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A perception scale on the use of webquests in mathematics teaching: A study of scale development

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This study was aimed to develop a valid and reliable perception scale in order to determine the perceptions of pre-service teachers towards the use of WebQuest in mathematics teaching. The study was conducted with 115 junior and senior pre-service teachers at Balıkesir University's Faculty of Education, Computer Education and Instructional Technologies Department in the spring semester of the academic year 2013 to 2014. The data analysis was carried out with statisitical package for social sciences (SPSS) 17. The construct validity of the scale was tested with factor analysis, while the Cronbach Alpha reliability coefficient was employed to determine the reliability of the scale. The distinguishability of the items was determined by adjusted item-total correlation and the calculation of t values between groups lower and higher than 27%. These analyses generated a scale of 38 items aggregated under 5 factors. The Cronbach's Alpha reliability (internal consistency) coefficient was found to be 0.91, and the t test revealed a significant difference for all items in the groups lower and higher than 27%.

Key words: Perception on the use of WebQuests, reliability and validity, scale development, computer education and instructional technologies, mathematics education.

INTRODUCTION

Nowadays, we are living in the age of technology; computers are having a significant impact on peoples' learning and their behaviors (Martinovic and Zhang, 2012). The internet has become the platform to enable people to communicate as well as to access and share information. Although, a wide range of valuable information is accessible on the internet, the fact that it also has numerous web sites with deficient, inaccurate and useless information (Halat, 2007) leads learners into incomprehensibility and causes them to face difficulties in organizing information and accessing accurate information. The quest to distinguish which sites are adequate for the purpose of learning distracts the subject and wastes time (Faichney, 2002). There have been various attempts to develop an approach towards the use of internet in educational and instructional activities that would eliminate these challenges. One of these attempts is WebQuest, developed in 1995 by Bernie Dodge.

WebQuest overview

WebQuest is a research-oriented and research-based activity designed to enable students to use their time

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more effectively, to encourage interactive study and to obtain all or most of the necessary information from internet resources (Dodge, 1997; Dodge, 2002). March (2003a) has been contributed significantly to the enrichment and diversification of WebQuest. Dodge (2002) defines it as: “a graded learning model which build links between the necessary resources on the internet and the real world, and that encourages students to participate in group-processes in their basic researches, open-ended questions, and the development of personal expertise as well as the transformation of the newly obtained knowledge into elaborate learning.”

WebQuests are composed of at least six sections: introduction, task, process, information resources, evaluation and conclusion. In the introduction, the activity is presented to the students in the form of a scenario, a story or in any other format that will make the problem appear more attractive and interesting as contextualized within a real situation, thereby allowing the students to use their prior knowledge of the subject. In addition, both the instructor and the student are provided with the knowledge of the steps to be taken during the instruction process (Halat, 2007; Kurtuluş and Kılıç, 2009; Öksüz and Uca, 2010a). The task is the most important section in WebQuest, since it expresses the learning acquisitions in a concrete manner (Dodge, 2002).

Students are provided with a brief and clear account of activities that will be meaningful, viable, interesting and entertaining, and these activities are organized in order to support higher order thinking abilities (Halat, 2007; Kurtuluş and Kılıç, 2009; Öksüz and Uca, 2010a). The process section includes instructions to guide the students in each step of the activity (Halat, 2007; Öksüz and Uca, 2010a).

Information resources offer a list of resources prepared or chosen by the instructor to help the students accomplish their tasks. These resources should be adequate enough for the student and to the task at hand, easily accessible and supportive of learning (Halat, 2007; Öksüz and Uca, 2010a). The list consists of internet based resources as well as activity books, PowerPoint presentations, rhymes or puzzles. The resources can also be provided in the process section (Chatel and Nodell, 2002; Kılıç, 2007; Öksüz and Uca, 2010a). The criteria to be followed in evaluation are given in the evaluation section (Kurtuluş and Kılıç, 2009). The conclusion includes the presentation of all that has been accomplished or learnt by the student; the student may also be encouraged to extend their experiences to other fields (Dodge, 1997). Naturally, this section is usually closely related to the introduction (Akçay and Şahin, 2013).

WebQuest and learning

WebQuest was developed using the constructive learning approach. It should not be seen as only a method to encourage the use of internet in education, but also a way to develop a variety of abilities, to explore subjects and to achieve educational goals. This is why WebQuests should be structured effectively (March, 2000). Below are the requirements for a well prepared WebQuest:

1. The first thing to be taken into account in the preparation of WebQuest should be the learning acquisitions to be attained. The resources should be determined from the standpoint of these acquisitions; students should not be permitted to waste their time on useless subjects.
2. Tasks should be related and applicable to the real world, and organized in order to arouse the interest and curiosity of students.
3. The activity should include open-ended questions that require higher order thinking.
Information resources should be appropriate to the age and abilities of the students.
4. To attract the attention of students, WebQuests should use images, maps, animations, audio and visual resources.
5. An effective WebQuest pairs the tasks to be accomplished by the students with a variety of related evaluation mechanisms (March, 2003a, March, 2003b; Wooster and Lemcool, 2004; URL 1).

Recently, the rapid development of technology creates new opportunities for meaningful mathematics teaching, and makes it necessary to reconsider the equipment used in schools. In fact, under The increasing opportunities and improvement of technology movement project in Turkey, the Ministry of Education (2011) has tried to provide the schools with computer, interactive whiteboard and internet network infrastructure in all levels of the elementary, primary and high schools; it has started given out tablets (computers) to all teachers to effectively administer courses, train and aid students’ learning process (URL 2). The internet is now available to students at any time.

However, the accessible websites should be filtered in order to prevent access to bad websites, which can adversely affect the students development (Kamacı and Durukan, 2012). WebQuest is an important teaching model to solving this problem, to select the useful internet websites for students and to prevent the students' direction to malicious internet sites (Kobak, 2013).

The internet is integrated in the educational and teaching environment using WebQuest in mathematics teaching. It improves the academic achievement in mathematics aspects, increasing the students' attitudes towards mathematics by manipulating the mood for the course and the effectiveness and persistence of learning through high level of cognitive activities. In addition, it

helps the students to adopt their mathematical knowledge to daily life by converting gained knowledge to a product (Kılıç, 2007). According to the Halat (2007), WebQuest is an effective method because it enables the students to self-learn and become active.

Perceptions of WebQuests

The value of technology depends on how effective school teachers use it to support teaching in the classroom because only effective use of technology can improve students' learning (Fulton et al., 2004). In addition, prior studies have revealed that WebQuest activities have a positive effect on the academic success and attitudes of the students (Kobak, 2013).

Although new information and communication technologies are very significant and useful in contemporary education, the fact remains that: "it is the instructor who provides education its meaning, and makes it functional, effective and productive." This implies that the efficiency and functionality of the possibilities provided by the current technology are still dependent on the capacities of educated humans. It should never be forgotten that only teachers can manage the information technologies to build ties with students (Aktepe, 2011). Undoubtedly, another important aspect of effectively integrating technology into instruction is individuals' perspectives on technology (Paraskeva et al., 2008).

Indeed Geer et al. (1998) emphasize that individuals using technologies need to be proficient and feel safe in order to be effective. This case reveals the importance of the individuals' perception towards to technology. The perception is the process of understanding the surrounding objects, events and relations through the sensory organs (Yanık, 2010). The previous experience, psychological and physical structure and requirements of each individuals are different. Therefore, their perceptions will be different (Erkuş, 2012). For this reason, it is important to have a valid and a reliable scale to reveal the general situation.

The internet is a new technology compared to other traditional information technology; it offers a richer environment to meet various personal needs (Gömleksiz and Erten, 2013). Prior studies show that the internet is used mostly for communication (Akkoyunlu, 2008), entertainment, education (Scherer, 1997), games, music and chatting (Huang, 2008).

However, WebQuests is used commonly for the purposes of education and training activities. The perception of using WebQuest in teaching is individuals' awareness of its characteristics and importance in learning and teaching environment (Ersoy and Türkkan, 2009). This study will make an important contribution due to the absence of a valid and reliable developed scale to reveal the perceptions of the use of WebQuests in mathematics instruction.

In this study, we develop a valid and reliable perception scale to determine the perceptions of pre-service teachers towards the use of WebQuest in mathematics instruction.

METHODOLOGY

This section presents the stages of the development of the scale as well as the properties of the study group.

Study group

In the research, a purposive sampling method, one of the non-random sampling methods, which allow an in-depth study on the states having richer knowledge was used (Patton, 2002). Three basic criteria were used by the researchers for sample selection:

1. The senior pre-service teachers selected have adequate training in the field and education
2. The pre-service teachers have previously designed WebQuests for teaching
3. The pre-service teachers have previously been informed about using WebQuests in teaching.

In order to get realistic scale responses, it is important that the participants prepared WebQuests. For this reason, only students who had once designed WebQuests were used as study group. The study was carried out with 142 junior and senior pre-service teachers in the 2014 spring semester at Balıkesir University, Necatibey Faculty of Education, Computer Education and Instructional Technologies Department. After eliminating inaccurate or deficient scale questionnaires, the resulting number of the participants was 115 (55 women and 60 men). Among them, 49 were juniors (23 women and 26 men), and 66 were seniors (32 women and 34 men).

The development of the scale

The first step in the development of the scale was the preparation of the scale items, which were identified based on the findings on WebQuest (Akçay, 2009; Akçay and Şahin, 2013; Çığrık, 2009; Dodge, 1997; Faichney, 2002; Halat and Jakubowski, 2001; Halat 2008a, 2008b, 2007; Kelly, 2000; Kobak, 2013; Kurtuluş and Kılıç 2009; March, 2000, 2003a, 2003b; Öksüz and Uça, 2010b; Summerville, 2000; Wooster and Lemcool, 2004; Zencirci and Asker, 2009; Zheng et al., 2005).

In the process development scale, the pre-pilot applications was carried out with 85 pre-service teachers. In this stage, the pre-service teachers were grouped to design WebQuests; additional items were obtained during observation and interviews. The basic features of WebQuests, as well as the advantages and the limitations of use were also considered.

To ensure the content validity of the scale, designed using a Likert type five point scale, the study resorted to the views of the academic experts in Computer Education and Instructional Technologies as well as Mathematics Education. Miles-Huberman reliability formula was calculated to check the compliance between the experts. The value is considered sufficient if the compliance value is greater than 70% (Miles & Huberman, 1994). In this study, this calculated value was 82%; this result was acceptable for the content validity of the scale. The scale took its final form in line with

the views of the experts.

Data analysis

The construct validity of the scale was tested by means of a factor analysis in the statistical program SPSS 17. Cronbach's Alpha reliability coefficient was employed to identify the reliability of the scale. The distinguishability of the items was measured using adjusted item-total correlation and the calculation of t values between groups lower and higher than 27%.

FINDINGS

Findings on validity

Factor analysis was used to collect data on the construct validity of the scale. The adequacy of the data to the factor analysis was determined using the Kaiser-Meyer-Olkin coefficient and the Barlett Sphericity test. To determine whether the data and the size of the sample were sufficient, the Kaiser-Meyer-Olkin test was employed (Büyüköztürk, 2010). In factor analysis, the size of the sample is considered sufficient if its KMO score is equal to or greater than 0.7(Can, 2013).

However, Büyüköztürk suggests that a KMO score of 0.6 or above is sufficient for factor analysis. In this study, the KMO score was calculated to be 0.787; the size of the sample was taken to be sufficient based on literature and the views of the experts (Murphy and Davidshofer, 1991). Factor analysis is based on parametric data (Şencan, 2005); this data display a normal distribution. This is why the Barlett Sphericity test was employed to test the normality of the data, and it produced a significant result (□^2=2285,19 ; p<0.05). Thus, the factor analysis is appropriate for the variables (Aiken, 1996).

To generate a significant construct for the perception of pre-service teachers towards the use of WebQuest in mathematics lectures and to reveal the construct of the factors, principal components analysis and the varimax vertical rotation technique were employed. Büyüköztürk (2010) suggests that a factor loading point equal to or greater than 0.45 should be used for the selection of items. Besides, in order to decide the factor under which an item related to other items is to be placed, the difference between the levels of relation of these cyclical items with various factors should be above 0.1. If it is below 0.1, then the item must be excluded from the scale. In this study, the inclusion of any item into a factor is conditioned by a loading point of at least 0.45; the difference between the loading point of the item in the factor it is placed and its loading points in other factors is required to be 0.1 or above. Finally, a scale of 38 items was constructed after the items found to be redundant by these conditions were eliminated. The number of the factors in the scale obtained by means of the factor analysis, the factor loading points of the items and the common variance are shown in Table 1.

The results of the factor analysis of scale show that 38 items in the scale are gathered under 5 factors. The first factor consists of 9 items; where their factor loading points range between 0.482 and 0.801. This factor by itself explains 11.819% of the total variance in the scale. In the second factor, including 6 items, the factor loading points vary between 0.604 and 0.913, which explains 11.669% of the total variance. The loading points of the third factor vary between 0.339 and 0.745. This factor of 10 items explains 10.123% of the total variance. The forth factor with 8 items explains 8.851% of the total variance, and the fifth factor of 5 items 8.309%. The loading points of the items in the fourth factor vary between 0.438 and 0.624, while the loading point of the items in the fifth factor vary between 0.548 and 0.712. The explained total variance in the scale is 50.501%. Çokluk et al. (2010) suggest that an explained total variance of 40 to 60% is acceptable for multi-factor scales. The scree plot related factors' eigen value is presented in Figure 1.

The reliability of the scale

The internal consistency among the items of the scale was calculated using Cronbach's Alpha Reliability Coefficient. In cases where the number of responses given to the test items is 3 or more, Cronbach's α coefficient is used (Büyüköztürk, 2010). Özdamar (1999) suggests that a reliability coefficient between 0.90 and 1.00 is an indicator of high level reliability (Tavşancıl, 2006).The number of the items loaded with factors, the average per each factor, the standard deviation, the highest and lowest points as well as the Cronbach's alpha internal consistency coefficient are all presented in Table 2.

As shown in Table 2, the reliability coefficients of the factors are 0.85 for the first factor, 0.88 for the second, 0.80 for the third, 0.78 for the forth and finally, 0.74 for the fifth. The Cronbach's Alpha reliability coefficient for the scale as a whole is 0.91, which indicates a high level of reliability and internal consistency among the scale items.

To be able to measure the distinguishability of the items in the scale, the adjusted item correlations were calculated; the t test was applied to determine the significance of the differences in the average item points between groups lower and higher than 27% (Büyüköztürk et al., 2004). The results of these calculations are presented in Table 3.

As shown in Table 3, the adjusted item-total correlations range between 0.32 and 0.60. The items whose item-total correlations are 0.30 or above represent a greater distinguishability (Büyüköztürk, 2010). As a result of the comparisons between the higher 27% and

Table 1. The results of the principal components analysis rotated by means of the varimax method.

Item number	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
M1	0.801	-	-	-	-
M2	0.801	-	-	-	-
M3	0.686	0.367	-	-	-
M4	0.630	-	-	-	-
M5	0.547	0.346	-	-	-
M6	0.534	-	0.336	-	-
M7	0.522	-	-	-	-
M8	0.492	-	-	-	-
M9	0.482	-	-	-	-
M10	-	0.913	-	-	-
M11	-	0.852	-	-	-
M12	-	0.825	-	-	-
M13	-	0.657	-	-	-
M14	-	0.643	-	-	-
M15	-	0.604	-	-	-
M16	-	-	0.745	-	-
M17	-	-	0.699	-	-
M18	-	-	0.649	-	-
M19	-	-	0.632	-	-
M20	-	-	0.520	-	-
M21	-	-	0.504	-	-
M22	-	-	0.484	-	-
M23	-	-	0.466	-	-
M24	-	-	0.449	-	-
M25	-	-	0.339	-	-
M26	-	-	-	0.624	-
M27	-	-	-	0.590	-
M28	-	-	-	0.553	0.397
M29	-	-	-	0.535	-
M30	0.416	-	-	0.530	-
M31	-	-	-	0.512	-
M32	-	-	-	0.475	-
M33	-	-	-	0.438	-
M34	-	-	-	-	0.712
M35	-	-	-	-	0.645
M36	-	-	-	-	0.639
M37	-	-	-	-	0.576
M38	-	-	-	-	0.548
Eigenvalues	9.772	3.394	2.685	1.743	1.596
Explained variance	11.819%	11.669%	10.123%	8.581%	8.309%
Explained total variance			50.501%		

*Factor loading points below 0.30 are excluded from the table to make it easier to interpret.

the lower 27%, it was understood that the difference between the groups for each item is significant ($p<0.001$). Based on these results, it may be argued that the scale items exemplify similar behaviors and their distinguish-ability as well as reliability is high.

The factors obtained at the end of the analysis are: "Using WebQuests effectively", “the technology, software, material etc. necessary for preparing WebQuests”, “using WebQuest in mathematics instruction for students”, “the characteristics of WebQuests to be used in mathematics

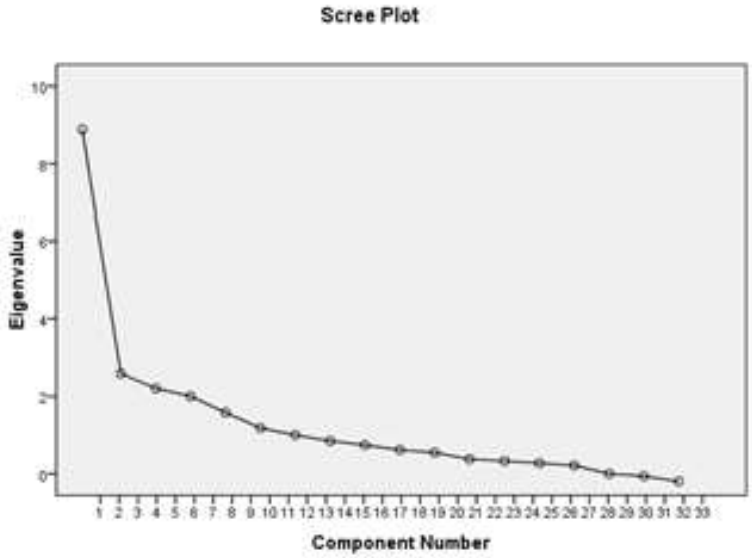

Figure 1. Plot related factors' Eigen value.

Table 2. Cronbach's alpha internal consistency coefficient.

Factors	The number of items in the factor	$\bar{X}$	sd	The lowest-highest points	Cronbach's Alpha Coefficient
Factor 1	9	38.22	4.13	15-45	0.85
Factor 2	6	25.71	2.90	19-30	0.88
Factor 3	10	39.70	4.44	27-50	0.80
Factor 4	8	35.06	3.07	27-40	0.78
Factor 5	5	20.08	2.40	15-25	0.74
Total	38	158.80	12.50	136-190	0.91

instruction", and "using WebQuest in mathematics instruction for teachers". These factors are described below:

Using WebQuests effectively

The items under this factor is relevant to determine the necessity of the students and teachers' ICT information and skills, infrastructure of the schools, the quality of the WebQuests to be used and the awareness of the parents and teachers about using WebQuest effectively.

Technology, software, material etc. necessary for preparing WebQuests

This factor composed of 6 items is a factor including the technologies such as visual elements, picture/animation/ maps, mathematical software (geogebra, cabri, sketchpad etc.), internet based sources, models prepared on the web (algebra tiles, integer visual material etc.), and 3D animations prepared on the web.

Using WebQuets in mathematics instruction for the students

This factor is composed of 10 items including the benefits of using WebQuests in mathematics instruction. Some items under this factor are: it increases the opportunities of their learning practice, it develops the higher-order thinking skills, it allows the students to inidividually construct the knowledge.

The characteristics of WebQuests to be used in mathematics instructions

This factor is related to features required to have a good WebQuest. There are 8 items in the factor. They are

Table 3. The adjusted item-total correlation of the scale factors and the irrelevant t test results between groups lower and higher than 27%.

Factor	Item number	The adjusted item-total correlation [1]	t (lower %27-higher %27) [2]
Factor 1	M1	0.40	5.47*
	M2	0.48	6.87*
	M3	0.46	7.16*
	M4	0.45	4.36*
	M5	0.50	5.19*
	M6	0.52	6.23*
	M7	0.60	7.73*
	M8	0.37	3.30*
	M9	0.35	3.47*
Factor 2	M10	0.50	8.12*
	M11	0.55	8.77*
	M12	0.49	7.06*
	M13	0.45	6.17*
	M14	0.44	5.42*
	M15	0.46	6.09*
Factor 3	M16	0.41	4.49*
	M17	0.49	5.22*
	M18	0.46	5.39*
	M19	0.46	4.93*
	M20	0.46	5.05*
	M21	0.39	3.66*
	M22	0.44	5.97*
	M23	0.49	5.39*
	M24	0.32	2.02*
	M25	0.48	7.35*
	M26	0.42	5.89*
	M27	0.35	3.59*
Factor 4	M28	0.56	6.29*
	M29	0.47	6.06*
	M30	0.56	6.73*
	M31	0.44	5.36*
	M32	0.40	5.45*
	M33	0.46	5.86*
Factor 5	M34	0.48	5.12*
	M35	0.54	4.98*
	M36	0.36	3.61*

[1] n=115, [2] $n_1 = n_2$=31, *p<0.001.

related characteristics to feasibility of tasks, activities included open-ended questions related to everyday life, supported to higher thinking level, provided the discovery of learning opportunities and wake up curiosity.

Using WebQuests in mathematics for the teachers

The items included in this factor composed of the 5 items providing information to the teachers about students' readiness, the level of the knowledge, the ability of using technology.

CONCLUSIONS AND SUGGESTIONS

The study was aimed to develop a valid and reliable

perception scale used to determine the perception of pre-service teachers towards the use of WebQuest in mathematics teaching. Factor analysis was conducted to collect data about the construct validity of the scale. Factor analysis generated a construct with 5 factors; the explained total variance was found to be 50.501%. Since an explained variance of 40 to 60% is accepted as reasonable for multi-factor scales (Çokluk et al., 2010), it was established that the scale obtained has the required construct validity.

To determine the reliability of the scale, Cronbach's Alpha Reliability Coefficient (internal consistency coefficient) was calculated. The reliability coefficients of factors were found to be 0.85 for the first factor, 0.88 for the second, 0.80 for the third, 0.78 for the forth and finally, 0.74 for the fifth. The Cronbach's Alpha reliability coefficient in the entire scale was 0.91, which indicates a high level of reliability of the scale and internal consistency among the scale items.

To measure the distinguishability of the items in the scale, the adjusted item correlations were calculated, which were found to range between 0.32 and 0.60. In addition, the t test was applied to determine the significance of the differences in the average item points between the groups lower and higher than 27%. As a result of the comparisons between the groups lower and higher than 27 %, it was observed that the difference between the groups for each item is significant ($p<0.001$). Based on these results, it is concluded that the scale items exemplify similar behavior and are characterized as a sufficient reliability and distinguishability. It may be concluded that the scale is valid and reliably determines the perceptions towards the use of WebQuest in mathematics instruction.

There is only a study on developing perception scale using WebQuests. Öksüz and Uca (2010b) made similar study. They developed a perception scale on the use of WebQuests in the study carried out with 200 pre-service teachers and 30 teachers; they developed a scale including 41 items.

To reveal the construct of the factors, principal components analysis and the varimax vertical rotation technique were employed in this study; four factors were obtained. Five factors explained the 50.501%, while Öksüz and Uca (2010b) reported 50.7% of the variance for four factors. They also found the reliability coefficient in the entire scale as 0.93.

The determining the perception on using WebQuests is especially important to use this technology effectively in a teaching environment. This study was carried out with the preservice teachers.

However, this scale can be used to determine the teachers' perceptions on using WebQuests as a teaching aid. The scale used for mathematics teaching may also be developed for chemistry, physics and language teaching.

Conflict of Interests

The authors have not declared any conflict of interests.

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