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# How Do Pre-service Mathematics Teachers Organize Information Sources in the WebQuest?

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ABSTRACT

**Purpose**: WebQuests are employed for many different instructional aims by offering students to take an active role and encouraging their critical thinking skills to construct their own meaning about an inquiry. The purpose of the study was to explore pre-service mathematics teachers' decisions about the organization of information sources in which students are supported to think critically for school algebra using WebQuests.
**Method:** The case study approach was utilized in this study. The participants were pre-service mathematics teachers attending a Bachelor's program in mathematics teaching in middle school (N = 48). The WebQuest design was addressed to prompt pre-service teachers to connect mathematics with technology. The framework of critical thinking skills developed by Jonassen (2000) was used for data analysis.
**Findings:** The findings of the study revealed that among the general critical thinking skill categories, analyzing was mostly observed, followed by connecting and evaluating. The results highlighted the importance of teacher education programs and teacher educators to focus on the organization of information sources in WebQuest and addressed how pre-service teachers approach the WebQuest process and encourage students to think critically. **Implications for Research and Practice:** The present study emphasized the importance of a WebQuest facilitating the transformation from teacher-led teaching to student-directed learning via changing teaching patterns.



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## Introduction

The last decade has seen a dramatic increase in the use of computers and the Internet for teaching in various fields. One of the distinctive attributes of information and communication technologies (ICT) in developing student learning is the extensive utilization of the Internet in educational settings as an instructional tool (Allan & Street, 2007). Although the scope and intensity of research regarding ICT in the area of education is growing, the use of Internet resources should be particularly taken into consideration because of the inconsistent, complex, and inaccurate information that is available on the Internet (Yang, 2014). In general, productive utilization of the Internet and its effective usage in the instructional environment should be considered as a requirement for teachers and students (Cigrik & Ergul, 2010). Based on features contained in the constructivist approach, WebQuests might satisfy this requirement (Cigrik & Ergul, 2010) since WebQuests have been considered as one of the prime examples of the design of Internet-based learning experiences (Gibson, 2006).

Supporting learners to acquire critical thinking (CT) skills is one of the vital goals in their educational life. Yang (2014) suggested that designing WebQuests provides students with the opportunity to acquire academic knowledge and reinforce aptitudes for improving their organizational and integrated thinking skills. WebQuests have also been considered an instructional approach to help students develop essential higher-level thinking, problem-solving, and communication skills (Gibson, 2006). They are also powerful tools to broaden students' CT skills (Vidoni & Maddux, 2002). Therefore, it is important to carefully design and develop WebQuests to achieve the desired results. The resource which is one of the six components of WebQuest (i.e., introduction, task, resources, process, evaluation, and conclusion) and the organization of information sources play a vital role in this process because the websites embedded in this component support students in both resolving the problem stated in WebQuest and constructing their own personal meaning. In this study, we examined pre-service teachers' decisions about the organization of information sources in WebQuests designed for developing students' CT skills necessary for school algebra.

### *Critical Thinking (CT)*

Although CT is considered to be one of the most important skills in the information age (Saade, Morin & Thomas, 2012) and essential in adult life (Tiruneh, Verburg & Elen, 2014), in the literature, there is no consensus regarding its definition (Niu, Horenstein & Garvan, 2013; Vieira & Tenreiro-Vieira, 2016). According to Halpern (2001), CT incorporates skills in applying, analyzing, synthesizing, and evaluating information and the disposition to utilize these skills. Although definitions of CT vary in the literature, there seem to be common terms and skills, such as analyzing, evaluating, inference, and interpretation (Saade et al., 2012). More specifically, most researchers agree that CT skills are connected with higher-order thinking (Saade et al., 2012) and cognitive skills (Tiruneh et al., 2014). Jonassen (2000) developed a theoretical framework to understand general CT skills and their components (see Table 1) and suggested that "CT is the most common among contemporary conceptions of thinking in schools" (p. 22). Jonassen's (2000) work used in this study was based on Mindtools that are critical thinking tools and represent a constructivist approach, which was similarly indicated in the philosophy of WebQuest. In this framework, CT was identified using three general skills: (1) evaluating, (2) analyzing, and (3) connecting. Evaluating refers to forming judgments, and analyzing involves dividing an entire entity into its substantive components and comprehending their interconnections. Connecting concerns inferring "relationships between the wholes that are being analyzed" (Jonassen, 2000, p. 29).

**Table 1**

*The Framework of CT Skills (Jonassen, 2000, pp. 27-28)*

| General CT Skills | Components of General CT Skills |
|---|---|
| Analyzing | Recognizing patterns of organization |
| | Classifying objects into categories based on common attributes |
| | Identifying assumptions, stated or unstated, including suppositions and beliefs that underlie positions |
| | Identifying the main or central ideas in text, data or creations, and differentiating core ideas from supporting information |
| | Finding sequences or consecutive order in sequentially organized information |
| Connecting | Comparing/contrasting similarities and differences between objects or events |
| | Logical thinking required to analyze or develop an argument, conclusion, or inference or provide support for assertions |
| | Inferring deductively from generalizations or principles to instances |
| | Inferring a theory or principle inductively from data |
| | Identifying causal relationships between events or objects and predicting conclusions from possible effects |
| Evaluating | Assessing information for its reliability and usefulness, and discriminating between relevant and irrelevant information |
| | Determining criteria for judging the merits of ideas or products by identifying relevant criteria and determining how and when they will be applied |
| | Prioritizing a set of options according to their relevance or importance |
| | Recognizing fallacies and errors in reasoning, such as vagueness, non-sequiturs, and untruths |
| | Verifying arguments and hypotheses through reality testing |

In the literature, however, there is no agreement regarding the most effective conditions, instructional programs or methods with which to obtain desirable outcomes related to CT skills (Tiruneh et al., 2014). One of the possible reasons for this is the difficulty of attaining the best approach (Saade et al., 2012). Fortunately, as suggested by Kwan and Wong (2015), constructivist learning environments, such as WebQuests, have a positive impact on the improvement of students' CT skills.

*WebQuests in the Educational Context*

A brief review of the literature reveals multiple definitions of and explanations for WebQuests. For example, a WebQuest has been defined as an inquiry-oriented activity (Gibson, 2006; Lim & Hernandez, 2007; Papastergiou, Antoniou & Apostolou, 2011; Vidoni & Maddux, 2002; Yang & Tzuo, 2011), a teacher constructed web-based class (Vidoni & Maddux, 2002), a web-based classroom-learning tool (Vidoni & Maddux, 2002), a practice of the constructivist learning theory (Zhongyun, 2011), and a learning strategy (Cruz & Carvalho, 2008). As proposed by Dodge (1995), the design and development procedure of a WebQuest consists of the following six major components: introduction, task, resources, process, evaluation, and conclusion. In WebQuests, students are required to take a perspective on a specific problem or issue (Caviglia & Delfino, 2016; Gibson, 2006). They would engage in inquiries and conduct research on the Internet to create an argument and find a solution to a problem based on evidence by working together. Then, students are required to develop a critical reflection on the information provided (Cruz & Carvalho, 2008) and share their findings with the class for drawing a conclusion or resolution to the issue engaged (Gibson, 2006). In these processes, students construct their own personal meaning about the problem under investigation on the Internet. Based on constructivist principles (Yang, 2014), WebQuests provide learners with an information space to actively search the web (Segers & Verhoeven, 2009).

*The Importance of the Resource Component of WebQuests*

The resource component in WebQuests is particularly important since it lists the websites according to the inquiry. Hyperlinks embedded in a WebQuest play a vital part in supporting students in performing the task to produce knowledge (Cruz & Carvalho, 2008). Allan and Street (2007) considered this process as guiding students in determining 'where to look' and directing them to proper web resources. These information sources include the web pages of individual experts, current news, web databases, web documents, books, and other documents that can be used by students individually or in pairs (Gibson, 2006).

Since there is no single way of performing a task presented in WebQuests, students need to construct their own personal meaning based on a set of information sources (Gibson, 2006). In general, WebQuest teaching helps students to apply higher-order thinking to transfer information into beneficial knowledge (Yang, 2014). More specifically, WebQuests support the learning process of students by teaching them how to effectively apply their CT skills to the information given (Cruz & Carvalho, 2008). As suggested by Dodge (2001), WebQuests both challenge students to explore required information and facilitates the improvement of their ability to analyze, integrate, evaluate, and solve problems. Similarly, Vidoni and Maddux (2002) stated that WebQuests provided students with an opportunity to put their CT skills into practice.

In WebQuests, the information presented in the resource section is drawn from the websites to be used by students (Gibson, 2006). Allan and Street (2007) highlighted that an active engagement, such as helping students with hyperlinks on the Internet, is very important in practice. These websites establish an interaction between students and sources in a way that students' learning occurs meaningfully allowing them to distinguish between different sources of information and then utilize them in their own problem-solving practices (Lim & Hernandez, 2007). Reading, analyzing, and synthesizing information are among the main efforts students engage in when using websites during a WebQuest process (Kurtulus & Ada, 2012).

Although WebQuests offer considerable educational benefits for students, Zhongyun (2011) warned that surfing the Internet instead of focusing on a task is questionable advantage. Similarly, Allan and Street (2007) pointed out that WebQuests might lead to surface learning by encouraging certain actions, such as briefly skimming or scanning the content of websites and using direct quotes without forming their own ideas and meaning. In addition to the danger of surface learning, the hypertext structure of the Internet may also result in cognitive overloading, getting lost in hyperspace, and being presented unreliable information or information that is not appropriate for the age or reading level of children (Segers & Verhoeven, 2009). Therefore, information sources in WebQuests should be organized in a way that will keep the focus of the students on the given activity. Similarly, a set of appropriate information sources should be selected and organized for students to engage in discussions and participate in activities when accomplishing a web task and help students acquire and effectively use higher-order thinking skills (Yang, 2014).

### *Significance and Purpose of the Study*

Although our research has several similarities to the previously mentioned studies, we adopted a different perspective when examining how and why pre-service mathematics teachers organized information sources in their WebQuests to help learners acquire CT skills. While previous studies addressed general issues about the problems and designs related to the development of CT skills, we specifically focused on the organization of a set of information sources in WebQuests that could be used to engage students in thinking critically. While the focus of this study is limited to characterizing the way of pre-service teachers' decisions, we do suggest that such decisions may have a potential effect on students' CT skills. In the literature, we have only found a limited number of studies addressing the issues related to the innovative ways of acquiring CT skills in mathematics. Moreover, there is a need to investigate how pre-service teachers can be better prepared in terms of the design of WebQuests and their integration into real-world settings (Wang & Hannafin, 2008). Although the potentials of WebQuests in education have been widely examined, there is only limited information concerning the components, especially for the resource sections. Thus, our main goal was to help pre-service mathematics teachers develop a stronger understanding of the organization of information resources in WebQuests that could be used as a powerful tool to improve students' CT skills. The purpose of the study was to explore pre-service mathematics teachers' decisions about the organization of information sources in which students are supported to think critically for school algebra using WebQuests. The main research question that guided the study was:

> How did pre-service teachers organize information sources in WebQuests to promote their students' CT skills related to algebraic thinking and why did they choose these specific sources?

## Method

### *Research Design*

In this research, a case study approach was utilized in which researchers scrutinize a contemporary phenomenon (e.g., a program, event, activity, and process) within a real-life context (Creswell, 2009; Yin, 2009). The term case study may refer to the process of analysis, the product of analysis or both (Patton, 2002). With these theoretical premises offered by the case study methodology, we analyzed the participants' reflections and discussed their rationales regarding the organization of a set of information sources in their WebQuests to identify the CT skills.

### *Participants and Context*

The participants were pre-service mathematics teachers attending a Bachelor's program in mathematics teaching in the middle school (N = 48) at a university in the south of Turkey. They were in the third year of a four-year program. At the time of the study, the participants enrolled in the course of methods of teaching mathematics. The WebQuest design was addressed in class as part of the course to prompt pre-service teachers to connect mathematics with technology. The participants were asked to design their own WebQuests to guide their prospective students to collect, read, watch, and analyze data obtained from Internet sources. They were informed about how prospective students develop CT in mathematics and how the WebQuests play a vital role in supporting students' critical thinking skills. In addition, all the participants selected an algebra topic and learning outcome from the fifth- to the eighth-grade mathematics curriculum. There was no restriction in terms of the content areas, learning outcomes, and grade levels.

### *Data Collection*

To collect data, we first developed a WebQuest design template. As shown in the left column of Table 2, the template consisted of three parts; instructions, websites listed, and images found on the Internet. Moreover, to obtain detailed information about how and why to integrate and organize information sources in their WebQuests, the participants were given a form and asked to explicitly write their reflections on how they gathered, synthesized, and evaluated the information available, and how they selected the websites for the resource section in their WebQuests (Table 2, middle column). This report allowed them to freely respond using their own words; and hence, resulted in a variety of responses.

### *Data Analysis*

We analyzed the data from the reflection reports by quantitative content analysis (Chi, 1997). This type of analysis consists of two steps: segmentation and coding. Before coding the data, the coders (i.e., authors) came together in a training session to discuss their individual sample coding on the reports of five participants. In this session, the coders reviewed the participants' comments and discussed their rationales. Following the training session, the coders independently coded a sample of 48 participants' reflections and discussed them until 100% inter-rater reliability was reached concerning interpretations. Then, the coders read the reflection papers to familiarize with the consistent and interesting patterns within the reflections. Each comment rationalized by the pre-service teachers related to the listed web sources was regarded as a *segment*. The coders agreed on 95% of the segments. The remaining segments (5%) were ambiguous. As a result of discussions, a total of 96 segments were identified. The main ideas in the participants' reflection reports, which were generally linked to a group of sentences or paragraphs, were used as coding units. For coding, each segment was to be assigned to either of the three general CT skill categories (analyzing, connecting, evaluating) developed by Jonassen (2000), which are described in Table 1. As an example, one of the comments written by the participant as shown in the right column of Table 2 was coded in the analyzing category. All the rationales and comments for each segment were coded as in the example given in Table 2.

**Table 2**

*An Example: One of the Participant's Instruction and Comments on How and Why to Use Internet Sources*

| The Design Template | Comments from Reflection Report | Assigned General CT Skill– Component Skill |
|---|---|---|
| [Instruction] In the first step, you should recognize the representation of patterns in the real-life models.<br>[Listed the websites and images]<br>First source: Patterns in parquets<br><br>http://pred.boun.edu.tr/ps/turkish/ps4.html | In my example, I used websites including paving stones, parquets, and leaf patterns. As shown in the figure [second source], students would recognize how the number of paving stones increases by each step as they move away from the center of the quarter-circle. Similarly, there are similar patterns in a leaf. From these examples, I think that students would recognize the patterns. | Analyzing-Recognizing patterns of organization |

Table 2 Continue

| The Design Template | Comments from Reflection Report | Assigned General CT Skill– Component Skill |
|---|---|---|
| Second source: Patterns in paving stones<br><br>http://tr.depositphotos.com/11810432/stock-photo-marble-stone-mosaic-texture-high.html<br>Third source: Zebra<br><br>https://rlv.zcache.com/zebra_stripes_photography_pattern_photo_print-r95dfdf8a6cc9471bbfb95424683ee375_ftof3_8byvr_324.jpg<br>Fourth source: Leaf patterns<br><br>http://static.boredpanda.com/blog/wp-content/uploads/2014/12/Perfect-Geometric-Patterns-In-Nature8__880.jpg | | |

## Results

Table 3 shows the frequency distribution of pre-service teachers' comments from the reflection reports.

**Table 3**

*The Frequency Distribution of Pre-service Teachers' Comments from Their Reflection Reports*

| General CT Skills | Components of General CT Skills | Frequency (f) |
|---|---|---|
| Analyzing | Identifying the main or central ideas in text, data or creations, and differentiating core ideas from supporting information | 40 |
| | Recognizing patterns of organization | 10 |
| | Finding sequences or consecutive order in sequentially organized information | 2 |

Table 3 Continue

| General CT Skills | Components of General CT Skills | Frequency (f) |
|---|---|---|
| Connecting | Logical thinking, required to analyze or develop an argument, conclusion, or inference or provide support for assertions | 16 |
| | Inferring a theory or principle inductively from data | 15 |
| | Comparing/contrasting similarities and differences between objects or events | 5 |
| Evaluating | Assessing information for its reliability and usefulness, and discriminating between relevant and irrelevant information | 8 |
| | *Total* | *96* |

In the following, we briefly present the data obtained from the participants' reflections under the three distinct CT categories of analyzing, connecting, and evaluating.

*Analyzing*

*Identifying the main or central ideas in text, data or creations, and differentiating core ideas from supporting information*. The analysis of the participants' reflections indicated that they paid special attention to including examples related to painting, music, craft, architecture, and nature in their WebQuests. For instance, they used Escher paintings and Dipylon Vase decoration to determine the pattern rules; Leonardo Da Vinci paintings, Bach's music, and nature photographs to explore golden ratios; architectural works to examine tessellations; and leaves of a tree to examine fractals. For instance, Participant A explained why she used Leonardo da Vinci's paintings in her work as follows:

> I would like students to investigate Leonardo da Vinci's life and works, examine the ratios in his works and access illustrations [through my hyperlinks]. I think that I am giving the students a chance both to get information about Leonardo da Vinci and his works and to see a good example about the ratio concept. For instance, Mona Lisa's body exhibits several golden ratios.

Here, the participant's intention was to obtain information from the text about Leonardo da Vinci and analyze the main ideas in the context. Similar to Participant A, Participant B emphasized:

> Students need to see the ceramic tiles in the architectural works. I try to achieve this through videos (hyperlinks) that show the inside of mosques. With these videos, I intend for the students to form an idea about tessellations via the

> information given about ceramics. I believe that this information is important for patterns and tessellations.

Participant B put emphasis on analyzing the context, i.e., tiling on the walls. In general, the participants tended to include more real-life situations in their WebQuest. On the other hand, they tended to engage less in imparting algebraic content to their prospective students using real-life connections. Thus, it can be suggested that they valued the connections since they offered an opportunity to gain a deeper understanding about real-life context.

*Recognizing patterns of organization*. The participants used different representations to present examples (e.g., the Richter scale, paving stone, parquet, zebra, leaf, and calendar). They examined why they used these different representations in their work. For instance, Participant E explained:

> In my example, I used websites, including paving stones, parquets, and leaf patterns. As shown in the figure [referring to the picture of paving stones in Table 2], students would recognize how the number of paving stones increases by each step as they move away from the center of the quarter-circle. Similarly, there are similar patterns in a leaf. From these examples, I think that students would recognize the patterns.

In her design, Participant E tried to provide students with appropriate assistance and more opportunities to work on the relations between the different representations of a pattern. She used models and focused on analyzing the pattern representations in meaningful contexts. It is clear that her intention was to recognize the patterns of representations in the example and to reveal the rich relationships between the models and mathematics.

*Finding sequences or consecutive order in sequentially organized information.* Two participants put emphasis on how to draw a fractal step by step and using the Geometer's Sketchpad to create fractals. They had a certain degree of understanding how to follow sequential steps to draw fractals. For example, Participant F stated, "I used hyperlinks to show students how fractals can be easily drawn, and mathematics can be used when drawing". In this case, students were required to understand that there was a repeating pattern in each step and to find the sequences for fractals. Although there were limited numbers of cases related with this category, it can be suggested that the participants underlined the importance of determining the sequential steps of action to apply the algebraic process.

*Connecting*

*Logical thinking required to analyze or develop an argument, conclusion, or inference or provide support for assertions.* Patterns and tessellations were most underlined being related to different examples from architecture, painting, and music. Throughout the process, the participants often presented the issues from a variety of perspectives, thus allowing students to analyze the issues and connect them with algebra. Participant H explained this as follows:

> In my examples, students must investigate and analyze different patterns that exist in nature. Following these examples, they should reveal that the nature presents different types of patterns, one of which is repeating patterns. The first video link is about repeating patterns and the second is on recursive patterns. My intention is for the students to develop perspectives about the patterns in nature…After this, they are required to present their own examples and create an online photo gallery.

Here, the participant intended to draw students' attention to exploring examples from nature comprising repeating and recursive patterns. He seemed to be able to make a connection between algebra and nature and demonstrated his ability to apply this to his example. In brief, all the participants aimed to encourage the students to think about the issues in their design in different ways.

*Inferring a theory or principle inductively from data*. There were commonalities of context and concerning the participants' apparent attempt to connect real life with algebra. In particular, most of them relied on developing pattern-finding strategies, finding the basic three attributes for tessellations, calculating the golden ratio, and identifying the stages of fractals. Great attention was explicitly given to making a connection between patterns and real-life contexts related to art (e.g., music, dancing, paintings, and tiling) and nature. However, the findings cannot be presumed to reflect the participants' overall use of the context. The following excerpt presents a discussion about how Participant I used a real-life context in a pattern example:

> I used two hyperlinks in my design. In the first link, students will be introduced to the Fibonacci Sequence (the series of numbers: 0, 1, 1, 2, 3, 5, 8, 13…) and find a rule for this sequence. In the second hyperlink [referring to 'click play to hear how the pattern sounds'; i.e., musical counter], they will listen to the patterns they constructed and identify the rule for this pattern. These are important for students to explore how the music and mathematics are connected with each other.

Here, the participant tried to draw students' attention initially to seeing the pattern in the Fibonacci series and then to testing their patterns through the music. She used real-life examples as a context in which to display students' ability to work through algebra and make generalizations.

*Comparing/contrasting similarities and differences between objects or events.* The common explanations in this category included the participants' expectation that students would compare similarities and differences between algebra topics. In particular, the participants made a significant attempt to explore in detail the connection of patterns with tessellations and fractals. Participant F provided the following explanation for his choice of website:

> In this website, the definition of fractals is presented impressively. How can patterns be extended to fractals? Why is a fractal a pattern? What is the relationship between fractals and patterns? Why is something considered a fractal? …these

> questions are clarified with visuals and examples. In brief, the reason why I chose this website is that the content and learning outcomes are well-structured.

In a similar vein, Participant J stated, "With the internet resources listed below, students have a chance to obtain sufficient information to identify the rules of patterns and tessellations. I want students to realize the difference between the two concepts." Overall, the participants provided clear and concise explanations for their choices when creating their WebQuest design. It seems that their intention was to help students understand and reveal the underlying meaning of algebraic concepts through comparing their definitions.

*Evaluating*

In this category, there is only one type of skills that matched the participants' reflections: Assessing information for its reliability and usefulness, and discriminating between relevant and irrelevant information. The participants' intentions were to evaluate the different types of algebra definitions that were most reliable in a WebQuest design. Based on the findings, it can be suggested that the students were first directed to verify the content given on the websites accessed by hyperlinks and then discriminate between the relevant and irrelevant information. Participant K explained this as follows:

> Firstly, students must learn what tessellations are. Therefore, they must examine the definitions. However, they must also check and evaluate the accuracy of the definitions; then, they should compare and contrast these descriptions.

Here, the participant relied on making a decision about how the definition of tessellation could be used in the process. Students should be careful when comparing different explanations of tessellations. They need to evaluate the reliability of the definitions given on websites referred by hyperlinks.

## Discussion, Conclusion and Recommendations

The findings of the study revealed that among the general CT skill categories, *analyzing* was mostly observed, followed by *connecting* and *evaluating*. Indeed, one of the important findings of this study was that it highlighted the importance of *analyzing* skills. Most of the reflections indicated that the pre-service teachers paid great attention to the identification of the main ideas in the contexts. This would also provide students with an opportunity to engage in CT skills and supports Halpern's (2001) argument that the ability to identify main ideas and analyze information are indicators of CT skills. Another prominent finding was that the participants' intentions in their organization of information sources in WebQuests were to recognize the patterns of representations and analyze the algebraic idea in the models. This result supports Halpern's (2001) classification of CT skills, which places seeking patterns among thinking skills. Similarly, Enright and Beattie (1992) suggested that students' identification of a pattern depends on their CT skills framework. This finding also has implications regarding algebraic thinking, in particular concerning the generalization of patterns (Carraher, Martinez & Schliemann, 2008; Swafford & Langrall, 2000). In parallel to Cooper and Warren (2008) and Wilkie (2014), it was found that the choice of pattern representation in different ways, such as real-world situations and pictures, increased the learners' opportunity to develop algebraic thinking and represented explicit generalization.

These findings suggest that disregarding the pre-service teachers' reasons for their decision regarding whether to use real-world issues in their WebQuests may lead to an incomplete understanding of how students acquire *analyzing* skills. An important implication of this study is that the pre-service teachers' interpretation of real-world issues depends on their ability to encourage students to identify the main ideas and recognize the patterns of representations in a text. Thus, the findings support the claim that using real-life issues can influence the interpretation of students' development of CT skills.

In this study, the importance of *connecting* skills was also underlined by the participants' using examples from real-life settings to help students develop a point of view about WebQuests. It can be suggested that in their design, the pre-service teachers encouraged students to interpret the content highlighted on the websites referred by the links and make connections with real-world settings. This supports the findings of a recent study conducted by Kim (2015) that demonstrated that basic analysis and reasoning with specific student reactions would indicate their CT levels. Additionally, Saade et al. (2012) made the same argument by suggesting that CT skills entailed the interpreting aspect. Another similar finding about the *connecting* skills indicated that the pre-service teachers provided opportunities to make generalizations based on pattern activities using a collection of images of relevant examples. In this regard, real-life examples were used as a context in which to display students' ability to work through algebra and support their generalization. It can be suggested that the pre-service teachers engaged in drawing conclusions from the given real-life examples and providing evidence for their conclusion, which Halpern (2001) considered to be an example of thinking skills. Consistent with the findings of previous studies (e.g., Beswick, 2011; Carpenter & Lehrer, 1999; Gainsburg, 2008), the present study also demonstrated the importance of using real-life contexts to achieve the intended outcomes and improve students' engagement and participation in mathematics. One of the somewhat surprising conclusions is that the pre-service teachers valued real-life connections in their WebQuests because they had an opportunity to introduce ideas about algebra teaching. This does not mean that all the pre-service teachers followed the same template in their design or they all gained an insight into and appreciation of making real-life connections with algebra. However, we believe that the pre-service teachers facilitated the discussions of algebraic ideas in real life and eventually provided a basis for positively changing not only their prospective students' algebraic thinking but also their own ability to explain the connection between algebra and its real-life applications and overall perceptions of algebra.

Lastly, the importance of *evaluating* skills was highlighted by the participants that the pre-service teachers' reflections allowed making inferences about how they assessed information in terms of its reliability and usefulness. The participants emphasized the importance of comparing different explanations of algebra concepts and evaluating the reliability of the definitions given on the websites directed by hyperlinks. The finding supports Brookfield's classification (as cited in Kim, 2015) that distinguishing relevant from irrelevant information, claims, or reasons and determining the credibility of a source would be regarded as students' CT in-class activities. It is also parallel to the idea that the Internet helps learners create their own learning by offering written, audio, and video resources as long as they are selected appropriately (Segers & Verhoeven, 2009).

A significant result of this study was that the process of organization of information sources in WebQuests could help pre-service teachers apply their teaching algebra knowledge. Wang and Lin (2008) stated that teacher education programs played a vital role for pre-service teachers to develop conceptions about teaching and learning. Taking into consideration the participants' reflections, it is clear that WebQuests had an important role in the participants' application of their knowledge and instructional decisions. Moreover, the reflections of the pre-service teachers regarding their WebQuests provided the researchers with a valuable source of eliciting their ideas about algebraic thinking. Thus, this study joins others (e.g., Allan & Street, 2007; Kurtulus & Ada, 2012; Kwan & Wong, 2015; Vidoni & Maddux, 2002; Yang, 2014) in highlighting the importance of WebQuest to consider how to help pre-service teachers learn to use alternative teaching methods rather than following traditional ways and to involve components ensuring students to employ higher-order thinking, particularly CT.

The findings of the study have some implications regarding teacher education programs. Consistent with the findings from a previous study by Yang (2014), the present study emphasized the importance of a WebQuest facilitating the transformation from teacher-led teaching to student-directed learning via changing teaching patterns. In our study, the pre-service mathematics teachers organized the information sources in WebQuests by simplifying the web-browsing process and guiding prospective students' web search through links to websites, as also reported by Vidoni and Maddux (2002). Throughout the study, they had a chance to experience an alternative teaching method and improve their ability to utilize technology in mathematics teaching before entering the profession, which is in parallel with the argument of Wang and Hannafin (2008). Thus, the results of this study highlighted the importance of teacher education programs and teacher educators to focus on designing WebQuests for other mathematical topics such as geometry and arithmetic. Future research can also address how pre-service teachers implement WebQuest tasks in real classroom settings and encourage students to make real-world connections to develop their CT skills.

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## Matematik Öğretmen Adayları WebQuest'te Bilgi Kaynaklarını Nasıl Düzenlemektedir?

### Atıf:

Ozgeldi, M., & Yakin, I. (2021). How do pre-service mathematics teachers organize information sources in the WebQuest? *Eurasian Journal of Educational Research, 91, 237-256*, DOI: 10.14689/ejer.2021.91.11

### Özet

*Problem Durumu:* Öğrencilerin eleştirel düşünme becerileri kazanmalarını desteklemek, eğitim hayatlarındaki önemli hedeflerden biridir. Yang (2014) WebQuests tasarlamanın öğrencilerin akademik bilgi edinme ve örgütsel ve bütünleşik düşünme becerilerini geliştirme yeteneklerini pekiştirdiklerini belirtmektedir. WebQuests, öğrencilerin temel üst düzey düşünme, problem çözme ve iletişim becerilerini geliştirmelerine yardımcı olmak için öğretimsel bir yaklaşım olarak da kabul edilmektedir (Gibson, 2006). Ayrıca öğrencilerin eleştirel düşünme becerilerini genişletmek için güçlü araçlardır (Vidoni ve Maddux, 2002). Bu nedenle, istenen sonuçları elde etmek için WebQuest'leri dikkatlice tasarlamak ve geliştirmek önemlidir. Kaynaklar, WebQuest'in altı bileşeninden biridir ve bilgi kaynaklarının organizasyonu için önemli bir rol oynar, çünkü bu bileşene gömülü web siteleri öğrencileri hem WebQuest'te belirtilen sorunu çözme hem de kendi kişisel anlamlarını oluşturma konusunda destekler. Bu çalışmada, matematik öğretmen adaylarının öğrencilerin okul cebiri için gerekli eleştirel düşünme becerilerini geliştirmek üzere tasarlanmış WebQuest'lerde bilgi kaynaklarının organizasyonu hakkındaki kararları incelenmiştir.

*Araştırmanın Amacı:* Bu çalışmanın en genel amacı matematik öğretmen adaylarının WebQuests'te öğrencilerin eleştirel düşünme becerilerini geliştirmek için güçlü bir araç olarak kullanılabilecek bilgi kaynakları organizasyonu hakkında daha güçlü bir anlayış geliştirmelerine yardımcı olmaktır. Araştırmanın amacı matematik öğretmen adaylarının öğrencilerin WebQuest'leri kullanarak okul cebiri için eleştirel düşünmeleri için desteklendikleri bilgi kaynaklarının organizasyonu hakkındaki kararlarını araştırmaktır. Çalışmanın ana araştırma sorusu: Öğretmen adayları, öğrencilerin cebirsel düşünme ile ilgili eleştirel düşünme becerilerini geliştirmek için WebQuests'te bilgi kaynaklarını nasıl organize ettiler ve bu kaynakları neden seçtiler?

*Araştırmanın Yöntemi:* Bu araştırmada, araştırmacıların çağdaş bir fenomeni (örn., Bir program, olay, etkinlik ve süreç) gerçek hayat bağlamında incelediği bir durum çalışması yaklaşımı kullanılmıştır (Creswell, 2009; Yin, 2009). Durum çalışması metodolojisi tarafından sunulan bu teorik önermelerle katılımcıların yansımalarını analiz edildi ve eleştirel düşünme becerilerini belirlemek için WebQuest'lerinde bir dizi bilgi kaynağının organizasyonu ile ilgili gerekçelerini tartışıldı. Katılımcılar, Türkiye'nin güneyindeki bir üniversitede ortaokulda matematik öğretimi lisans programına (N = 48) devam eden matematik öğretmen adaylarıdır. Çalışma sırasında

katılımcılar matematik öğretme yöntemleri dersine katılmaktadır. WebQuest tasarımı, öğretmen adaylarının matematiği teknoloji ile ilişkilendirmeleri için dersin bir parçası olarak sınıfta ele alınmıştır.

*Araştırmanın Bulguları:* Katılımcıların yansımalarından elde edilen verileri kısaca üç farklı analiz, bağlantı ve değerlendirme kategorisi altında sunulmaktadır.

*Analiz*

Katılımcıların yansımalarının analizi, WebQuest'lerine resim, müzik, zanaat, mimari ve doğa ile ilgili örnekler eklemeye özellikle dikkat ettiklerini göstermektedir. Örneğin, katılımcılar desen kurallarını belirlemek için Escher resimleri ve Dipylon Vazo dekorasyonunu kullandılar; Altın oranları keşfetmek için Leonardo Da Vinci resimleri, Bach'ın müziği ve doğa fotoğrafları; mozaikleri incelemek için mimari eserler; ve fraktallar incelemek için bir ağacın yapraklarını kullandılar. Örneğin, Katılımcı A, çalışmalarında neden Leonardo da Vinci'nin resimlerini kullandığını şu şekilde açıkladı:

Öğrencilerden Leonardo da Vinci'nin hayatını ve eserlerini araştırmasını, eserlerindeki oranları incelemelerini ve [köprülerimden] resimlere erişmelerini istiyorum. Sanırım öğrencilere hem Leonardo da Vinci ve eserleri hakkında bilgi edinme hem de oran kavramı hakkında iyi bir örnek görme şansı veriyorum. Örneğin, Mona Lisa birkaç altın oran sergiliyor.

Burada katılımcının amacı Leonardo da Vinci ile ilgili metinden bilgi almak ve bağlamdaki ana fikirleri analiz etmektir.

*Bağlantı*

Süreç boyunca, katılımcılar genellikle sorunları çeşitli açılardan sundular, böylece öğrencilerin sorunları analiz etmelerine ve bunları cebirle ilişkilendirmelerine izin verdiler. Katılımcı H bunu şöyle açıkladı:

Örneklerimde, öğrenciler doğada var olan farklı kalıpları araştırmalı ve analiz etmelidir. Bu örnekleri izleyerek, doğanın, biri yinelenen desenler olan farklı desen türleri sunduğunu ortaya koymalıdırlar. İlk video bağlantısı tekrar eden kalıplarla, ikincisi ise yinelemeli kalıplarla ilgilidir. Amacım öğrencilerin doğadaki kalıplar hakkında bakış açıları geliştirmelerini sağlamaktır… Bundan sonra, kendi örneklerini sunmaları ve çevrimiçi bir fotoğraf galerisi oluşturmaları gerekmektedir.

Burada, katılımcı öğrencilerin dikkatlerini tekrarlayan ve yinelemeli kalıpları içeren doğadan örnekleri keşfetmeye yöneltmiştir. Katılımcı cebir ve doğa arasında bir bağlantı kurabilmektedir. Kısacası, tüm katılımcılar öğrencileri tasarımlarındaki konuları farklı şekillerde düşünmeye teşvik etmeyi amaçlamıştır.

*Değerlendirme*

Bu kategoride, katılımcıların yansımalarıyla eşleşen sadece bir tür beceri vardır: Güvenilirliği ve kullanışlılığı için bilgileri değerlendirme ve alakalı ve alakasız bilgiler arasında ayrım yapma. Katılımcıların niyetleri, bir WebQuest tasarımında en güvenilir olan farklı türdeki cebir tanımlarını değerlendirmektir. Bulgulara dayanarak, öğrencilerin önce köprülerle erişilen web sitelerinde verilen içeriği doğrulamaya ve daha sonra ilgili ve alakasız bilgiler arasında ayrım yapmasına yönelik oldukları söylenebilir. Katılımcı K bunu şöyle açıkladı:

İlk olarak, öğrencilerin mozaiklerin ne olduğunu öğrenmeleri gerekir. Bu nedenle tanımları incelemeleri gerekir. Ancak, tanımların doğruluğunu da kontrol etmeli ve değerlendirmelidir; o zaman bu tanımları karşılaştırmalı ve karşılaştırmalıdırlar.

Burada, katılımcı mozaikleme tanımının süreçte nasıl kullanılabileceğine karar vermektedir. Öğrenciler mozaiklerin farklı açıklamalarını karşılaştırırken dikkatli olmalıdır. Köprüler tarafından atıfta bulunulan web sitelerinde verilen tanımların güvenilirliğini değerlendirmeleri gerekir.

*Araştırmanın Sonuçları ve Öneriler:* Çalışmanın bulguları genel eleştirel düşünme beceri kategorilerinde analizlerin daha çok gözlemlendiğini, ardından bağlantı kurulduğunu ve değerlendirildiğini ortaya koymuştur. Gerçekten de bu çalışmanın önemli bulgularından biri, becerilerin analiz edilmesinin önemini vurgulamasıdır. Düşüncelerin çoğu öğretmen adaylarının bağlamlardaki ana fikirlerin belirlenmesine büyük önem verdiğini göstermiştir. Bu aynı zamanda öğrencilere eleştirel düşünme becerilerine katılma fırsatı sunacaktır. Bu sonuç, aynı zamanda Halpern'in (2001) ana fikirleri belirleme ve bilgileri analiz etme yeteneğinin eleştirel düşünme becerilerinin göstergeleri olduğunu savunduğunu desteklemektedir. Çalışma boyunca, öğretmen adayları Wang ve Hannafin'in (2008) argümanı ile paralel olan mesleğe girmeden önce, alternatif bir öğretim yöntemi deneyimleme ve matematik öğretiminde teknolojiyi kullanma yeteneklerini geliştirme şansı elde etmiştir. Bu nedenle, bu çalışmanın sonuçları, öğretmen eğitimi programlarının ve öğretmen eğitimcilerinin geometri ve aritmetik gibi diğer matematiksel konular için WebQuest tasarlamaya odaklanmasının önemini vurgulamıştır. Gelecekteki araştırmalar ayrıca öğretmen adaylarının WebQuest görevlerini gerçek sınıf ortamlarında nasıl uyguladıklarını ele alabilir ve öğrencileri eleştirel düşünme becerilerini geliştirmek için gerçek dünya bağlantıları kurmaya teşvik edebilir.

*Anahtar Sözcükler:* Eleştirel düşünme, matematik öğretmen adayları, öğretmen eğitimi, WebQuest, web tabanlı öğrenme