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The development of Hyper-MNP: Hyper-media navigational performance scale

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Abstract The present study aimed at developing a scale to evaluate navigational performance as a whole, which is one of the factors influencing learning in hyper media. In line with this purpose, depending on the related literature, an item pool of 15 factors was prepared, and these variables were decreased to 5 based on the views of 38 field experts. In the end, a 3-factor structured was obtained via a pilot application carried out with 32 Information Technologies (IT) students, via the confirmatory factor analysis conducted with 110 IT students and via the reliability analysis carried out with 33 IT students. The scale included 14 items, and the internal consistency coefficient regarding the whole scale was calculated as α=0.90. The results of the Pearson correlation analysis revealed that the test-retest correlation coefficients of the items ranged between 0.762 and 0.954. As a result of the analyses conducted, the Hyper-MNP scale was found to be a valid and reliable tool that can be used to measure the navigational performance in hyper media.

Keywords Hyper media · Navigational performance · Scale development

1 Introduction

In the last 20 years, thanks to the hyper media, it has become easier and quicker to reach a document in any node of the Web. According to Marchall (2001), the Web itself is the best example for hyper-media applications. The links provided by hyper media are undoubtedly important for the establishment of the network that the Web owns throughout the world. Lowe and Hall (1999) reported that hyper media allowed the

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management of information on the Web. In other words, hyper media constitute the basis of the system that allows instantly reaching the content found in any place in the world via the Web. According to McCool (1997), WWW, which is the primary and common way of providing integrated multimedia services via the Internet, is a world-wide hyper-media system. Information-sharing has become common thanks to the hyper-media feature of the Web, and the Internet has gained its real value. The flexibility and freedom of hyper media for the user have played an important role in the worldwide transformation that the Web and the Internet created.

Hyper media are systems that allow reaching, organizing and structuring the information by using multimedia nodes connected with one another via links (Conklin 1987). In literature, hyper media are also known as interactive multimedia (Jeffcoate 1995). The reason is that by gathering the features of both hyper texts and multimedia, hyper media allow learners to access non-linear information via the links of sources including such information types as texts, audios, graphics, animations and videos. In contrast with the system-controlled structures of multimedia, hyper media require a high level of interaction. This interactive feature of hyper media, which makes it learner-controlled, is considered to be one of the most important advantages of hyper media provided for learning and teaching.

Although hypermedia has provided a number of opportunities to increase the richness of user interfaces, it has also caused over-crowdedness and complexities that result from abundant information in the interface. The freedom provided by hypermedia for the user to control the interaction with the system may lead to cognitive overload (Scheiter and Gerjets 2007) because the cognitive sources that should be allocated to metacognition and executive skills necessary for navigation in hypermedia will be used for other subjects. Gathering a large amount of irrelevant information can negatively influence the process of information processing and cause cognitive overload. In addition, students cognitively overloaded among different choices due to the intensity of complex information in hypermedia may not know where they are, where they came from, and where they are going to go, which means they get disoriented (Dias and Sousa 1997).

Cognitive load can be defined as mental sources used in a memory that works simultaneously. People can process an average of seven units of information in average at a time in a working memory (Miller 1956); that is, as the amount of information processed in a memory working simultaneously due to its limited cognitive capacity increases, the cognitive load will increase as well. In general, there are two types of cognitive load (Moreno 2004): germane load/effective load and extraneous load/ineffective load. The germane load results from the difficulty of the content being learned. If the learner meets a complex content, his or her germane cognitive load will be high. Extraneous load is related to the design of the environment in which information is presented. When the environment includes additional information, which is inappropriate, and which impacts information processing, the extraneous load will be high. If both the germane load and the extraneous load are at a level higher than the limitedness of the working memory, cognitive overload occurs. Since the germane load and the extraneous load are added to each other, according to the cognitive load theory, the extraneous/ineffective load should be decreased and the germane/effective load be increased (Paas et al. 2003). According to the cognitive load theory, the limitedness of the working memory can be eliminated by encoding different information components

as one in cognitive schema, by the multiple presentation method or by automation rules (Kirschner 2002). Besides environmental interaction, the activities learners participate in and in what ways information is transmitted to learners may influence cognitive load. If this loading is higher than necessary and makes it difficult to create a scheme, then it is called cognitive overload (Paas et al. 2003).

Almost all users navigating in a Web environment to search for information are likely to encounter with the problem of disorientation. Users should be able to answer such questions as "Where am I?", "Where do I want to go?", "Am I on the right way?" and "How will I know I will get to where I want?" so that they can know where they are within the whole system in a dynamic environment like the Internet and that they can take action appropriate to their goals (Karadeniz 2006). Users who cannot find answers to such questions are said to have got lost. Disorientation is defined as a situation in which due to cognitive overload and to the complexity of the environment, learners do not know where they are or how they can reach the place they want (Conklin 1987; Theng et al. 1996). In other words, disorientation means that learners are not aware of their places within the whole structure and do not know how they have reached that place and how and where they will go. The disorientation problem in hypermedia-based learning environments and other undesired problems that result from disorientation can be considered in such three categories as navigational disorientation, the problem of abundance of choices, and the phenomenon of art museum (Foss 1989). Navigation disorientation is related to the fact that by following the nodes, users navigate in the environment in repeated cycles without achieving effective results. The problem of abundance of choices means that users know they are wasting their time, that they feel lost, that they lose their way by following various directions provided by the environment, and that they thus wander astray from the main subject. As for the phenomenon of art museum, it refers to the problems arising from the fact that users navigate in the hypermedia in an uncontrolled manner in order to reach information (Demirbilek 2004). This situation is similar to the situation of a person who goes around in an art museum spending the whole day without being interested in any specific shape or model. On the second day, this person is likely to be unable to define any of the drawings or shapes he or she saw in the museum the previous day.

2 Related literature

With its active and non-linear structure, hyper media provide learners with a high-rate of flexibility for action and allow them to reach a wide variety of multimedia materials. However, the flexibility and information provided by hyper media for learner-control have also brought about such navigational problems as disorientation, cognitive overload, distraction of attention and loss of time which all negatively influence the learner's navigational performance in hyper media. Besides the factors negatively influencing the navigational performance in hyper media, some other factors such as motivation and satisfaction could be regarded as the factors positively influencing the navigational performance of the learner in hyper media. Among these factors, some of these factors which directly influence the navigational performance and which have been emphasized most frequently in related literature include cognitive load (Chen and Macredie 2002; Kılıç and Karadeniz 2004; Neilsen 1990; Nunes and Fowell 1996),

disorientation (Beasley and Waugh 1995; Dias et al. 1999; Dias and Sousa 1997; Karadeniz 2006; Neilsen 1990), attention (Mann et al. 2000; Preece 1993), time (Littlefield 2010), adaptation (Nanlohy 2009; Pulliam et al. 2007), satisfaction (Chien 2010; Gullikson et al. 1999) and motivation (Cipolla-Ficarra and Cipolla-Ficarra 2009).

When studies conducted on hyper media are examined, it is seen that they investigated the effects of such variables as different content structures, navigation components, the media structure and individual characteristics on the components of navigational performance. The results obtained in these studies demonstrated that different content structures did not influence the navigational performances of learners with high levels of background knowledge (Amadieu et al. 2009; Patel et al. 1998; Potelle and Rouet 2003) and that well-structured contents helped those with low levels background knowledge comprehend the content deeply and holistically (Potelle and Rouet 2003).

In literature related to navigation in hyper media, it is seen that there is no relationship between learners' thinking styles and their navigational behavior in hyper media (Fiorina et al. 2007); that there is a significant relationship between students' cognitive styles and interface formats (Lee and Hsu 2004); that users in network hyper media demonstrate a higher level of navigational performance than those in hierarchical hyper media (Chien 2010); that users demonstrate better performance in sequential texts than they do in non-sequential ones (McDonald and Stevenson 1996); that metaphorical interfaces increase the learning performance (Lee and Hsu 2004; ChanLin and Chan 1996); and that learners with low levels of knowledge made more use of such support tools as maps in hyper media (Dee-Lucas and Larkin 1995; Möller and Müller-Kalthoff 2000).

In related literature, it is seen that a few number of variables such as the individual's views about his or her own navigational performance; time; and an appropriate number of navigated nodes for navigational performance in hyper media have been used. However, the factors influencing users' navigation in hyper media are not limited to these variables. These variables prominent in related literature include cognitive load (Chen and Macredie 2002), disorientation (Dias et al. 1999), time (Littlefield 2010), task achievement (Craven 2003), adaptation (Pulliam, Sajan and Hofmann 2007), entertainment (McKnight et al. 1996) and motivation (Cipolla-Ficarra and Cipolla-Ficarra 2009).

When the related literature is reviewed, it is seen that there are a number of studies conducted on navigation in hyper media. In addition, it is seen that such factors as satisfaction, motivation, disorientation and cognitive load regarding navigation in hyper media were studied separately and that the changes or the innovations made on the interfaces were investigated. It is also evident in related literature that the navigational problems experienced in hyper media were not examined together. In one of the most comprehensive studies in the field, Dorum and Garland (2011) measured navigational performance only with the help of the scores regarding task achievement, disorientation and recall. To Brusilovsky and Pesin (1998) in hyper media navigation, two most important elements of navigational performance are the way followed and the time spent. In addition, in related literature, it is seen that various measurement tools were developed regarding such navigational performance factors as disorientation, cognitive load and motivation in hyper media and that there is no measurement tool for evaluating the related factors together in order to determine navigational performance in hyper media. Therefore, examining the variables influencing the user's navigational performance in hyper media together from a holistic perspective is considered to be an

important necessity in literature. In this respect, the present study conducted is thought to be important as it aimed at developing a scale to evaluate the navigational performance factors in hyper media.

3 Method

The purpose of the present study was to develop a scale to determine navigational performance in hyper media. Figure 1 presents the studies conducted in line with this purpose.

As can be seen in Fig. 1, the studies conducted regarding the development of the Hyper-MNP scale could be gathered under two main headings: the phase of determining the factors and the scale development phase. In the phase of determining the factors, an item pool was prepared in line with the related literature and presented to field experts for their views. In the scale development phase, the validity and reliability studies were conducted regarding the factors determined.

3.1 Phase of determining the factors

This phase of the study was a pre-research entitled "Determining the Variables of Instructional Hypermedia Navigation Performance" that carried out by researchers and published in *e-Journal of New World Sciences Academy NWSA* as a research article. With the help of the items obtained via the studies reported in literature related to navigational performance in hyper media, an item pool was prepared. In the process of decreasing the 15 items in the item pool to seven and in the process of preparing the questionnaire items for the expert-view form, the brain-storming technique was used. In the process of determining the navigational performance factors, six experts were asked for their views. The phase of determining the factors lasted 3 weeks. Every week, 20-minute sessions were held. Phase of determining the factors carried out with academicians in Anadolu University, Sakarya University and Gazi University who have experience about hypermedia navigation studies. As a result of the six experts' suggestions and corrections regarding the 15 items obtained via the related literature, such variables as motivation, disorientation, cognitive load, adaptation, achievement and entertainment were determined (Fırat et al. 2012).

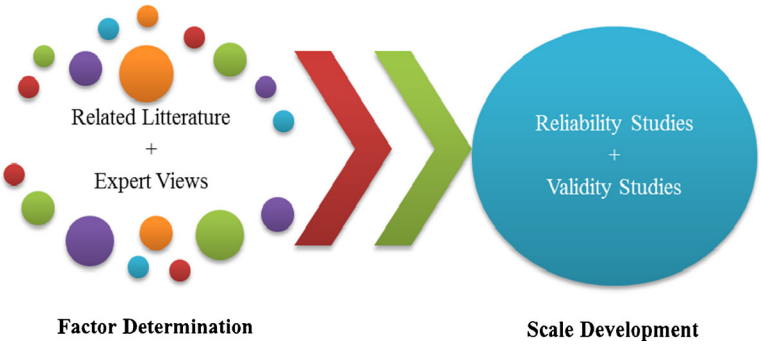

Fig. 1 Studies conducted regarding the development of the Hyper-MNP scale

In the first phase of the research process, a study was conducted to determine the navigational performance variables in hyper media. The expert-view form prepared was applied to IT experts who were specialized in educational technologies and who had carried out scientific studies on hyper media. As a result, the form was sent to 38 academicians, and a return-rate of 68 % (26) was achieved. Among these academicians, 4 of them were professors; 3 were associated professors; 7 were assistant professors; 3 were instructors; and 10 were research assistants.

In the phase of determining the factors, 7 variables determined in related literature were presented to expert views. Among these variables, 3 of them were excluded (achievement, entertainment and adaptation), and one variable (satisfaction) was added. As a result, 5 variables were obtained in total (Fırat et al. 2012). In the study, based on the findings obtained via the expert views, certain important results were found. Accordingly, the experts reported that regarding navigational performance in hyper media, the variable of "achievement" could not be accepted as a clear indicator of navigational performance since it was influenced by such different situations as individual differences, content type, content structure and the teaching method besides navigation. In addition, as the variables of "entertainment" and "adaptation" were in the same direction with the variable of "motivation", it was seen that these variables were frequently criticized by experts. It was stated that these two variables could not be accepted as a clear indicator of navigational performance. According to the experts, the comfort and freedom of the individual in the media, which was what these two variables meant, could be reflected with the variable of "satisfaction". Thus, the variables necessary for the scale of Navigational Performance in Hyper Media were determined as disorientation, cognitive load, motivation, time and satisfaction.

3.2 Scale development phase

In line with the studies reported in literature and with the help of such variables as cognitive load, disorientation, time, motivation and satisfaction revealed in the related study conducted to determine the navigational performance variables in hyper media, a scale form was developed. For the scale, three questions for each of these five items were prepared together with field experts. The 15-item scale was made up of in 5-point Likert-type items. Table 1 below demonstrates an example of one positive item and one negative item regarding the related factor.

Table 1 Sample scale items

Sample items	Related factor
I effortlessly reached the information I searched for on the Website.	Cognitive Load
I tried hard to reach the information I searched for on this Website.	
I had difficulty understanding the links between the pages on the website.	Disorientation
I quickly reached the information I searched for on the Website.	
I would like to navigate on this Website again.	Satisfaction
I was satisfied with navigating on this Website.	

3.2.1 Validity studies

Within the scope of the validity studies of the scale form developed, such analyses as the content validity, face validity and construct validity of the scale as well as item analysis of (item validity) of the 15 items found in the scale were conducted.

Face validity and content validity For the face validity and content validity of the scale developed, expert view was requested. In line with the views and suggestions of 4 field experts who were specialized in the field of Information and Communication Technologies and who had previously conducted scientific studies on hyper media, the scale form was revised, and the necessary corrections were made. As a result, the 15-item scale form was finalized prior to the pilot application.

For the scale, two application processes were conducted: pilot application and main application. The pilot application of the scale form obtained in line with the experts' views was carried out with 32 students attending the department of CEIT at the Education Faculty of Anadolu University. In the metaphorical hyper media prepared for the pilot application, the students were assigned two different tasks and requested to complete these tasks in the media provided. These tasks was "Please give definition of computer assisted education, What are the applications of computer assisted education and What is the Role of Teacher in computer assisted education?". The pilot application was monitored by the researcher as well as by the course instructor, who was also a field expert. As a result of the pilot application, it was seen that the two tasks assigned in the hyper media lasted 4 min on average and that it took 2 min on average to fill out the scale. The pilot application also revealed that all the items worked. In addition, the statements in two of the items were corrected, and the scale was finalized before the main application.

Construct validity The scale form prepared to determine navigational performance in hyper media included 5-point Likert-type items rated as "I completely disagree (1)", "I disagree (2)", "I am neutral (3)", "I agree (4)" and "I completely agree (5)". The scale form finalized before the application was carried out with 110 students attending the department of Computer Education and Instructional Technologies at the Education Faculty of Osmangazi University in the city of Eskisehir in the academic year of 2011–2012. Table 2 presents the demographic backgrounds of the participating students.

As can be seen in Tabl3 2, of all the participants, 51.8 % of them were female students, and 48.2 % of them were male. Among the students participating in the scale development study, approximately 69 % of them were freshman and 2nd grade students. In addition, it was seen that the students had moderate levels of Internet use frequencies. Of all the participating students, 77 % of them used the Internet for 2 to 6 h a day on average. Thanks to the data collected, the structured previously determined was examined with factor analysis. For the analysis of the data, the AMOS 16 software was used.

In order to find out whether the data collected from 110 students attending the department of Computer Education and Instructional Technologies at the Education Faculty of Osmangazi University in the city of Eskisehir had a normal distribution or not, the Kolmogorov Smirnov Test was applied. The results revealed that the mean score calculated with the help of the data collected via the scale had a normal distribution [$D_{(110)}$= 1.313, p=0.064>0.05]. Figure 2 presents the normal distribution diagram regarding the scale scores. Figure 2 presents the normal distribution diagram regarding the scale scores.

Table 2 Demographic backgrounds of the participants

Demographic background	Frequency (f)	Percentage (%)
Gender		
Female	57	51.8
Male	53	48.2
Total	110	100
Grade		
Freshman	40	36,4
2nd Grade	36	32,7
3rd Grade	18	16,4
Senior	16	14,5
Total	110	100
Average frequency of daily internet use		
Less than 1 h	19	17.2
Between 1 and 2	34	30.9
Between 3 and 4	33	30
5 h or longer	24	21.7
Total	110	100

As can be seen in Fig. 2, parallel to the Kolmogorov Smirnov Test result, the measurements had a normal distribution. Therefore, the measurements conducted regarding the validity studies of the scale form could be said to meet the normal distribution condition primarily required by parametric tests.

The items and variables of the scale were determined in line with the related literature and with the experts' views. In other words, there was no previously-determined structure. Therefore, this structured obtained via the related literature was tested with the confirmatory factor analysis because exploratory factor analysis is used for theory-development purposes, while confirmatory factor analysis aims at testing a current theoretical structure (Rennie 1997). The first-level and secondary-level confirmatory

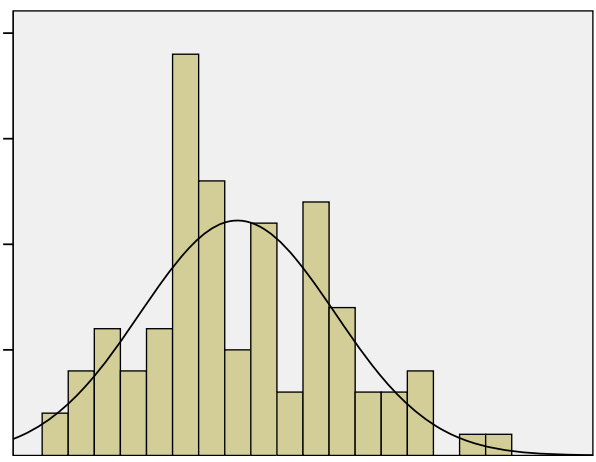

Fig. 2 Normal distribution diagram

factor analyses of the scale were conducted. For the confirmatory factor analysis, the "maximum likelihood" method, one of the most frequent techniques, was used.

In order to determine whether the data were appropriate to factor analysis, various techniques were used in related literature. In the present study, the appropriateness of the data to factor analysis was examined with the Kaiser-Meyer-Olkin (KMO) coefficient. In addition, for the purpose of determining the correlation between the variables, the significance level and value of the Barlett Sphericity test were examined. The result that KMO was higher than 0.60 and that the Barlett test was significant demonstrated the appropriateness of the data to factor analysis (Büyüköztürk 2001). Table 3 presents the KMO and Barlett test results regarding the scale developed.

When the results presented in Table 3 are examined, it is seen that the KMO coefficient was much higher than 0.60 and that the Barlett test result was significant (KMO=0.865; χ^2=764.969; p<0.001). This result demonstrated that the data group was appropriate to factor analysis. The first-level confirmatory factor analysis model obtained as a result of the analysis conducted can be seen in Fig. 3.

As can be seen in Fig. 3, the correlation between satisfaction and motivation was 0.94, and the correlation between disorientation and loss of time was 0.98. According to Bagozzi (1981) and Peter (1981), in order for each dimension within any structure to exist alone, the dimensions are supposed to have a moderate level of correlation between one another (with a range of 0.70 and 0.89). Depending on the values of the correlation coefficients ranging between −1 and +1, it was seen that the correlations between the related variables (r=0.98, r=0.94) were positive and considerably high. Therefore, the factors with high correlation values were found to be in the same direction; in other words, they were cyclical factors and were likely to gather under one factor. Thus, the time factor was combined with the disorientation factor, and the motivation factor with the satisfaction factor. When the related literature is reviewed, it is seen that combined factors are frequently used as related variables.

According to Muyllea et al. (2004), user satisfaction in hyper media could be explained with the gathering of such different components as the content provided, the structure of the hyper media and the motivational elements supporting user satisfaction. This demonstrates that motivational elements in hyper media navigation could be regarded as a component of the satisfaction factor. Similarly, it is seen related literature that the time component could also be regarded as an indicator of the disorientation factor in hyper media (Fırat and Kabakçı 2010; Beasley and Waugh 1995; Dias and Sousa 1997). Thus, the first-level factor analysis was repeated. The three-factor model obtained as a result of the analysis conducted can be seen in Fig. 4.

As can be seen in Fig. 4, when the correlation between such sub-dimensions of the hyper media navigational performance scale as cognitive load, disorientation and satisfaction were examined, it was found as 0.65 between satisfaction and cognitive load; as 0.82 between cognitive load and disorientation; and as 0.57 between disorientation and satisfaction. In addition, Fig. 4 also demonstrates that the lowest correlation was calculated as 0.57 and the highest as 0.82. This result demonstrates a moderate level of correlation

Table 3 KMO and bartlett test results

KMO	χ^2	Sd	P
,860	764,969	105	,000

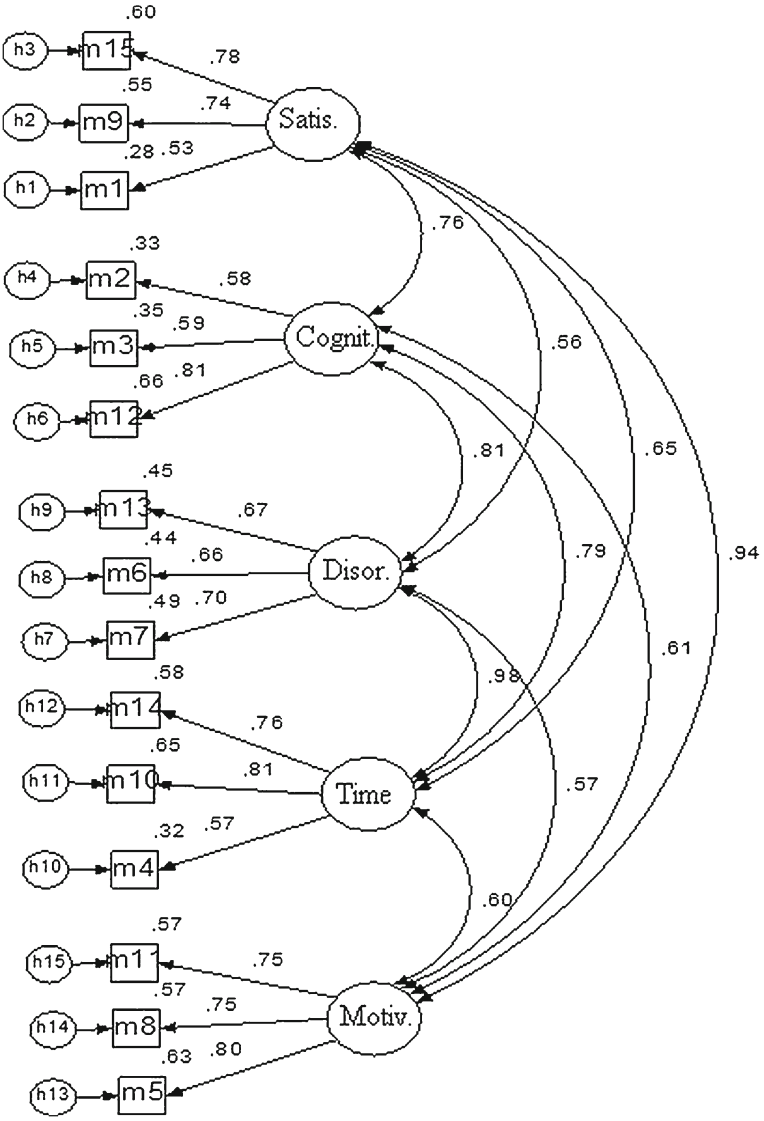

Fig. 3 Five-factor first-level factor analysis regarding Hyper-MNP

between these three dimensions of the hyper media navigational performance scale. Below are the standardized regression coefficients of all the ways regarding the model.

According to the results presented in Table 4, it is seen that the standardized regression coefficients of the model regarding the scale and all the ways found in the model were statistically significant. The model of the secondary-level confirmatory factor analysis conducted to examine the theoretical model of the hyper media navigational performance scale can be seen in Fig. 5.

As can be seen in Fig. 5, the Hyper Media Navigational Performance Scale predicted the dimension of satisfaction at the level of 0.67 ($p<0.01$); the dimension of cognitive load at the level of 0.97 ($p<0.001$); and the dimension of disorientation at the level of

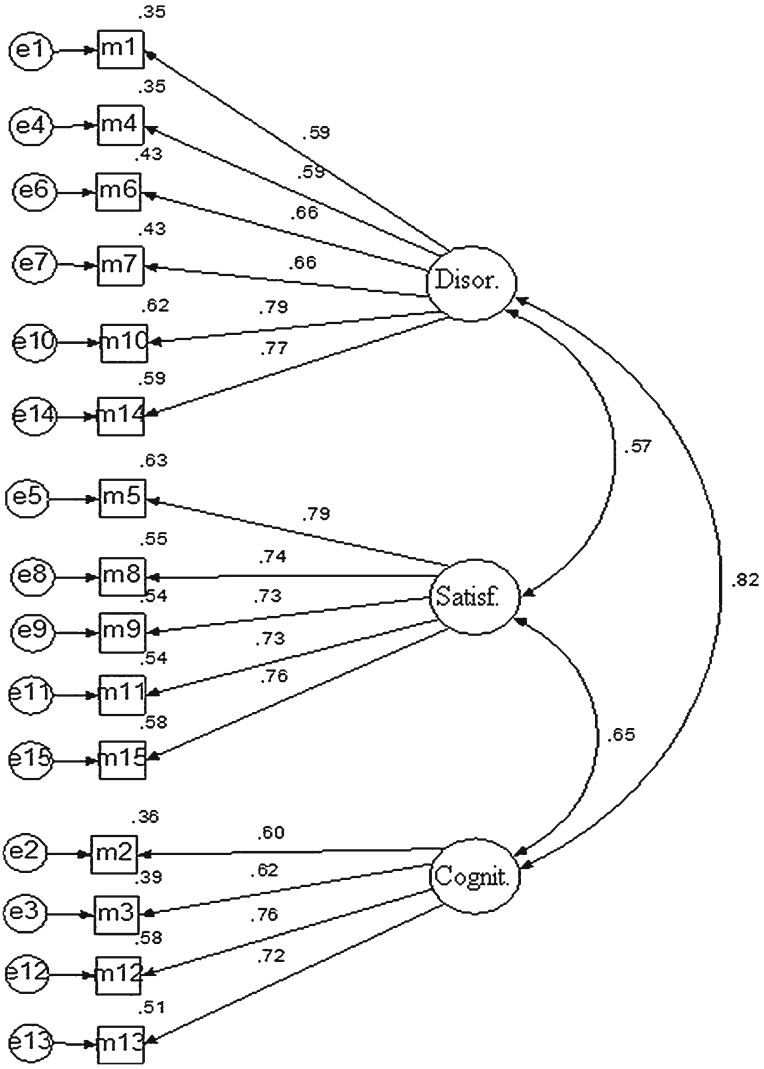

Fig. 4 First-Level repeated confirmatory factor analysis regarding Hyper-MNP

0.71 ($p<0.01$). The standardized factor loads (λ=Lambda) refer to the correlation between the variable observed and the related latent variable. The standardized factor load demonstrates to what extent **a** unit of variation in the latent variable will lead to variation in the variable observed (Hacıfazlıoğlu et al. 2011). The high values of Lambda mean the existence of a strong relationship between the latent variable and the variable observed (Yılmaz and Çelik 2009). Therefore, the hyper media navigation performance scale could be said to represent all its three sub-dimensions. Table 5 below presents the $\chi 2$ statistics and the goodness of fit indices between the three-factor original structure and the data obtained within the scope of the study.

When the other fit indices in the analysis were examined, RMSEA was found as 0.079; GFI as 0.86; AGFI as 0.80; CFI as 0.917; and GFI as 0.861. The RMSEA value between 0 and 0.08 is reported to be an indicator of good fit (Hooper et al. 2008), while 0.06 is

Table 4 Regression weights of all the ways regarding Hyper-MNP

			Estimate	S.E.	C.R.	P
Disorientation	<——	Navigational Performance	,754	,108	6,982	***
Satisfaction	<——	Navigational Performance	,653	,112	5,808	***
Cognitive Load	<——	Navigational Performance	,840	,119	7,053	***
Item 13	<——	Cognitive Load	1,000			
Item 12	<——	Cognitive Load	1,077	,154	6,985	***
Item 3	<——	Cognitive Load	,777	,133	5,832	***
Item 2	<——	Cognitive Load	,827	,147	5,609	***
Item 15	<——	Satisfaction	1,000			
Item 11	<——	Satisfaction	,835	,111	7,497	***
Item 9	<——	Satisfaction	,770	,103	7,488	***
Item 8	<——	Satisfaction	,883	,116	7,620	***
Item 5	<——	Satisfaction	,872	,107	8,147	***
Item 14	<——	Disorientation	1,000			
Item 10	<——	Disorientation	,997	,122	8,170	***
Item 7	<——	Disorientation	,884	,132	6,722	***
Item 6	<——	Disorientation	,829	,124	6,702	***
Item 4	<——	Disorientation	,739	,124	5,973	***
Item 1	<——	Disorientation	,674	,112	5,994	***

*** $p<0.001$

claimed to be a cut point (Hu and Bentler 1999). GFI and AGFI take values between 0 and 1, and 0 refers to a lack of fit, while 1 refers to perfect fit (Schumacker and Lomax 2004). Values equal to higher than 0.90 (Hoyle 2000; Hooper et al. 2008) refer to good fit. The fact that the values obtained in the study were equal or close to the cut points mentioned above demonstrates that there was good fit between the data and the structure of the model.

The degree of freedom and the Chi-Square value obtained as a result of the confirmatory factor analysis conducted ($\chi^2=145.705$) were calculated as 85. In addition, the results of the statistical analysis revealed that the model was significant at the level of ($p<0.01$). In confirmatory factor analysis, χ^2 is used as the extent to which the correlational matrix observed is away from the theoretical correlational matrix. Low level of X^2 refers to how good fit the model and the data demonstrate. If χ^2/sd is 5 or lower, then there is good fit between the model and the data (Gillaspy 1996). In the present study, χ^2/df was calculated as 1.67. This result demonstrates that the model suggested for the Hyper-MNP scale had good fit with the data collected.

Item analysis (Item Validity) In order to determine the capability of the navigational performance scale to discriminate between the individuals in terms of each item, item validity was examined. For this purpose, item analysis independent samples *t*-test was conducted based on the bottom 27 % and top 27 % group means determined according to the scores for each item of the scale. In this analysis, if the scores for one item and those for the whole scale demonstrate a positive and sufficiently high correlation, then that item is considered to have discrimination capability (Erkuş 2003). If the item-test correlation

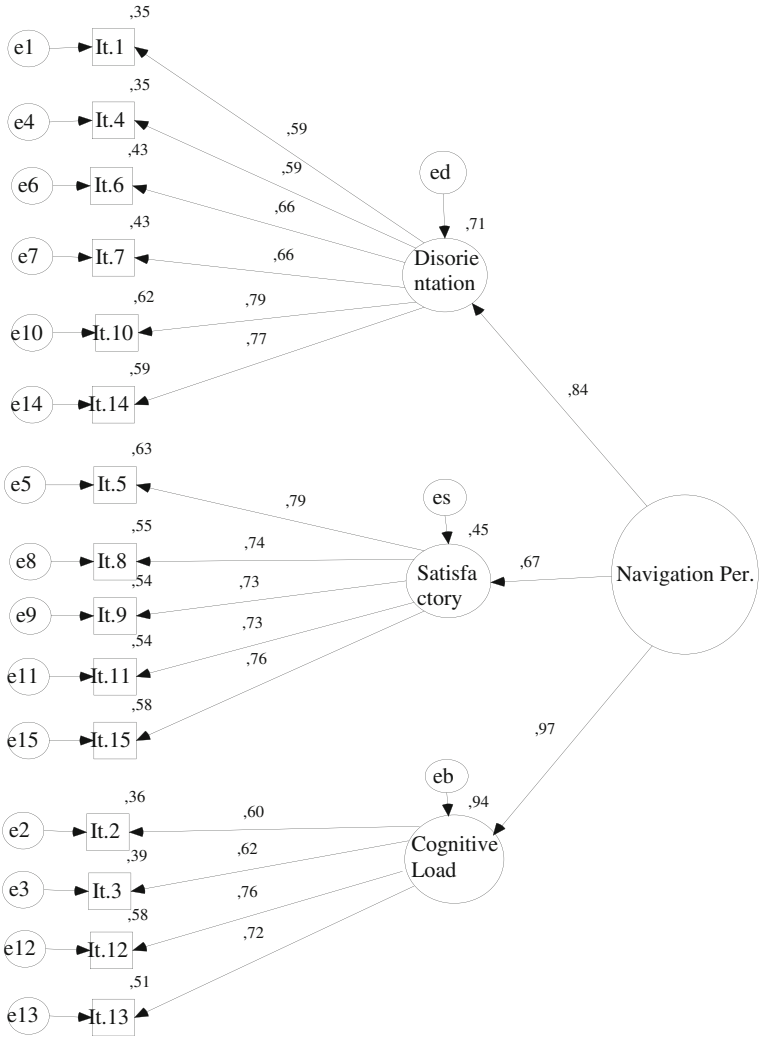

Fig. 5 Secondary-level factor analysis regarding Hyper-MNP

coefficient regarding the discrimination capabilities of the items was 0.40 or higher, then those items were regarded as very good; if it ranged between 0.30 and 0.40, then those items were considered to be good; and if it ranged between 0.20 and 0.30, then they were regarded as those to be corrected. The values obtained are presented in Table 6.

As a result of the analysis, the items demonstrating a high level of correlation with the whole scale scores were not excluded from the measurement tool. It was seen that

Table 5 χ^2 Statistics and goodness of fit indices regarding Hyper-MNP

N	X^2	sd	χ^2/sd	CFI	GFI	AGFI	RMSEA
110	145.705	87	1,67	0.917	0.861	0.808	0.079

Table 6 Item analysis results

Item number	Item-total correlation	Bottom-top (27 %) groups t value	*p*
Item 1	,625	5.229	0.001
Item 2	,549	8.285	0.001
Item 3	,587	6.559	0.001
Item 4	,513	5.291	0.001
Item 5	,660	7.980	0.001
Item 6	,581	6.132	0.001
Item 7	,641	6.538	0.001
Item 8	,645	6.967	0.001
Item 9	,606	5.593	0.001
Item 10	,766	9.349	0.001
Item 11	,653	7.438	0.001
Item 12	,738	10.884	0.001
Item 13	,699	10.275	0.001
Item 14	,695	8.154	0.001
Item 15	,664	6.471	0.001

the item total correlations ranged between 0.513 and 0.766 and that the t values were considerably significant ($p<0.001$). When the item total correlations were examined, it was seen that all the items had correlation values higher than 0.40. This demonstrates that the items had a very good discrimination capability.

3.2.2 Reliability studies

Within the scope of the reliability study of the navigational performance scale, in order to test the consistency of the scale items with each other, the Cronbach alpha coefficient was calculated. In addition, for the purpose of testing the consistency of the scale within the context of time in terms of the quality the scale measures, the test-retest reliability coefficient was calculated.

Internal consistency As a result of the analysis conducted to test the consistency of the scale items with one another, the Total Cronbach alpha value of the scale was found as $\alpha=0.90$, $p<0.01$. According to the related literature, Cronbach alpha values higher than 0.60 demonstrate that the internal consistency of the scale is acceptable, and those higher than 0.75 show that the internal consistency of the scale is considerably high (Cortina 1993; Iacobucci and Duhachek 2003). The Cronbach alpha values to be obtained when each item is excluded from the test are presented in Table 7 below.

As can be seen in Table 7, when each item was excluded from the scale, the Cronbach alpha value of the scale did not exceed 0.90. Therefore, all the items remained in the scale.

Test-retest reliability In order to test the invariance of the scale over time, the scale form was applied to 33 IT students twice after 2 weeks. The criterion for invariance over time

Table 7 Item total statistics

Item	Cronbach's Alpha when an item excluded
I easily reached the information I searched for on the website.	,895
I had difficulty focusing my attention while navigating on the website.	,899
I tried hard to reach the information I searched for on this Website.	,896
I wasted time navigating between the pages.	,899
I enjoyed navigating on this website.	,894
I had difficulty finding the web pages I had navigated on the website before.	,897
I had difficulty understanding whether I was on the correct page on the website or not.	,893
I enjoyed searching for the information I needed.	,894
I was satisfied with navigating on this Website.	,895
I wasted time reaching the information I searched for on the website.	,888
I was willing to navigate on the website.	,893
I lost my attention while searching for the information I needed on the website.	,890
I had difficulty understanding the links between the pages on the website.	,892
I quickly reached the information I searched for on the Website.	,892
I would like to navigate on this Website again.	,893

refers to the relationship correlation coefficient between the data groups obtained as a result of the measurements of anything under similar conditions with a certain time interval. This technique frequently used in scale development studies is known as test-retest. For the test-retest reliability, the correlation coefficient between the mean scores obtained in the first application and those obtained in the second one was calculated as $r=0.941$, $p<0.01$. The correlation coefficients between the mean scores obtained in the first application and those obtained in the second one for the test-retest reliability and the paired two-sample *t*-test results are presented in Table 8 below.

It was seen as a result of the Pearson correlation analysis that the test-retest correlation coefficients of the items ranged between 0.762 and 0.954. Thus, the correlation between the mean scores for the 15 items in the first and second applications were considerably significant ($p<0.001$). Besides the correlation coefficients regarding the test-retest reliability, in order to determine whether there was a significant difference between the mean scores in the first and second applications, paired-sample *t*-test was applied. As can be seen in Table 8, according to the *t*-test results regarding the test-retest application, no significant difference was found between the mean scores for the items in the first and second applications. These high levels of correlation coefficients calculated and the t values demonstrate that the scale invariant over time.

4 Discussion

When studies in related literature conducted on navigational performance in hyper media were reviewed, it was seen that the components of navigational performance in hyper media were examined separately. Therefore, in different studies, navigational performance

Table 8 Test-retest reliability analysis results

Item	N	r (Pearson)	t	p (two-way)
Item 1	33	,837	,494	,625
Item 2	33	,863	−,373	,712
Item 3	33	,804	−,627	,535
Item 4	33	,762	−,239	,813
Item 5	33	,763	−1,305	,201
Item 6	33	,909	−,702	,488
Item 7	33	,954	,571	,572
Item 8	33	,838	,000	1,000
Item 9	33	,867	,329	,744
Item 10	33	,825	−,297	,768
Item 11	33	,863	1,000	,325
Item 12	33	,914	−,812	,423
Item 13	33	,947	−1,677	,103
Item 14	33	,843	−1,161	,254
Item 15	33	,935	−,373	,712
Mean	33	,941	−1,161	−1,161

was examined with respect to different variables. However, navigational performance in hyper media is a comprehensive concept that, besides disorientation meaning failing to find one's way, covers not only the time spent for the achievement of a task but also the easy achievement of that task (Fırat and Kabakçı 2010). According to the results of the present study conducted, navigational performance is structured on three basic factors.

Within the scope of the present study, first, 15 factors were determined as a result of the review of the related literature regarding navigational performance factors. In line with the experts' views about navigational performance in hyper media, these factors were discussed again. Accordingly, since the variable of 'achievement' is influenced by such different situations as the teaching method, the content type and structure and individual differences besides navigation, it was reported by the experts that it could not be accepted as a clear indicator of navigational performance. In addition, as the factors of "entertainment" and "adaptation" were in the same direction as "motivation", they were criticized by the experts. It was claimed that it was not possible to consider these two variables to be a clear indicator of navigational performance. Therefore, the experts stated that comfort and freedom of the individual in the media, which was what the variables of entertainment and adaptation meant, could be reflected with the variable of "satisfaction". In this way, based on the experts' views, navigation performance was thought to be a relational variable including such factors as disorientation, cognitive over load, loss of time, motivation and satisfaction. This finding is consistent with the related literature. In literature, navigational performance is defined in its widest sense as a relational variable reflecting the relationship between the components of a system covering individual differences, tasks, hyper media features and the context in which learning occurs (Land and Hannafin 1996; Barab et al. 1997; Federico 1999).

A 15-item scale form regarding the hyper media navigational performance factors revised in line with the experts' views was developed. For each factor determined, 3 items were prepared. The confirmatory factor analysis conducted during the validity

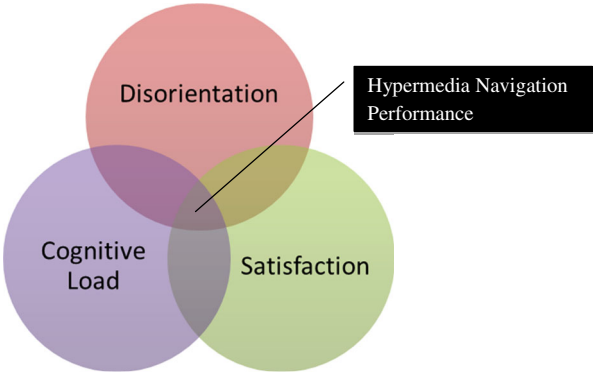

Fig. 6 Hyper media navigational performance factors

and reliability studies of the scale revealed that the factors of time and disorientation and those of motivation and satisfaction were cyclical factors. Figure 6 below summarizes the factors influencing the variable of hyper media navigational performance.

According to Fig. 6, the Hyper-MNP scale developed within the scope of the present study had a 3-factor structure. The factors of disorientation, cognitive load and satisfaction were determined to be the factors influencing one another. The common interaction area for these three variables constituted the variable of navigational performance. In this respect, it could be stated that hyper media navigational performance refers to users' navigation in hyper media with satisfaction and without experiencing cognitive overload or disorientation.

Disorientation used within the scope of the present study means that users lose their place in the whole media structure asking such questions regarding the hyper media as "where was I?", "where am I?" and "where will I go" and that they do not know how to go to the place they want. Cognitive load is related to mental sources which are used in memory functioning at the same time and which result from the relationship between the cognitive structure and the structure of the information. According to the related literature, cognitive load is divided into two types: the main load and extraneous load (Kirschner 2002; Moreno 2004). In the present study, cognitive load was regarded as extraneous load. As for satisfaction, it refers to the users' perceptions of their own navigational experiences as well as the quality of their interactions with the media.

The three-factor structure obtained as a result of this scale-development study differs from Dorum and Garland's claim (2011) that navigational performance can be measured with the scores of task achievement, disorientation and recall. This finding obtained in this study also differs from Brusilovsky and Pesin's view (1998) that in hyper media navigation, two most important elements of navigational performance are the way followed and the time spent. The reason is that both the way followed and the time spent are related only to the variable of disorientation. However, navigational performance in hyper media is also influenced by the factors of cognitive load and satisfaction besides the factor of disorientation.

The results obtained in the present study demonstrated that the Hyper-MNP scale is a valid and reliable tool to be used in determining the navigational performances of Information Technologies pre-service teachers.

4.1 Limitations

The validity and reliability studies of the Hyper-MNP scale were conducted by applying it only to information technologies pre-service teachers. Therefore, various other scales could be developed to determine the hyper media navigational performances of a larger population.

The validity and reliability studies of the scale were carried out with 110 Information Technologies pre-service teachers. Therefore, the low number of the participants could be considered as one limitation to the present study. However, Gorsuch (1983) and Kline (1979) reported that factor analysis should be conducted with at least 100 participants. For this reason, the number of the participants in the present study could be said to be sufficient for factor analysis.

For the construct validity of the scale, Confirmatory Factor Analysis was run. Exploratory Factor Analysis is one that helps the researcher obtain information about the nature of the factors measured with the measurement tool and about the number of the factors measured. However, in the present study, the number of the factors and factor structures were previously determined. Therefore, in order to find out whether the scale factor structure previously determined differed with respect to certain variables, the confirmatory factor analysis technique was used. Confirmatory factor analysis is more complex when compared to exploratory factor analysis and is a technique used in the following phases of studies for the purpose of testing a theory regarding latient variables (Tabachnick and Fidell 2001). Thus, in the scale development study, the application of only the confirmatory factor analysis rather than the use of both exploratory and confirmatory factor analyses was not regarded as a limitation.

5 Conclusion

The flexibility and the potential of high-level interaction provided by hyper media for users depend on their navigational performance in hyper media. Since users' navigational performances in hyper media reflect the interaction and flexibility of the media, it is believed that it is important to determine navigational performance in hyper media as an integrated variable. In this respect, the present research, which included the validity and reliability studies of the Hyper-MNP scale, is believed to be important as, in related literature, it is the first scale developed to determine navigational performance in hyper media.

In the study conducted, the purpose was to develop a scale evaluating the hyper media navigational performance factors as a whole. Depending on this purpose, a pool of 15 factors determined in line with the related literature was prepared. Following this, 38 field experts were asked for their views, and these variables were decreased to five. Finally, as a result of a pilot application carried out with 32 Information Technologies students, the confirmatory factor analysis conducted with 110 Information Technologies students and the reliability analysis carried out with 33 Information Technologies students, a three-factor structure was obtained for navigational performance of the Hyper-MNP scale.

The Hyper-MNP scale, whose validity and reliability studies were conducted, included 15 items, seven of which were positive and eight of which were negative.

Six of these items were for the factor of disorientation; five for satisfaction; and four were for cognitive load. The Hyper-MNP scale, whose internal consistency coefficient was calculated as α=0.90, was a 5-point Likert-type, and for each statements, and the participants assigned scores to each statement ranging between 1 and 5, the former meaning "I completely disagree" and the latter meaning "I completely agree". The lowest score to be produced by the scale was 15, and the highest was 75. Scores lower than 40, the middle score in the scale, demonstrated that the participants had low levels of navigational performance in hyper media and, those higher than 40 demonstrated that the participants had high levels of navigational performance in hyper media.

The Hyper-MNP scale developed within the scope of the study is a valid and reliable tool to be used to determine the flexibility and potential that hyper media provide for users. In this respect, this measurement tool will help determine the flexibility and potential—in other words, the navigational performance—provided by hyper media for users designed for a wide range of purposes from education and social sharing to trading. Considering the fact that hyper media constitute the basis of the widely-used Web, it is believed that the Hyper-MNP scale can be used in quite a wide range of areas to determine users' navigational performance in hyper media.

The validity and reliability studies of the Hyper-MNP scale were conducted by applying it to information technologies pre-service teachers. Therefore, different studies could be conducted to adapt the scale to other pre-service teachers with different characteristics. In addition, the scale developed could also be adapted to different-age groups. Besides the Hyper-MNP scale developed for information technologies pre-service teachers, more comprehensive scale development studies could be conducted to determine users' navigational performance in hyper media.

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References

Amadieu, F., Tricot, A., & Mariné, C. (2009). Prior knowledge in learning from a nonlinear electronic document: disorientation and coherence of the reading sequences. *Computers in Human Behavior, 25*, 381–388.

Bagozzi, R. P. (1981). Evaluating structural equation models with unobservable variables and measurement error: a comment. *Journal of Marketing Research, 18*, 375–381.

Barab, S., Bowdish, B., & Lawless, K. (1997). Hypermedia navigation: profiles of hypermedia users. *Educational Technology Research and Development, 45*(3), 23–41.

Beasley, R. E., & Waugh, M. L. (1995). Cognitive mapping architectures and hypermedia disorientation: an empirical study. *Journal of Educational Multimedia and Hyper Media, 4*, 239–255.

Brusilovsky, P., & Pesin, L. (1998). Adaptive navigation support in educational hypermedia: an evaluation of the ISIS-Tutor. *Journal of Computing and Information Technology, 6*(1), 27–38.

Büyüköztürk, Ş. (2001). *Deneysel desenler*. Ankara: Pegema Yayincilik.

ChanLin, L., & Chan, K. (1996). Computer graphics and metaphorical elaboration for learning science concepts. *Paper presented at The Annual Meeting of the Association for Educational Communication and Technology*. Indianapolis, IN.

Chen, S. Y., & Macredie, R. D. (2002). Cognitive styles and hypermedia navigation: development of a learning model. *Journal of the American Society for Information Science and Technology, 53*(1), 3–15.

Chien, Y. H. (2010). Effects of three hypermedia topologies on users' navigational performance. *Asian Journal of Information Technology, 9*(2), 72–77.
Cipolla-Ficarra, F. V., & Cipolla-Ficarra, M. (2009). Attention and motivation in hypermedia systems, human-computer interaction. Interacting in various application domains. *Lecture Notes in Computer Science, 5613*(2009), 78–87.
Conklin, J. (1987). Hypertext-an introduction and survey. *IEEE Computer, 20*, 17–41.
Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*, 98–104.
Craven, J. (2003). Access to electronic resources by visually impaired people. *Information Research, 8*(4), 454.
Dee-Lucas, D., & Larkin, J. H. (1995). Learning from electronic texts: effects of interactive overviews for information access. *Cognition and Instruction, 13*(3), 431–468.
Demirbilek, M. (2004). A review of learner disorientation in hypermedia learning environments. In C. Crawford et al. (Eds.), *Proceedings of society for information technology and teacher education international conference 2004* (pp. 2852–2856). Chesapeake: AACE.
Dias, P., & Sousa, A. P. (1997). Understanding navigation and disorientation in hypermedia learning environments. *Journal of Educational Multimedia and Hypermedia, 6*(2), 173–185.
Dias, P., Gomes, M. J., & Correia, A. P. (1999). Disorientation in hypermedia environments: mechanisms to support navigation. *Journal of Educational Computing Research, 20*, 93–117.
Dorum, K., & Garland, K. (2011). Efficient electronic navigation: a metaphorical question? *Interacting with Computers, 23*(2), 129–136.
Erkuş, A. (2003). Psikometri Üzerine Yazılar: Ölçme ve Psikometrinin Tarihsel Kökenleri, Güvenirlik, Geçerlik, madde Analizi, Tutumlar; Bileşenleri ve Ölçülmesi. 1. baskı, Ankara. Türk Psikologlar Derneği Yayınları No:24. s. 34–148.
Federico, P.A. (1999). Hypermedia environments and adaptive instruction. *Computers in Human Behavior, 15*(6), 653–692.
Fiorina, L., Antonietti, A., Colombo, B., & Bartolomeo, A. (2007). Thinking style, browsing primes and hypermedia navigation. *Computers & Education, 49*(3), 916–941.
Fırat, M., & Kabakçı, I. (2010). Use of visual metaphors for navigation in educational hypermedia: effects on the navigational performance. *Journal of Educational Multimedia and Hypermedia, 19*(1), 5–22.
Fırat, M., & Kabakçı Yurdakul, I. (2012). Determining the variables of ınstructional hypermedia navigation performance. *e-Journal of New World Sciences Academy NWSA Education Sciences*, 1C0494, *7*(1), 296–304. Available: http://www.newwsa.com/download/gecici_makale_dosyalari/NWSA-5810-2628-4.pdf.
Foss, C. L. (1989). Tools for reading and browsing hypertext. *Information Processing and Management: An International Journal, 25*(4), 407–418.
Gorsuch, R. L. (1983). *Factor analysis* (2nd ed.). Hillsdale: Erlbaum.
Gullikson, S., Blades, R., & Bragton, M. (1999). The impact of information architecture academic Web site usability. *The Electronic Library, 17*(5), 293–304.
Gillaspy, J. A. (1996). A primer on confirmatory factor analysis. Paper presented at *Annual Meeting of the Southwestern Educational Research Association*. Austin, Texas. New Orleans, LA.
Hacıfazlıoğlu, Ö., Karadeniz, Ş., & Dalgıç, G. (2011). Eğitim yöneticileri teknoloji liderliği öz-yeterlik ölçeğinin geçerlik ve güvenirlik çalışması. *Kuram ve Uygulamada Eğitim Yönetimi, 17*(2), 145–166.
Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: guidelines for determining model fit. *Electronic Journal of Business Research Methods, 6*(1), 53–60.
Hoyle, R. H. (2000). Confirmatory factor analysis. In H. E. A. Tinsley & S. D. Brown (Eds.), *Handbook of applied multivariate statistics and mathematical modeling* (pp. 465–497). New York: Academic.
Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55.
Iacobucci, D., & Duhachek, A. (2003). Advancing alpha: measuring reliability with confidence. *Journal of Consumer Psychology, 13*, 478–487.
Jeffcoate, L. (1995). *Multimedia in practice, technology and applications*. NewYork: Prentice Hall.
Karadeniz, Ş. (2006). Kaybolma açısından kullanışlı çoklu ortamların tasarlanması. *Yüzüncü Yıl Üniversitesi, Eğitim Fakültesi Dergisi, 3*(2), 79–97.
Kılıç, E., & Karadeniz, Ş. (2004). Hiper Ortamlarda Öğrencilerin Bilişsel Yüklenme ve Kaybolma Düzeylerinin Belirlenmesi. *Educational Administration Theory-Practice, 40*, 562–579.
Kirschner, P. A. (2002). Cognitive load theory: implications of cognitive load theory on the design of learning. *Learning and Instruction, 12*(1), 1–10.
Kline, P. (1979). *Psychometrics and psychology*. London: Acaderric Press.

Land, S. M., & Hannafin, M. J. (1996). A conceptual framework for the development of theories in action with open-ended learning environments. *Educational Technology Research and Development, 44*(3), 37–53.

Lee, J., & Hsu, Y. (2004). Visual metaphor interface and cognitive style: A study for online learning. In L. Cantoni & C. McLoughlin (Eds.), *Proceedings of world conference on educational multimedia, hypermedia and telecommunications 2004* (pp. 4478–4481). Chesapeake: AACE.

Littlefield, J. (2010). *Multimedia learning in online classes*. About.com.

Lowe, D., & Hall, W. (1999). *Hypermedia ve the web: An engineering approach*. New York: Wiley.

Mann, B., Newhouse, P., Pagram, J., & Campbell, A. (2000). Divided attention in multimedia learning. In J. Bourdeau & R. Heller (Eds.), *Proceedings of world conference on educational multimedia, hypermedia and telecommunications 2000* (pp. 1444–1447). Chesapeake: AACE.

Marchall, D. (2001). *The introduction of multimedia*. Retrieved 20 July, 2011 from http://www.cs.cf.ac.uk/Dave/Multimedia/node1.html.

McCool, M. D. (1997). *Hypermedia, multimedia, metamedia, and the web*. Retrieved December 19, 2013 from https://ece.uwaterloo.ca/~ieee_kw/Newsletters/mar_96.html#web.

McDonald, S., & Stevenson, R. J. (1996). Disorientation in hypertext: the effects of three text structures on navigation performance. *Applied Ergonomics, 27*(1), 61–68.

McKnight, C., Dillon, A. & Richardson, J. (1996). User-centered design of hypertext/hypermedia for education. In D.H. Jonassen (Ed.). *Handbook of research for educational communications and technology* (pp.622–632). New York: Macmillan.

Miller, G. A. (1956). The magical number seven, plus minus two: some limits on our capacity for processimg information. *Psychological Review, 63*, 81–97.

Möller, J., & Müller-Kalthoff, T. (2000). Learning with hypertext: the impact of navigational aids and prior knowledge. *German Journal of Educational Psychology, 14*(2/3), 116–123.

Moreno, R. (2004). Decreasing cognitive load for novice students: effects of explanatory versus corrective feedback on discovery-based multimedia. *Instructional Science, 32*, 99–113.

Muyllea, S., Moenaertb, R., & Despontin, M. (2004). The conceptualization and empirical validation of web site user satisfaction. *Information and Management, 41*(5), 543–560.

Nanlohy, P. (2009). Exploring student engagement through classroom use of hypermedia authoring. *Proceedings of the m-ICTE2009 conference, reflections and innovations in integrating ICT in education* (pp. 1156–1160).

Neilsen, J. (1990). *Hypertext and hypermedia*. Boston: AP Professional.

Nunes, M. B., & Fowell, S. P. (1996). Hypermedia as an experimental learning tool: a theoretical model. *Information Research News, 6*(4), 15–27.

Paas, F., Renkl, A., & Sweller, J. (2003). Introduction: cognitive load theory and instructional design: recent developments. *Educational Psychologist, 38*, 1–4.

Patel, S. C., Drury, C. G., & Shalin, V. L. (1998). Effectiveness of expert semantic knowledge as a navigational aid within hypertext. *Behavior and Information Technology, 17*(6), 313–324.

Peter, J. P. (1981). Construct validity: a review of basic issues and marketing practices. *Journal of Marketing Research, 18*(2), 133–145.

Potelle, H., & Rouet, J. F. (2003). Effects of content representation and readers_prior knowledge on the comprehension of hypertext. *International Journal of Human Computer Studies, 58*(3), 327–345.

Preece, J. (1993). Hypermedia, Multimedia and Human Factors. In Latchem, C., Williamson, J., ve Henderson-Lancett, L. (Eds.). *Interactive Multimedia* (pp. 135–149). London: Kogan Page.

Pulliam, J. O., Sajan, R., & Hofmann, K. (2007). Modeling engagement in educational adaptive hypermedia. *Proceeding of artificial intelligence in education: Building technology rich learning contexts that work*. IOS Press Amsterdam: Netherlves.

Rennie, K. M. (1997). Exploratory and confirmatory rotation strategies in exploratory factor analysis. *Paper presented at the Annual Meeting of the Southwest Educational Research Association*. TX: Austin.

Scheiter, K., & Gerjets, P. (2007). Learner control in hypermedia environments. *Educational Psychology Review, 19*(3), 285–307.

Schumacker, R. E., & Lomax, R. G. (2004). *A beginner's guide to structural equation modeling* (2nd ed.). Hillsdale: Erlbaum.

Tabachnick, G. B., & Fidell, S. L. (2001). *Using multivariate statistics* (4th ed.). Allyn and Bacon: A Pearson Education Company.

Theng, Y. L., Rigny, C., Thimbleby, H., & Jones, M. (1996). *Cognitive task graphs and executable user models for better hypertext, APCHI'96* (pp. 421–433). Singapore.

Yılmaz, V., & Çelik, H. E. (2009). *Yapısal eşitlik modellemesi-I*. Ankara: Pegem A.