depth, significance, precision, relevance, and logic. CT discussed as a process, requires logical decision-making through reasoning about the actions to be taken in a situation or notions to believe (Çubukçu, 2006; Ennis, 1985). CT differs from the other thinking styles (Facione, 1990), and represents both the dispositions involving affective processes and the skills involving cognitive processes (Ennis, 1985; Zhang, 2003). CT dispositions of the individuals indicate their attitudes towards using CTS (Ertaş Kılıç & Şen, 2014).

Paul et al. (1990) emphasize the skill and disposition dimensions of CT and states that CT comprises effective strategies that guide individuals to think independently and cognitive strategies that compose of micro-skills and macro abilities. In the Delphi Report, a project by the American Philosophical Association, some definitions were put forth of the CTS and its dispositions (Facione, 1990). According to the project, CTS are identified as interpretation (categorization, decoding intended meaning, clarifying meaning), analysis (identifying ideas and independent variables), evaluation (assessing claims and arguments), inference (querying evidence, anticipating alternative hypothesis), explanation (stating results, justifying procedures, presenting arguments), and self-regulation (self-examination and self-correction). The dispositions of CT, as discussed in the project, are presented as being "analytic, self-confident, inquisitive, cognitively mature, open-minded, systematic, and truth-seeker" (Facione, 1990). Moreover, Paul and Edler (2008) point out that reasoning for thinking skills within the scope of universal intellectual standards has a purpose. Thinking skills are also entails asking proper questions about the subject. The questions are based on assumptions, requires a point of view, is based on information, data and evidence, shaped by ideas and concepts, leads to conclusions through inferences and interpretations of the data, leads to an inference or a consequence at the end of each process (Paul & Edler, 2008). It can be considered that learners' CTS can be improved with a curriculum to be designed in light of this information.

CT that enables querying new information and passing it through cognitive evaluation processes (Güneş, 2012) has gained importance in today's educational programs framed by constructivist perspectives as a form of higher-order skill (Kazancı, 2014). CT is a skill that can be taught (Ennis, 1991; Halpern, 1999), and various exercises, questions, investigations, and several problems should be included for the sake of developing CTS (Halpern, 2003; Paul, 1987). Therefore, curricula that enable learners to think actively and organize their thoughts should be utilized (Paul & Elder, 2001). In this regard, four different approaches consisting of subject-based, content-based, skill-based, and mixed-methods are adopted to teach CT (Eğmir, 2016; Kurnaz, 2019). Among these, it is thought that transferring the thinking skills acquired by a skills-based approach without depending on a specific subject such as reviewing the course topics will make it easier to transfer them to other courses (Ennis, 1991). In skill-based teaching, thinking skills can be enhanced with discussions about the stories or incidents in daily life regardless of the course content (Kurnaz, 2019; Yılmaz, 2019). Therefore, in this study, it is considered that designing and implementing a skill-based curriculum enriched with Web 2.0 tools would be appropriate.

Web 2.0 Tools in Education

Technological literacy, one of the 21st-century skills, is a must (Çelik, 2021; Dede, 2010) with the effective use of technology in the educational field as much as other fields (OECD, 2018; P21, 2015). Especially today, it is possible that individuals, referred to as digital natives (Prensky, 2001) and spending a great deal of time with technology, will be obtained with both technological literacy and necessary knowledge and skills required in our age with the educational technologies (Anderson, Van Weert & Duchâteau, 2002; OECD, 2017; Yurdakul, Dönmez, Yaman & Odabaşı, 2013). To that end, web 2.0 tools, which appear as a way of using technology in education are described as the internet that allows individuals to share information and data, creativity and global communication on a wide web, and the chance to collaborate and interact (Drexler, Baralt, & Dawson, 2008).

Web 2.0 tools are technological applications that allow participants to create content collaboratively and easily it shares with others in the process via internet databased blogs, wikis, podcasts, multimedia, and social networks (Anderson, 2007). This feature of Web 2.0 tools makes it more encouraging in terms of learning (Kazancı, 2014; Magnuson, 2012). The use of Web 2.0 tools in educational environments necessitates active participation on the part of the students and the process becomes learner-centered. Learners can both gain experience through learning by doing and have the opportunity to learn from their peers. Correspondingly, using Web 2.0 tools also promotes the occurrence of constructive learning (Çelik, 2021; Horzum, 2010). On the other hand, thanks to the opportunity of active participation of all individuals with internet access regardless of time and place, creativity in the context of collective intelligence can be developed by preparing various multimedia contents with Web 2.0 tools (Çelik, 2021; Magnuson, 2012).

Traditional methods in distance education may cause a loss of interaction (Ilgaz, 2018). However, the interactions during the process provide an opportunity for permanent learning with Web 2.0 tools (Kaya, 2006). It seems likely to keep this interaction alive and ensure permanent learning in the distance education process thanks to Web 2.0 tools (Anderson, 2007; Horzum, 2007). The Web 2.0 applications that enable questioning together with communication and collaboration features (Pürbudak, 2020) could be utilized in an effort to develop the CTS of the individuals (Kazancı, 2014). Described as a social learning tool, web 2.0 tools make it possible to share and discuss ideas, express themselves and produce new ideas by providing the interaction between the students with

individual differences thanks to the internet (Horzum, 2007). Accordingly, the curriculum designed in this study is assisted with web 2.0 tools. Web 2.0 tools used in the study are presented in the methodology section below.

METHOD

Research Design

In this study, the aim is to design and implement a curriculum to develop CTS in secondary school learners and to evaluate the effects of the curriculum. In line with this objective, the research employs an embedded research design among mixed methods research designs. Embedded mixed methods design is a research design that includes various types of data that support the quantitative and qualitative designs within the scope of the main objective of the research (Creswell & Plano Clark, 2020).

In the study, primarily qualitative data was obtained. In this context, the opinions of the secondary school learners were taken in order to determine their prior knowledge. Learning objectives and outcomes were identified and the curriculum was designed based on the data obtained and literature review. The objectives and the outcomes of the curriculum were scrutinized by an expert faculty member in the field whether they were suitable or not. The curriculum designed in the next phase was administered to a sample group consisting of 21 students. The quantitative data of the research was collected by measuring the CTS and dispositions of the learners before and after the implementation. The participants were also asked to write a learning journal throughout the study since it was aimed to obtain more in-depth information about the process in the phase where the quantitative data of the research was being collected. After the eight-week implementation phase of the curriculum was completed, a qualitative dimension was included at the end of the research, hence the student participants were interviewed in order to determine how they evaluate the curriculum. The symbolization of the research is determined as; qual + QUAN (qual) + qual (Creswell & Plano Clark, 2020).

Participants

The participants of the study consist of 21 students studying at 5th and 6th grade at a secondary school in Bursa in the 2020-2021 academic year. In order for the school to determine to implement the curriculum, a convenience sampling method was adopted among purposive sampling methods while to determine the students, a criterion sampling method was preferred. Patton (2018) defines convenience sampling as the most common sampling method that is quick and practical for saving time, money, and effort whereas criterion sampling is defined as "scrutinizing and analyzing all aspects in the data system that embody the qualifications of the pre-determined criteria".

In accordance with convenience sampling, an official secondary school with a middle socio-economical level, where the practitioner-researcher works, was determined. Students, on a voluntary basis, were selected from the selected school using the criterion sampling method. As for the criteria of student selection, qualifications of studying at 5th or 6th grade and being able to use Web 2.0 tools were sought. This research was carried out during the covid 19 pandemic period, and during the pandemic period, students had all their school lessons with distance education. The number of participants in the research is limited to those whose parents gave consent among the students who volunteered for a different distance education research after the lessons. This limitation prevented the establishment of a control group to support the validation of the experimental results. The demographic features of the study group are specified in Table 1. Student opinions were coded as G1, G2... for girls and B1, B2... for boys.

Table 1. Demographic Features of the Participants

		%	*f*
Gender	Girl [G]	11	52.40
	Boy [B]	10	47.60
Class Level	5th Grade	13	61.90
	6th Grade	8	38.10
	Total	21	100.00

Research Procedure

The development, implementation, and evaluation stages of the curriculum to be designed were followed during the research procedure. In the curriculum development process, firstly, the problem was identified and then the model of the design was determined. Afterward, the foundations of the curriculum development were investigated, and a work plan was prepared. After the needs analysis, initial objectives and outcomes were specified. The content was organized, and learning experiences, teaching materials, and testing and assessment options were decided. During the implementation stage of the curriculum, it was administered to the students who participated voluntarily, and finally, the evaluation of the curriculum was completed. The research procedure is shown in Figure 1.

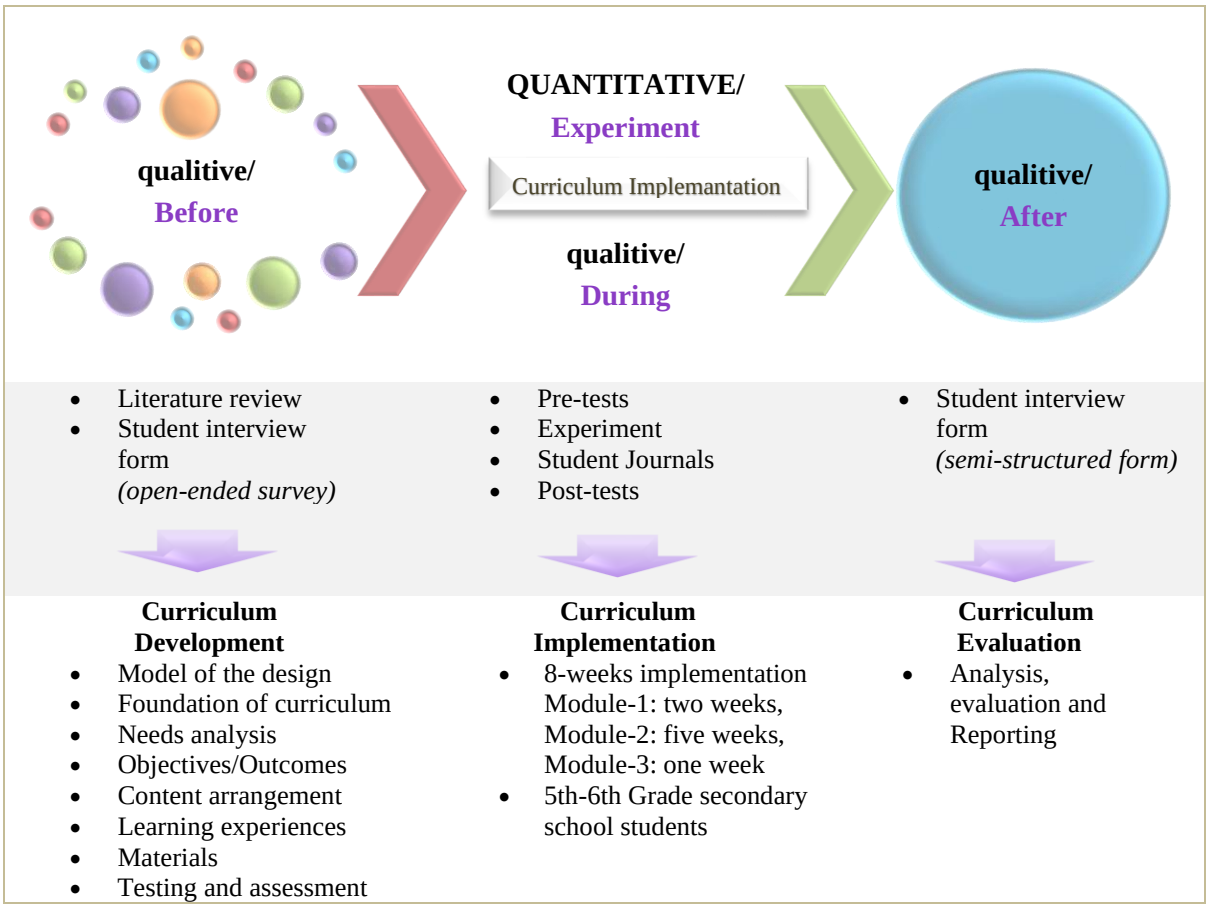

Figure 1. Research Procedure

Curriculum Development

The curriculum was designed according to the "Problem Centered Design" for the need to develop students' thinking skills with the technological opportunities in line with the 21st-century knowledge and skills. The curriculum is based on the philosophy of reconstructivism on the basis of pragmatism with the aim of constructing the society according to the requirements of the 21st-century with the support of education (Demirel, 2019; Şeker, 2017).

In the needs analysis of the curriculum, literature was reviewed, and an online survey consisting of open-ended questions was administered to the 5th and 6th-grade students of the sample school. It is observed that the students were mostly not familiar with the web 2.0 tools, yet found to be interested in the dynamic and visually enhanced activities involving collaboration and interaction. In addition, it is seen that the students emphasized the features of reasoning, point of view, and stating opinions clearly while defining CT; however, it is seen that they consulted their parents or searched online about how to use these skills. In this case, the necessity of students' using their CTS individually composes a need. Therefore, on the grounds of student needs and suggestions, literature was reviewed, objectives and outcomes were established, and expert opinion was obtained.

The literature review and the results of the needs analysis were taken into consideration while determining the curriculum objectives. The objectives and outcomes within the framework of "Critical Thinking Skills" for cognitive objectives, "Critical Thinking Dispositions" for affective objectives and the rules of reasoning in CT specified within Facione (1990), Paul et al. (2008) and, Paul & Edler (2008) respectively.

A modular curriculum approach was preferred while arranging the content of the curriculum (Şeker, 2017; Demirel, 2019). For content selection, firstly, related literature was reviewed, and the selected modules, "Cognitive Awareness", "Analyticalness", and "Innovativeness", were constituted based on the sub-dimensions occurring in the UF/EMI scale development process. Among the disposition dimensions, addressed in the Delphi Report (Facione, 1990), in the scale that is developed by the University of Florida and adapted into Turkish by Ertaş Kılıç and Şen (2014), analyticalness and self-confidence under the engagement dimension, open-mindedness under the cognitive maturity dimension, curiousness and seeking the truth under the innovativeness dimension were discussed. In the curriculum, the cognitive maturity is dimension addressed as "cognitive awareness" in the 5th and 6th-grade levels, engagement dimension as "analyticalness" since analysis is emphasized, and the dimension of "innovativeness" that encourages investigation are considered as modules.

While organizing the instructional process, the teaching environment that will grab students' attention and increase their motivation to learn, and that can appeal to various learning styles at the same time have been taken into consideration. Animations and digital

stories including a sample case were used at the beginning of the activities while web 2.0 tools that enable interactive writing were used to discuss the sample case. Web 2.0 tools with interactive true/false, matching, and multiple-choice tests at the end of each activity and each module were employed as a testing and assessment tool. In order to evaluate the students' opinions about the activities in the curriculum, students were asked to write on their learning journal on web 2.0 bulletin boards at the end of each lesson. All activities and exams are published on the website so that students would be given the opportunity to review them at any time they want. Besides, the pictures of the activities were shared via social media account (Instagram).

Curriculum Implementation

On a voluntary basis and parental consent, the curriculum was implemented on Zoom online platform for two hours a week, within eight weeks, after the students of 5th and 6th grades at an official secondary school in Bursa were informed. (Module-1: two weeks, Module-2: five weeks, Module-3: one week). After the lessons, students were able to review the content independently of the teacher. Successful students were given certificates at the end of the implementation. The visuals of the activity examples are presented in Figure 2.

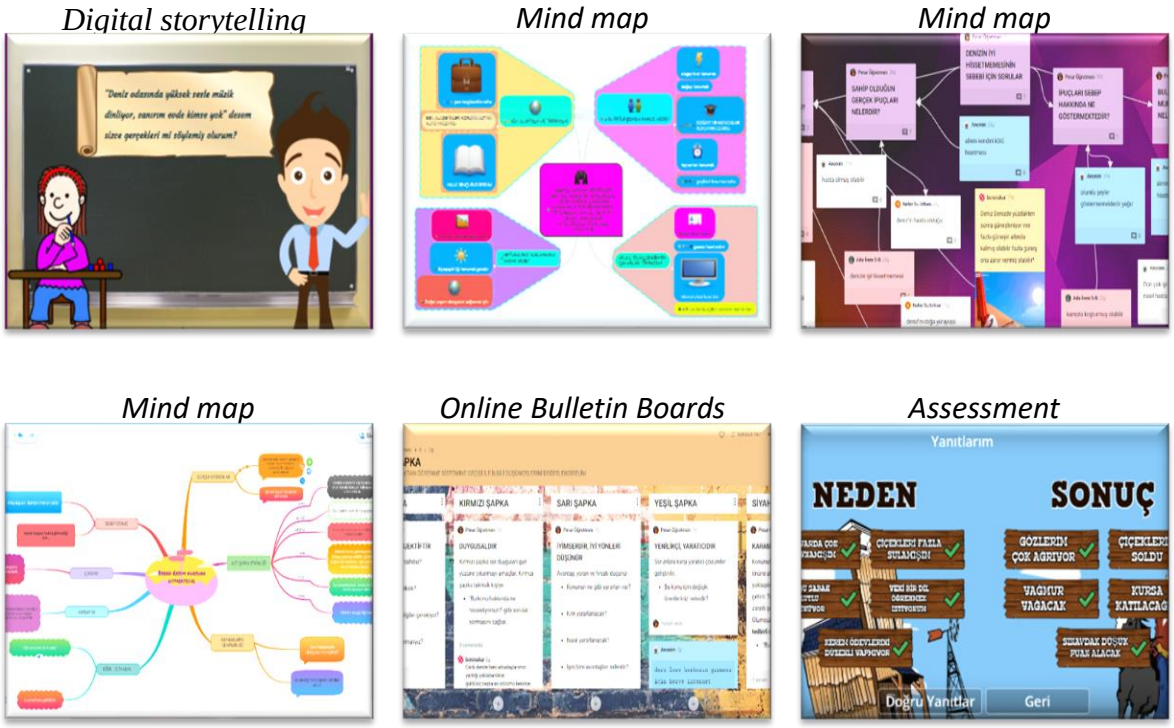

Figure 2. Examples of Activities

Curriculum Evaluation

Before and after implementing the curriculum, "UF/EMI Critical Thinking Disposition Instrument (CTDI)" and "Critical Thinking Skills Test (CTST)" were administered, and the pre-test and post-test scores were analyzed with SPSS 23.0 statistics program. Furthermore, the data obtained from student interview forms to identify the educational needs as a part of needs analysis pre-curriculum, learning journals kept at the end of each lesson to specify the opinions about the curriculum implementation process, and the student interviews made at the end of the curriculum were investigated. The results of the analysis are presented in the findings section.

DATA COLLECTION INSTRUMENTS

Qualitative Data Collection Instruments

In the research, qualitative data were collected at three different times, which are before, during, and after the curriculum implementation. Qualitative data before the implementation was collected for the needs analysis of the curriculum. In this respect, literature was reviewed and an online questionnaire, developed by the researcher for secondary school students and consisting of ten open-ended questions, was conducted. The initial version, designed after the literature review, was examined by two faculty members and three Ph.D. students, who are experts in the department of curriculum development. The questionnaire was sent via online platforms, Google Docs, to 5th and 6th-grade secondary school students, and nineteen students filled the questionnaire.

The qualitative data obtained during the curriculum implementation was collected in order to understand the effect of the curriculum on the participants and to determine the conditions that may influence, whether positively or negatively, the success of the curriculum. Therefore, learning journals, developed by the researcher, including four open-ended questions were utilized. The opinions of one faculty member and two Ph.D. students, who are experts in the department of curriculum development, were taken into consideration regarding the questions. At the end of each lesson, participating students expressed their opinions in learning journals in the "Padlet" application that is used as bulletin boards among the web 2.0 tools.

With the qualitative data obtained after the curriculum implementation process is over, it is aimed to reveal participating students' reactions to the curriculum and to explain the results of the implementation. For this, a student interview form that consists of six open-ended questions was used. With interviews, discovering the participants' points of view is aimed (Patton, 2018), and in order to reveal these points of view, open-ended questions that enable to answer freely are included in semi-structured interview form (Berg & Lune, 2019). The initial version, composed after the literature review, was reviewed by two faculty members and three Ph.D. students who are experts in the department of curriculum development. In addition, pilot interviews were carried out with two secondary school students. Upon taking its final shape after necessary revisions were made, the interviews were carried out on the zoom platform with seven voluntary students, and parental consent was taken. Interviews took approximately 15-30 minutes.

Quantitative Data Collection Instruments

Within the quantitative scope of the research, two different assessment tools were used to measure participant students' CT skills and CT dispositions.

Critical Thinking Skills Test (CTST): The test developed by Eğmir (2016) for secondary school students composes of twenty-five multiple-choice questions. CTST was administered online to the students both before and after the implementation of the curriculum. Kuder-Richardson values for skill test reliability (KR-20= .61; KR-21= .63) were tested by Eğmir and Ocak (2016). In addition, it was seen that the item difficulty index (.37) and item discrimination index (.32) of the whole test.

UF/EMI [University of Florida Engagement, Maturity and Innovativeness] Critical Thinking Disposition Instrument (CTDI): The instrument developed by the researchers of the University of Florida (Irani, et.al., 2007) was adapted into Turkish by Ertaş Kılıç and Şen (2014). The instrument is structured in a five-point Likert type (strongly disagree:1 point/ disagree: 2 points/ neutral: 3 points/ agree: 4 points/ strongly agree: 5 points) and consists of three dimensions of "Engagement", "Cognitive Maturity", and "Innovativeness", in total twenty-five items. In the Turkish adaptation study, CFA (χ2/sd= 2.99, RMSEA=0.08) was tested for the construct validity of the scale, and Cronbach's alpha (α) was tested for the scale's reliability (the original version of the scale α= .93; Turkish version of the scale α= .91, the engagement sub-dimension α= .88, the cognitive maturity sub-dimension α=.70, the innovativeness sub-dimension α=.73). CTDI was administered to students as an online form before and after the curriculum implementation.

DATA ANALYSIS

Qualitative Data Analysis

In the study, the analysis of the student interview form with open-ended questions administered to students online before the implementation, learning journals kept online on the padlet application during the implementation, and student interview forms carried out via zoom application after the implementation was performed with content analysis. Content analysis is defined as reducing the statements of the participants to the core meaning in order to make interpretations in line with the interview notes (Patton, 2018). In the content analysis, respectively, data were coded by analyzing the interview transcripts, themes were extracted, and finally, the relations between them is interpreted. Coding validity in the qualitative data analysis was ensured by taking the opinions of one expert in the coding process. As a result of the independent coding, the codes with consensus and disagreement were determined among the codes obtained. Findings were compared by calculating [reliability = consensus / (consensus + disagreement) x 100] the coding reliability of Miles and Huberman (1994). The coefficient of agreement being .90 indicates high reliability.

Quantitative Data Analysis

In the study, Wilcoxon signed-rank test was utilized in the analysis among the nonparametric tests in the SPSS 23.0 statistics program in order to see if there is a significant difference between the scores of pre-tests and post-tests of the data, which is obtained from "CTST" and "CTDI" administered before and after the one-group experimental treatment. Moreover, post-test results of both measurement tools were analyzed with the Mann Whitney-U Test in the SPSS 23.0 statistics program to see whether there is a significant difference regarding the variables of grade level and gender. Since it was seen that parametric conditions could not be met in the study (n< 30), it was analyzed with non-parametric tests.

Validity and Reliability

In the research, data collection tools were diversified by utilizing a literature review of the subject, interview form, learning journal, a skills test, and disposition instrument with the objective of credibility and internal validity. Expert opinion was obtained about the

pre-implementation interview form (two faculty members and three Ph.D. students), about the learning journal (one faculty member and two Ph.D. students), and about the post-implementation interview form (two faculty members and three Ph.D. students) in the department of curriculum development. Additionally, a pilot interview was carried out with two secondary school students. While determining the objectives and outcomes of the curriculum, the opinions of the two faculty members who are experts in the field of curriculum development, three Ph.D. students, three Turkish language teachers, and three information technologies teachers were taken. Besides, expert opinions of two faculty members were asked in order to evaluate the suitableness of the determined objectives and outcomes. Coding validity in the qualitative data analysis was ensured by taking the opinions of one expert in the coding process. In the content analysis of the qualitative data, the coders were provided to create code-category-theme patterns without knowing each other's results. As a result, these analysis results were compared and consensus among the coders was observed. The sample group was selected in accordance with the purpose of the research for external validity and generalizability. In addition, further information about the procedures was elaborated on in the methodology section.

Ethical Considerations

In this research, scientific ethical principles were considered in order to contribute to the field by giving importance to the original ideas, not using the works of others without permission and reference. Ethical rules were abided by in data collection and the development of data collection tools used in the research. The parents of the participants were informed before the interviews by getting voluntary participation and informed consent. Personal information of the participants was kept confidential and the participants were provided with pseudonyms for the findings. Interview records were kept confidential, were not shared with third parties, and were not used except for research purposes. It was taken into consideration that data analysis and interpretation of the findings abide by the data itself. Additionally, Yildiz Technical University Humanities and Social Sciences Research Academic Ethics Committee Approval (meeting date: 29.04.2021 and no: 2021/02) was received before the study was implemented.

FINDINGS

Qualitative Findings of the Students' Opinions

The journals written by the students during the program implementation process and the findings obtained from the interview forms at the end of the program are presented in Table 2.

Table 2. Themes and Codes of Qualitive Findings of the Students' Opinions

	Themes	Codes
Student Journals During the Implementation	Learning	• Technological Applications • Point of View • Critical Thinking Knowledge
	Interesting Feature	• Web 2.0 applications • Interaction
	Suggestions	• Activities
Student Opinions After the Implementation	Outcomes	• Critical thinking awareness • Web 2.0 applications • Communication-Collaboration
	Affective Aspects	• Finding it interesting • Finding it entertaining • Motivation to transfer it to daily-life
	Disadvantages	• Technological problems • Number of participants
	Suggestions	• Verbal communication • Being active • Duration • Extracurricular assignments

Findings of the Student Journals During the Implementation

In line with the student opinions appearing in the learning journals that students keep after the lesson during the curriculum implementation process, the themes of "learning", "interesting feature", and "suggestions" have emerged. Themes and codes discovered in the opinions in the learning journals are shown in Figure 3.

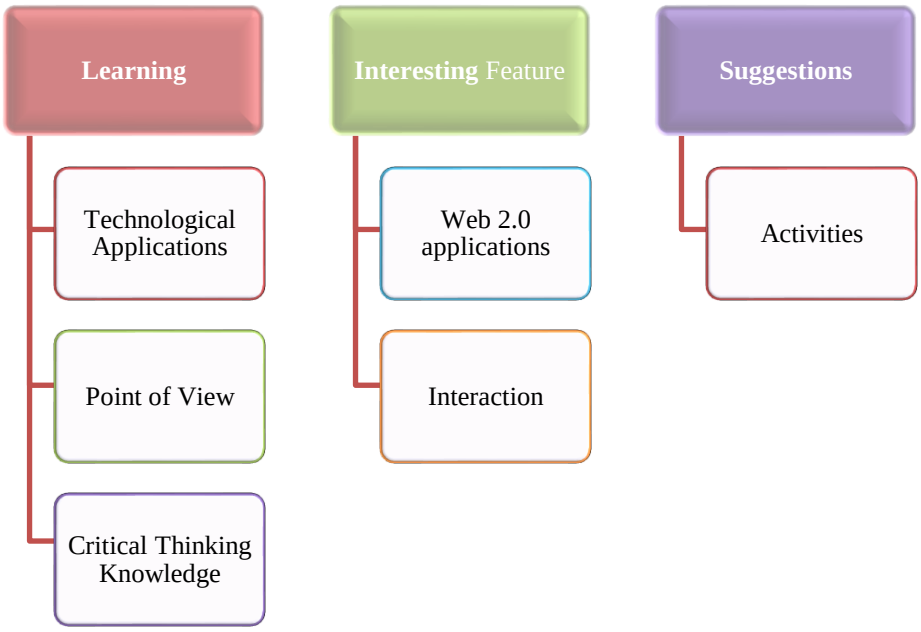

Figure 3. Themes and Codes from Learning Journal Data

Theme 1: Learning

During the curriculum implementation process, it is observed that students have learned various technological applications in class activities and they were able to use these applications. Students have realized that they should investigate the issues they face in their daily lives with different points of view before reaching a decision. Moreover, they were informed with new concepts for reasoning and thinking independently besides point of view techniques required for CT.

Students stated in their journals that they have started using new technological applications they learned in their daily lives as follows;

"I learned many Web 2.0 applications since I have participated in this curriculum .... I write and add pictures on dotstorming, padlet, wakelet ..."[G1]

"I got closer to technology..."[G4]

Students investigated the significance of analyzing the issues from different points of view in decision-making process in several sample cases, and expressed their views as;

"I learned how to look at cases from plenty of different perspectives this week."[B1]

"Today, I learned about six thinking hats."[B2]

Furthermore, students expressed that they were informed about the reasoning techniques necessary to think critically, and they would pay attention to these in daily life as follows;

"I learned that we should understand whether something is a claim or the truth."[B3]

"I learned what an assumption and an inference mean."[G3]

"I learned that finding the main ideas of the issues is important."[B2]

Theme 2: Interesting Feature

Students have got acquainted with various web 2.0 tools by using a different web 2.0 tool for each activity in the curriculum implementation process. They expressed that it made the curriculum interesting and that they focused on the subjects with interest thanks to the features of the applications that allow interaction with their friends.

Students expressed that it was interesting for them to acquire the ability to create a common product, to learn new technological applications and to use these applications with their friends in the curriculum with the following statements;

"It was interesting to learn about Web 2.0 tools in the curriculum that I've never heard of, building mind maps were intriguing."[G1]

"I can prepare digital books on Storyjumper on my own now and this was interesting for me."[G3]

"Kahoot exam was appealing."[G2]

In addition, students explain that thanks to these tools, it was engaging for them to brainstorm and decide together with their peers in the group on a solution of a problem along with expressing themselves through peer interaction as follows;

"Critical thinking and expressing our opinions was interesting for me."[B1]

"Everybody trying to find a common solution to a problem and presentations that my friends prepared was interesting."[B2]

"It was nice to write with our friends."[G1]

Theme 3: Suggestions

It is seen from the learning journals that students had suggestions for the activities regarding the curriculum, and the activities were improved every week in line with the suggestions. Students indicated expectations to socialize more socialization, to enhance communication and collaboration.

When they were asked for suggestions to increase their motivation in the activities, they emphasized verbal communication, active participation and extracurricular assignments. In this matter, student statements are as follows;

"We can speak more during the activities."[G1]
"Activities requiring being more active could be involved."[B2]
"We can increase the amount of activities in which we can add pictures, figures besides text."[B1]

Findings of the Student Opinions after the Implementation

The content analysis of the data obtained from the interviews with the participant students was carried out after the implementation and information on emerging themes and codes are presented below. As a result of the analysis, four themes were detected regarding the curriculum; "outcomes", "affective aspects", "disadvantages", and "suggestions". Themes and codes, extracted from the views after the implementation, are specified in Figure 4.

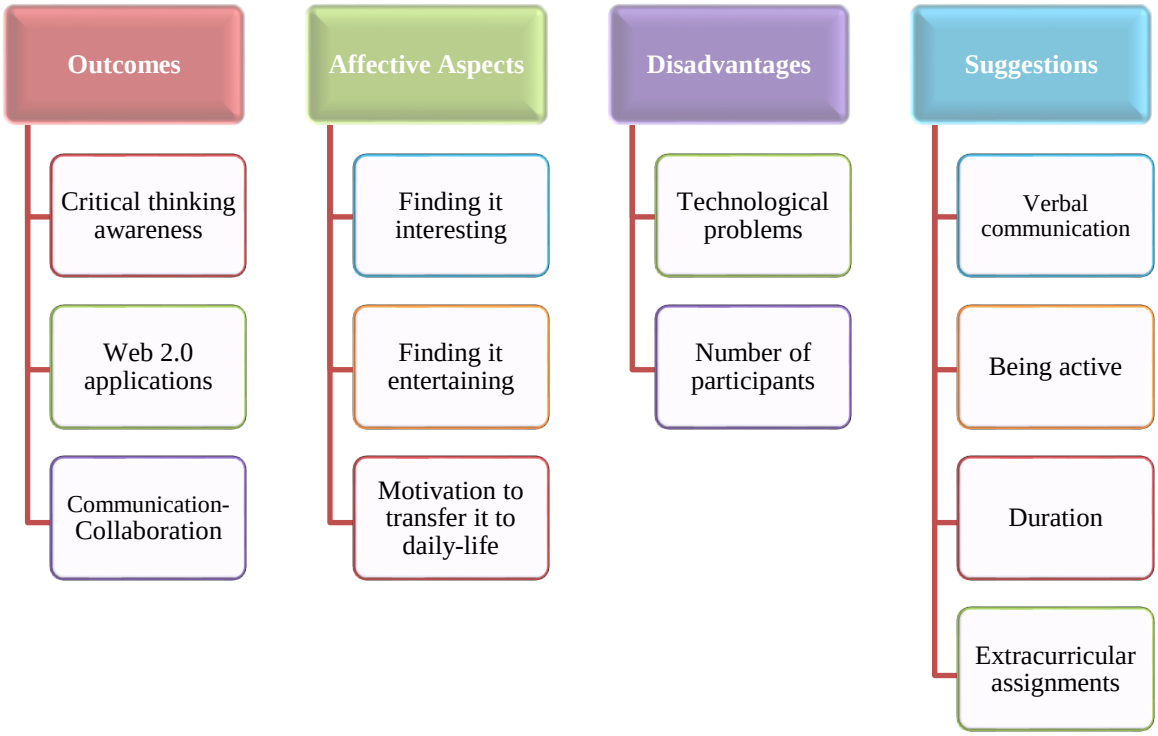

Figure 4. Themes and Codes of Student Opinions after the Implementation

Theme 1: Outcomes

It is observed that Web 2.0 based CT curriculum has raised students awareness of CT to access true and reliable information, helped students to learn web 2.0 applications that they were not familiar with, and enabled collaboration and communication with their friends via online platforms with distance education.

Students touched upon the importance of problem-solving by utilizing new information and skills they acquired, investigating if the information was true, and thinking with different points of view thanks to this curriculum. In this regard, B3 expressed his views as "I learned that we need to comprehend the subject first…I learned that we need to act accordingly in consideration of these. I learned thinking like in the six hats". Other statements expressed regarding CT is as follows;

"I learned that thinking has many details and to make interpretations and inferences about something with various thinking techniques."[G3]
"I realized that learning CT is crucial. For example, I learned that I shouldn't trust every website. It is a necessity to know the source of the subject, the reliability of the sources, from whom an information is taken, and to think with different points of view."[B1]

Students stated that they have learned various Web 2.0 technological applications in the visually enhanced activities that varies in each lesson and promotes active engagement of the students. G1 reflects own views as "for instance, I learned to write texts, to add

pictures and figures in dotstorming application. Also, I learned about wakelet, padlet, storyjumper". Another student expresses the applications he/she learned in the following statement as;

> *"I learned about the applications in this curriculum such as weebly, wakelet, dotstorming, mindmeister, mind map, digital stories, renderforest, kahoot."[G3]*

Also, it is observed that the students, who were away from the school and classroom environment in the distance education process stressed the fact that they can socialize by virtue of the activities involving communication and collaboration and that they can exchange their opinions with their friends. On this issue, G4 presents her opinion about the curriculum as "it helped me to communicate with some peers whom I didn't meet before,…we carry out varying activities, conduct zoom meetings, socialize, make various interpretations". Besides, some students state their views as;

> *"I can both speak with my friends and write on the applications in this curriculum… It is better to do the activities in a society. if I was alone, I wouldn't know about the different opinions of my friends. I was able to improve myself with my friends…"[G1]*
>
> *"We learn together when we are with our friends, we can take their opinions as well…"[G2]*
>
> *"…The applications on which we write gave us more chance to express our opinions since we cannot sometimes convey what we mean while speaking, hence it is better to write."[B2]*

Theme 2: Affective Aspects

It is observed that students find it interesting and entertaining in terms of affective aspects when the lesson begins with audible dynamic animations and digital stories in addition to the online interactive web 2.0 enhanced activities. The lesson, which are more fruitful as a result, provides students with the motivation to transfer what they've learned to daily life.

Among the Web 2.0 applications that students have learned recently in the curriculum regarding affective aspects, for G1 "padlet, wakelet, weebly website", for G3 "mindmeister and mind maps", and for G2 "wordart, padlet, storyjumper, weebly, ayoa, edmodo" were the several applications they stated that they find appealing. In addition, students stated that being able to express their opinions by means of sharing texts and visuals online at the same time from different locations made the applications appealing to them. In this regard, some student remarks are as follows;

> *"I was more intrigued in Padlet. It was nice to have pictures, text, visuals in the Web tools. Besides, kahoot exam was also appealing."[G1]*
>
> *"Six thinking hats activity was nice because it was interesting for me to state different opinions with different colours."[B1]*

It is seen in the student remarks that they've found the curriculum nice and fun, and that they liked the curriculum. In this respect, some student remarks are as below;

> *"It was an entertaining course, I am glad that I participated…I liked this course so much…"[G4]*
>
> *"…the web 2.0 activities that we did, both in-class activities and assignments were entertaining…"[G3]*

Moreover, it is seen that they've acquired the motivation to transfer the thinking skills they learned to their daily lives because of the interesting feature of the web 2.0 applications in the curriculum. On this topic, G2 remarks her views as "…I learned about the characteristics of CT, I believe these will make many contributions in my daily life". Opinions of the other students are in the following way;

> *"...I can investigate better what my friends' statements are in my daily life now…"[G2]*
>
> *"...I can find various solutions to the problems that I face now…"[B2]*

Theme 3: Disadvantages

Students mentioned their views on the disadvantages occurred in the implementation process. While some students state that internet connection failures time to time, computer/tablet problems, technological problems when logging in the web 2.0 applications causes an disruption in the lesson period, some students express the inadequacy of the participants in quantity as a disadvantage.

B7 notes as "Sometimes, I just had trouble while logging in the applications..." about his problems logging in the web 2.0 applications included in the curriculum. In addition to this remark, some students expressed the difficulty of following up with the virtual classroom application as follows;

> *"It was difficult to log in some applications, there was no connection, we couldn't keep up with Edmodo, I had to follow the announcements there via e-mail, but I couldn't check them every time."[G1]*

B1, who is one of the students stating an opinion about the number of the participants in the curriculum, evaluates the number of the participants being inadequate as a disadvantage by stating that "more people could have participated".

Theme 4: Suggestions

It is observed that students have suggested about the curriculum that they were more active in the activities and verbal communication was enhanced apart from writing activities. Students also specified the need to increase the duration of the lesson in accordance with their expectations of activities that they can express themselves more. Besides, students suggested increasing the performance tasks to reflect what they've learned to outside of the classroom.

When the student opinions on improving the curriculum are examined, we observe these statements;

"I would suggest speaking activities, more group work activities would be better."[G2]

"It would be better if we were more active, and the duration of the lesson was more…"[G3]

"I would be better if there were more dynamic activities. Extracurricular assignments besides in-class activities would be nice if we presented them in the class."[B3]

Findings of the Quantitative Data Before and After the Implementation

Wilcoxon signed-rank test results indicating the relationship between the "UF/EMI Critical Thinking Disposition Instrument (CTDI)" pre-test and post-test scores of the students in the control group is specified in Table 3.

Table 3. Findings of the Pre-Test/Post-Test Results of CTDI

	N	SO	Z	*p*
Pre-test	21	8.68	-2.13	.033
Post-test	21	10.50		

Note. p<.05

According to Wilcoxon signed-rank test, it is seen that there is a significant difference, in favor of the post-test, in students' scores in the instrument after the implementation.

Mann Whitney-U Test results signifying the relationship between the "CTDI" post-test scores of the students in the experimental group regarding their grade level is shown in Table 4.

Table 4. Findings of the Post-Test Results of CTDI Regarding Grade Level

Variable	N	SO	Z	U	*p*
5th grade	13	10.96	-.36	51.50	.97
6th grade	8	11.06			

Note. p>.05

According to Mann Whitney-U Test, no significant difference was found between the test scores of the 5th and 6th grade students after the implementation.

Mann Whitney-U Test results of the "CTDI" post-test scores of the students in the experimental group based on gender variable is shown in Table 5.

Table 5. Findings of the Post-Test Results of CTDI Regarding Gender

Variable	N	SO	Z	U	*p*
Girl	11	11.05	-.03	54.50	.97
Boy	10	10.95			

Note. p>.05

According to Mann Whitney-U Test, it is shown that there is no significant difference between the test scores of the girl and boy students after the implementation.

Wilcoxon signed-rank test results of the relationship between "Critical Thinking Skills Test (CTST)" pre-test and post-test scores of the students in the experimental group is presented in Table 6.

Table 6. Findings of the Pre-Test/Post-Test Results of CTST

	N	SO	Z	*p*
Pre-test	21	6.00	-2.85	.004
Post-test	21	8.31		

Note. p<.05

According to Wilcoxon signed-rank test, a significant difference is observed, in favor of the post-test, in the test scores after the implementation.

Mann Whitney-U Test results of relationship between the "CTST" post-test scores of the students in the experimental group regarding their grade level is shown in Table 7.

Table 7. Findings of the Post-Test Results of CTST Regarding Grade Level

Variable	N	SO	Z	U	*p*
5th grade	13	10.04	-.90	39.50	.37
6th grade	8	12.56			

Note. p>.05

According to Mann Whitney-U Test, it is seen that there is no significant difference between the test scores of the 5th and 6th grade students after the implementation.

Mann Whitney-U Test results of the "CTST" post-test scores of the students in the experimental group based on gender variable is presented in Table 8.

Table 8. Findings of the Post-Test Results of CTST Regarding Gender

Variable	N	SO	Z	U	*p*
Girl	11	11.77	-.60	46.50	.55
Boy	10	10.15			

p>.05

According to Mann Whitney-U Test, there is no significant difference between the test scores of the girl and boy students after the implementation.

DISCUSSIONS AND CONCLUSION

This study was conducted with the aim of designing, implementing, and evaluating a web 2.0 based CT curriculum for secondary school students. In line with this objective, the study is carried out in the following order; in accordance with the embedded mixed design, first qualitative phase, then quantitative phase with one-group experimental design, and qualitative phase along with the experimental process, and a final qualitative phase after the implementation.

During the curriculum implementation, students have reported their views about the concepts they "learned", "technological applications" they used, and "activities" taking place in the lessons in their online learning journals at the end of each lesson. It was observed that students found web 2.0 tools among technological applications interesting in terms of active engagement in the lesson and making common interpretations by communicating with their friends in the activities. This led students to focus on the subjects included in the curriculum. It is seen that students, whose attention was drawn to the subject by means of web 2.0 tools, have gained awareness of the objectives and outcomes of CT embodied in the curriculum by participating in the activities with fun. It is seen in the journals that students have expected themselves to be more active with regard to activities. Correspondingly, in Pürbudak's (2020) study, web 2.0 assisted online activities indicated a positive impact on students' attitudes towards collaborative learning. Positive and negative remarks that students pointed out in the implementation process have contributed to the development process.

At the end of the interviews carried out after the curriculum implementation, students have stated their opinions about the the "outcomes", the "disadvantages" and the "impact" of the curriculum in terms of "affective aspects", and "suggestions" for improving the curriculum. It is observed that students, who preferred consulting their parents and doing unreliable research online when they encounter with a problem, have gained awareness of using CTS individually at the end of the curriculum. It can be uttered that before reaching a conclusion on either a new information or a problem, gaining knowledge about the ways of analyzing with different points of view, looking for new solutions by analyzing with reasoning paths would contribute to both the development of their own and the society they live in as future adults. In an age focused on information and technology, it may be possible for students to adapt to the society they live in by using their critical thinking skills (Chen & Wu, 2021). Online education, with its flexibility and accessibility in time and space, has changed people's perspectives on acquiring knowledge and skills (Saadati, Zeki, & Vatankhah Barenji, 2021). In addition to this, the curriculum also contributed students to socializing, communicating, and expressing themselves in collaboration. It can be thought that the curriculum will be beneficial in those students, who are called digital natives in 21st-century (Prensky, 2001) and in the age group spending plenty of time with technology, meet their needs to communicate and socialize with their friends by means of technological tools. In addition, it is seen that students found the curriculum interesting and entertaining as a result of collaborating with their friends, sharing their opinions through communication, learning various web 2.0 tools. This technology-assisted social network has led students to have the motivation to learn. Similarly, in Gündoğdu's (2017) study, it is seen that web-based collaborative studies have a great impact on motivation. In various studies, it is stated that social presence perception supports cognitive skills and meaningful learning can occur in online cooperative and interactive social learning networks (Garrison, Anderson, & Archer, 2001; Kim, Whon & Cho, 2011; Saadati, Zeki, & Vatankhah Barenji, 2021; Yücel, Usluel, 2016). In addition, considering the appropriate pedagogical approach and choosing interactive technology in an effective learning and teaching environment can improve students' cooperation, communication and critical thinking skills (Feng & Wang, 2021; Jou, Lin, & Wu, 2016). In Chen and Wu (2021)'s digital game-supported research, an improvement was observed in students' motivation to learn to think critically.

However, in addition to the positive features of the curriculum, it created a disadvantage when students experienced application-related problems while logging in to some web 2.0 applications. The fact that students have different technological interests and

skills can also affect their learning attitudes and performances. In this case, the teacher needs to remove technological difficulties (Jou, Lin, & Wu, 2016). In order to enhance the quality of the curriculum, students made suggestions about such as more active engagement and more verbal communication along with the web 2.0 applications. Active participation of students through questioning and sharing their ideas in the online learning community develop a sense of social presence (Garrison, Anderson, & Archer, 2001). At the same time, a positive relationship between student satisfaction and perceived learning level of social presence in online learning environments will also support the development of critical thinking skills (Turk, Heddy, & Danielson, 2022). It can be stated that it will be beneficial for students to increase the duration of the lessons to increase the activities including verbal communication and active participation. Besides, the desire to review the course content individually and to turn what they've learned into a product and share it with their friends increased the need for extracurricular assignments. This result supports the result of a study Kazancı (2014) carried out in that the inclusion of web 2.0 tools in education creates a desire for active participation on the part of students. In a similar vein, Horzum (2007) emphasizes the features of web 2.0 tools that enable active participation and interaction.

There is a significant difference in favor of the post-test between the pre-test and post-test scores of "CTDI" administered to students before and after the implementation. This difference indicates a contribution of the curriculum to the students' CT dispositions. Using appealing technological applications in the activities and sample cases involved in the curriculum aroused their attention towards the curriculum. At the same time, it can be thought that it contributes to students' CT dispositions seeing that they can reach various solutions by discussing the issues in a written form through interactions with their friends. This result show similarity with the findings in Eğmir's (2016) study indicating an increase in the post-test scores of the skills test. In a similar vein, it is presented in Alp's (2019) research that web tools and collaborative tasks lead students to acquire positive attitudes towards learning and achievement. In a different study on the technology-supported peer learning program, the positive effects of cooperation consisting of communication and interaction in the social learning environment were observed (Carvalho & Santos, 2022). Additionally, it has resulted that no significant difference is indicated in the post-test scores of the instrument according to the variables of grade level and gender. In this case, the results indicate that at the end of the curriculum, the scores of the 5th and 6th-grade students are equivalent and the scores of girls and boys are also equivalent. The fact that students were at the same developmental age and their learning psychologies were similar may have led to this result. Besides, it is also seen that CT disposition does not differ according to gender in Semerci's (2003) study conducted with graduate students.

There was a significant difference in favor of the post-test between the pre-test and post-test scores of "CTST", administered before and after the curriculum. This indicates that the curriculum has contributed to students' CTS. Activities that enable questioning and thinking in collaboration and communication in order to develop students' CTS under teacher guidance may have resulted in the improvement of students' cognitive process skills (Güneş, 2012). Similar to this, Aybek (2007) has shown that the group of skills-based education had higher post-test scores at the end of a subject and skills-based CT curriculum. In a study on teacher candidates, Hursen (2020) has observed an increase in the web 2.0-based CTS test scores. The contribution of digital tools to students' critical thinking skills can also be seen in similar studies (Meirbekov, Maslova, Shestak, & Gallyamova, 2022). At the same time, there is no significant difference between the post-test scores regarding grade level and gender. Accordingly, it wa concluded that the scores are equivalent both between 5th and 6th-grade students and between the girls and boys. This may have been caused by the fact that students were in the same developmental age and that they have similar learning psychologies. Besides, Eğmir (2016) has found that CTS do not differ based on gender.

In conclusion, it can be said that the web 2.0 based critical thinking curriculum contributes 5th and 6th-grade secondary school students to have positive attitudes towards critical thinking, to gain awareness regarding critical thinking, and to improve their critical thinking skills.

Limitations and Future Direction

The fact that the research was carried out in a school in the Yıldırım district of Bursa and the size of the sample was small leads to a limitation. However, in addition to these limitations, the curriculum implemented in the research can be disseminated in schools by developing it in consideration of its advantages and disadvantages, including suggestions. Furthermore, researchers can include different sample groups, conduct research through experimental design with a control group, and plan new studies by developing different activities.

Ethics Committee Approval Information: Ethics committee approval for this study was received from the Ethics Committee of Yildiz Technical University (Date: April 29, 2021; Approval Number: 2021/02).

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