Investigating the relationship between task complexity, cognitive ability and disorientation in hypertext navigation

Alper Bayazit*, Faculty of Education, Yeditepe University, Istanbul 34755, Turkey.
Servet Bayram, Faculty of Education, Yeditepe University, Istanbul 34755, Turkey.
Gonca Kizilkaya Cumaoglu, Faculty of Education, Yeditepe University, Istanbul 34755, Turkey.

Abstract

Users sometimes face a common and serious problem called disorientation, which is defined as the feeling of being lost in a web-based environment. It is important to determine the reasons for disorientation in order to make the students navigate more efficiently in these environments. The aim of this study is to investigate the relationship between navigation patterns, disorientation level and students' cognitive ability. For this purpose, an experimental research was designed and a 223-page Wiki environment was developed as a network structured hypertext environment. Sixty-nine university students' navigation processes including 6.880-row log data were recorded in order to measure their disorientation scores. We found that task complexity negatively affected disorientation scores. Disorientation scores decreased as the tasks became more difficult. Possible causes of the results are discussed.

Keywords: Disorientation, cognitive ability, hypermedia navigation, task complexity.

* ADDRESS FOR CORRESPONDENCE: **Alper Bayazit*,** Department of Computer Education and Instructional Technology, Faculty of Education, Yeditepe University, Istanbul 34744, Turkey. *E-mail address:* alper.bayazit@yeditepe.edu.tr / Tel.: +90 216 578 0000 3694

1. Introduction

In the twenty-first century, with advancements in technology, the way digital natives learn and communicate has begun to change. This also caused a change in instructional medium and resulted in the conversion of printed media into electronic media. Many of these sources are presented in hypermedia environments that consist of hypertext including nodes and links that contain text, graphics and multimedia, which allow for different information presentations such as sound, animation, graphics and video (Chen & Yen, 2013). Hypermedia is an extension of hypertext which is defined as a complex information space that demands users find their way around (Strobel, Jonassen & Ionas, 2008). It includes all features of hypertext such as nodes, links and non-linear access. However, there are limitations of hypertext: the first one is the visual representation of the material such as restrictions on names, links and technical specifications of web browsers. The other problems which are more challenging may affect the usefulness of hypertext: (1) disorientation (Ait Adda, Bousbia & Balla, 2016; Bhatti, Ismaili & Dhomeja, 2017; Shih, Huang, Hsu & Chen, 2012) and (2) cognitive load (Amadieu, Van Gog, Paas, Tricot & Marine, 2009; Sunawan & Xiong, 2017).

Disorientation is defined as the tendency to lose one's sense of location and direction in a non-linear document (Ahuja & Webster, 2001). Thus, users generally do not know where to go and where they are in an overall document (Ahuja & Webster, 2001; Van Oostendorp, Madrid & Melguizo, 2009). The literature shows that individual differences are among the most important factors affecting disorientation (Calcaterra, Antonietti & Underwood, 2005; Juvina & Van Oostendorp, 2005; Ruttun & Macredie, 2012; Slone, Burles & Iaria, 2016). Therefore, researchers particularly focused on investigating the relationship between disorientation and prior knowledge (Amadieu, Tricot & Mariné, 2009; Amadieu et al., 2009; Song, Kalet & Plass, 2016), cognitive style (Calcaterra et al., 2005; Eyuboglu & Orhan, 2011; Mampadi, Chen, Ghinea & Chen, 2011), cognitive load (Amadieu et al., 2009; Sunawan & Xiong, 2017), cognitive mapping (Edwards & Hardman, 1999; Hou, Rashid & Lee, 2017) and thinking style (Fan, 2012; Fiorina, Antonietti, Colombo & Bartolomeo, 2007). Recent studies have investigated the relationship between task difficulty and information seeking on the web (Li, Chen & Yang, 2013; McDonald, McGarry & Willis, 2013; Puerta Melguizo, Vidya & van Oostendorp, 2012).

As seen in the related literature, the issue of how cognitive ability influences web navigation has not been addressed. Cognitive ability has not been examined in navigation studies earlier. This variable can be more effective on disorientation compared to other variables according to task difficulty. Since cognitive processes affecting disorientation and task difficulty is an important factor during web navigation, the problem statement of this study is especially focused on how individuals' cognitive abilities and the difficulty level of the task given may affect disorientation. Thus, the purpose of this study is to investigate whether there is a significant difference between students with high and low cognitive abilities in terms of disorientation scores during a web search task. In addition, differences between tasks with different difficulty levels in terms of disorientation will also be investigated.

2. Related work

Hypermedia can be defined as a technology where information units are interconnected with buttons or hyperlinks in a linear or non-linear format (Ford & Chen, 2000). Learning platforms based on these technologies are important for online learning and emerge as hypermedia for learners (Bhatti et al., 2017; Guyer & Cebi, 2015). Learning materials are presented in a nonlinear structure (Amadieu et al., 2009; Strobel et al., 2008), when compared to linear environments and comprehension is directly affected by navigation paths (Janez & Rosales, 2016).

Hypertext is used in hypermedia learning systems including Wiki, learning management systems, massive open online courses, electronic books, and computer-based instruction applications. The advantages of hypertext are: to allow rapid access to information (Strobel et al., 2008), and to give students control to explore the document (Puerta Melguizo et al., 2012) within hypermedia learning

systems. In such systems, researchers, designers and teachers are interested in the effects of using hypermedia in learning processes (Hui-Fang, 2016; Sunawan & Xiong, 2017). However, giving students freedom for exploring content and letting them interact with the hypertext environment may result in them not being able to find what they are looking for. Non-linear structure of hypertext is the most important feature and gives students flexibility of information access. There is a greater degree of learner control and interaction when it is compared to linear learning environments (Bannert & Reimann, 2012; Sunawan & Xiong, 2017) and it can provide opportunities to teachers for personalised instruction through the data gathered from the environments (Ghorbel, Zayani & Amous, 2015). In addition, Hypermedia allows students to make choices by hosting different presentations. This non-linear property supports self-regulated learning (Moos, 2009). Walhout et al. (2015) examined the nonlinear structure of hypertext in terms of tag clouds and hierarchical menus. According to the results obtained, tag clouds provide more efficient navigation and facilitate the learning process in a hypertext environment. However, navigation can be difficult for some users and disorientation can be observed in a navigation process through environments (Amadieu et al., 2009). According to Janez and Rosales (2016), hypertext users can show efficient or disoriented navigation patterns. An efficient navigation pattern is generally task-related and the nodes visited are the key to carrying out tasks. On the other hand, a disoriented navigation pattern consists of randomised or inefficient navigation patterns. These patterns are skipping relevant nodes or visiting unimportant nodes several times.

Disorientation refers to a failure to determine the position within a network structure, or the inability to determine how to move from one node to another (Conklin, 1987). It is a serious and a common navigation problem (Chen & Huang, 2016; Firat & Yurdakul, 2016) faced by students in educational environments. Dealing with the problem and creating usable environments for students is a crucial solution for educational problems (Guyer & Cebi, 2015; Janez & Rosales, 2016). Previous studies showed that the possible cause of disorientation is cognitive processes because web navigation requires decision-making processes between links during hypertext reading. Thus, researchers investigated cognitive style (Calcaterra et al., 2005; Eyuboglu & Orhan, 2011; Mampadi et al., 2011) and thinking style (Fan, 2012; Fiorina et al., 2007) as important factors of disorientation in order to increase the level of efficient navigation.

Considering that previous studies mostly focused on and discussed the effects of individual differences in the navigation process, the link between disorientation and cognitive ability is still a question in the literature. We argue that students with higher cognitive ability may have an advantage in their navigation processes and it may prevent disorientation in more complex search tasks. Therefore, task complexity which is defined as the mental effort or cognitive load required in determining a problem or the solution process (Jung, Olfman, Ryan & Park, 2005) is an important variable for hypermedia search tasks. Task complexity can be expressed in terms of the purpose of performing a task and the total length of nodes visited in the process of reaching the target node. This information indicates the depth of the target information in the hierarchical structure of hypertext environments (Van Oostendorp et al., 2009). Our hypotheses also emphasise the importance of cognitive ability as an affecting variable on students' navigation process.

Raven Standard Progressive Matrices (RSPM) were used to evaluate non-verbal reasoning ability and general intelligence (Schweizer, Goldhammer, Rauch & Moosbrugger, 2007; Stough, Nettelbeck & Cooper, 1993; Waschl, Nettelbeck, Jackson & Burns, 2016) and applied to measure cognitive ability (Benito-Ostolaza, Hernandez & Sanchis-Llopis, 2016; Dodonova & Dodonov, 2013; Mert, Kelleci, Yildiz, Mizrak & Kugu, 2016). It consists of 60 diagrammatic problems, each with eight options (Williams & McCord, 2006). The matrices revealed that the completion of the problems given may require the processing of external information. The more difficult the matrices problems are, the higher are the demands on visual perception to take advantage of visual clues (Schweizer et al., 2007). In the hypertext environment, there are verbal and visual–verbal links and connections between the pages and it may be an advantage for students with higher visuospatial ability.

The perception of disorientation is defined as the tendency of a person to lose his or her sense of direction and place in a non-linear environment. It is often experienced by users in hypermedia and it affects their navigation in a negative way and often results in the abandonment of the task (Conklin, 1987). Users who are disoriented do not know how to extract the information they are searching for (Sunawan & Xiong, 2017) and where to go for the second step. Hypermedia learning systems will place more responsibility on the learner for accessing the information. This responsibility may increase cognitive processing requirements on the learners (Fiorina et al., 2007). As a result of individual differences, navigation patterns of the students who are using hypertext for learning purposes were affected (Hui-Fang, 2016; Juvina & Van Oostendorp, 2005; Ruttun & Macredie, 2012).

In the literature, several methods were used to understand and measure disorientation. According to Guyer and Cebi (2015), the applied methods can be classified under four main topics: performance, subjective opinions, metrics and optimal path. Accuracy and time spent on accomplishing a task were used to measure disorientation. Subjective opinions including Likert-type questionnaires were used to understand users' perceptions of disorientation in an information seeking (search) or learning process. Ahuja and Webster (2001) implemented a simple and quick way to measure users' perceived disorientation. Previous studies (Akcapinar, Altun & Mentes, 2012; Fiorina et al., 2007; Rezende & de Souza Barros, 2008) used log data and disorientation formulas to measure disorientation via metrics. In these studies, visited unique pages, visited repeated pages, time spent in each node, number of entries, etc., were collected and evaluated with the algorithms. Smith (1996) stated that disorientation was a deviation from the optimal path and it was calculated based on the navigation records with the following formula:

$$L = \left(N / S - 1 \right)^2 + \left(R / N - 1 \right)^2$$

R = number of nodes that must be visited to complete the task successfully (the number of connections on the optimal path),

S = number of pages visited by the user,

N = number of unique pages visited by the user. It is a metric that expresses how many different pages are navigated by ignoring repeated visits.

The smallest value that can be lost in the form is zero, which is an indication that the user is not lost. As L value increases, the amount of disorientation increases. Smith (1996) stated that users with a value of 0.42 or greater can be considered lost.

In summary, most of the studies have investigated the relationship between individual differences and web navigation and mostly focused on cognitive processes including cognitive style and thinking style to explain the disorientation process. The affecting factors of web navigation are varied but as can be seen from the literature, their effects are variously based on the study designed, the task given, and hypertext environment created. In addition, although all the studies stated that individual differences are a very important factor in explaining the disorientation process, no study has investigated the relationship between cognitive ability, task complexity and disorientation. In this study, we hypothesise that students with higher cognitive ability have more efficient navigation tasks and less disorientation scores in the tasks with higher complexity. Analysing the relationship between disorientation and cognitive ability will enable the researchers to have a deeper insight into investigating the disorientation problem and its possible reasons. Therefore, adaptive systems which were based on students' characteristics can use this data to create personalised learning environments.

3. Method

3.1. Design

An experimental design was used to compare the two groups: (a) students with high cognitive ability and (b) students with low cognitive ability. Before the search tasks were given, RSPM was applied, according to the results, the study group was divided into two groups based on their test scores.

3.2. Research questions

RSPM was applied to evaluate the university students' cognitive abilities, disorientation scores calculated within a Wiki environment to gather navigation patterns. A number of correct answers given to the Raven test were used to answer the research questions. The research questions are as given below:

i. Is there a statistically significant difference between the students with low and the students with high Raven scores (number of correct answers) in terms of hypertext disorientation?

ii. Is there a statistically significant difference between the tasks with different complexities in terms of students' disorientation scores?

3.3. Study group

Sixty-nine volunteer university students (14 males, 55 females) who were studying at the Department of Guidance and Counselling participated in the research. Raven scores were calculated by the number of correct answers given to the RSPM test. The descriptive statistics of the participants is given in Table 1 (*N* = 69).

Table 1. Distribution of sample by Raven scores

	Minimum	Maximum	Mean	Standard deviation	Variance
Raven score	34.00	57.00	49.03	4.54	20.65

3.4. Data collection tools

3.4.1. Raven's standard progressive matrices

RSPM consists of 60 nonverbal tasks which are made up of a series of diagrams with a part missing (Raven, 2000) and created in order to assess the ability to form perceptual relations. All tasks are arranged in increasing order of complexity and difficulty (Raven & Court, 1998). Raven is not a pure measure of intelligence (Gignac, 2015), however, it is highly correlated with cognitive ability (Dodonova & Dodonov, 2013; Martinez-Plumed, Ferri, Hernandez-Orallo & Ramirez-Quintana, 2017; Mert et al., 2016). The test is developed to measure two components of cognitive ability: (a) educative ability—the ability to make meaning out of confusion (b) reproductive ability—the ability to absorb, recall and reproduce information (Raven, 2000).

Arce-Ferrer and Guzman (2009) compared the paper and computer-based versions of the RSPM test on distribution, accuracy and meaning of row scores. The results showed a lack of test mode effect on the variables given. In addition, participants emphasised that they preferred computer-based testing. Williams and McCord (2006) examined the equivalence of the computer and the standard paper–pencil administered version. They also investigated the effects of state, trait and computer anxiety. The results showed no significant differences in performance scores and anxiety across formats. However, they found a significant difference between administration times to complete the test. Thus, in this study, we did not give a time limitation to complete the computerised test; the

students were informed that there was no time limitation, but they had to complete the test as soon as possible.

In the application, the participants took the computer-based version of the RSPM test and they were allowed to navigate, review and change their responses. Each question was given in one page and the participants' answers were recorded by the system. All the instructions were given before the exam.

3.4.2. Hypermedia environment

In line with the purpose of the research, a Wiki-like hypermedia environment was developed by the researchers with the aim of recording navigation data of the students. It consisted of 223 pages and was designed as a network structure. Nodes were automatically connected to each other based on the captions of the linked nodes. Five tasks were given via the environment and contents were added through the administrator interface. The system was developed using PHP programming language and MySQL database. Students were told to browse the hypermedia environment freely to find the correct answers and their movements were recorded to the database as a log file. They were also informed on how to navigate the questions and save their responses through the interface. After the tasks, students' 6.880 log data was exported from the database for the analysis and their responses were evaluated. Descriptive statistics obtained from the hypermedia environment are given in Table 2 ($N = 345$).

Table 2. Distribution of student navigation log data

	Minimum	Maximum	Mean	Standard deviation
Duration	17	739	238.38	134.85
Visited pages	3	125	18.86	15.15
Unique pages	2	43	8.06	5.29
Disorientation	0.04	2.50	0.66	0.33

According to Smith (1996), 0.42 is the limit value for determining disorientation. The mean value of participants' disorientation scores (0.66) was higher than the limit value.

The log data collected from the system is given below:

İ. Student ID: Identification number of the student navigating in the hypermedia.
II. Visited pages: Total number of pages visited by the student
III. Visited unique pages: Number of unique pages visited by the student
IV. Visit duration: The duration time of the student per page
V. Task number: Which task was accomplished in the stored log.
VI. Navigation path: Sequence of the visited pages.

3.5. Task complexity

The process of searching for information on the internet is an important issue and task complexity is one of the factors affecting the appropriateness of users' search strategies (Bystrom, 2002). Gwizdka and Spence (2007) investigated the complexity of the task in hypertext environment. They pointed out that the complexity of information retrieval tasks should be examined with three variables: (1) Path Length—expresses the length of the navigation paths that lead to reaching the target information. (2) Page Complexity—the complexity of navigation choices on each web page. (3) Page Information Assessment—the difficulty of relevance judgment on pages that contain the desired information. Path Length is related with structural aspects of the hypertext environment; it was widely used in previous studies to measure task complexity (Van Oostendorp et al., 2009). In this study, we also used path length to measure task complexity. The task questions given to the students in the hypertext environments are shown in Table 3.

Task number	Content	Path Length
Task 1	In what years did the psychiatrist, the creator of the Rorschach test, live?	1
Task 2	What is sublimation?	2
Task 3	What does relational psychoanalysis emphasise?	3
Task 4	Write the purpose of Holistic Psychotherapy from the types of psychotherapy.	4
Task 5	What is the psychological effect of CAJUPUT used in the treatment of health-impaired individuals?	5

Table 3. Tasks given to the students during the navigation process

In this study, a hypermedia environment was designed for the study and a search task was given to undergraduate students who were studying at the Department of Guidance and Psychological Counselling. The context of the hypermedia environment was created similar to the Wikipedia—Psychology category. The information seeking (search) tasks consisted of five different questions. A topic familiar with the student's educational background was chosen; however, finding the answers to the questions was very difficult without any navigation in the environment.

3.6. Application

Before the main application, the students were informed about the aim of the study. Participants indicated that they were given the test for the first time. All the instructions were given by an expert psychologist. First, the Raven Progressive Matrices were applied to the students and their answers to the test were collected. After the Raven test was administered, we conducted a pre-application in order to make the students familiar with the Wiki environment. Through the pre-application, we added two questions to the Wiki environment, which was designed by the researchers. Since the participants were university students at the Department of Guidance and Counselling, Psychology was selected as a subject given in the environment. Therefore, the categories, topics and information given in the Wiki consisted of Psychology subjects. However, we were careful to select questions that students would be able to take advantage of their background knowledge to find the answers but could not answer with only preliminary information. Thus, they needed a navigation process to accomplish the tasks given. The data collected during this process were not included in the analysis.

In the main application, we asked five questions through the interface. Students were able to read or change the questions during their navigation process. To accomplish the tasks, students clicked on the categories or topics in the environment and all the log data of the students (navigation patterns) were recorded in the database. We asked the questions at the top of the screen of the Wiki-like interface. The reason for this was that the student's navigation could be associated with the searched question and the data could be analysed based on the task type given. During the application, five tasks were given to the students. The task difficulty was determined according to the optimum path required to access the page where the answer was located. For instance, the optimum distance was 1 for the first task (the category involving the answer to the question was on the main page) and the optimum distance was 5 for the fifth task. In other words, to find out the answer, participant had visit at least five pages.

An answer button was used to record the students' responses online. When the students found the answer to the question, they clicked the 'answer button' via the interface. They added their responses to the database by typing their answers in the text box and clicking the 'save button'. The correct responses stored in the database were coded as 1 and wrong or omitted answers were coded as 0 by the researchers. Students also had the opportunity to change their answers.

4. Results

Research Question 1: Is there a statistically significant difference between students with low and students with high RSPM scores (number of correct answers) in terms of hypertext disorientation?

To answer the first research question, students were categorised according to their RSPM scores. The cut point was calculated by the median value of the participants' test scores. The scores between 34 and 47 were coded as 1 and called 'low score' and the scores between 48 and 52 were coded as 2 and called 'high score'. There was no normal distribution between the pairs; therefore, a Mann–Whitney U test was applied to investigate whether there was a significant difference between the variables regarding the score groups ($p < 0.05$).

Table 4. Mann–Whitney U test results between low-high Raven scores

	Duration	Visited pages	Unique pages	Disorientation
Mann-Whitney U	13,391	11,943	11,714	12,061
Wilcoxon W	21,266	19,818	19,589	19,936
Z	−0.40	−2.03	−2.30	−1.90
Asymp. Sig. (two-tailed)	0.686	0.042*	0.021*	0.058

The Mann–Whitney test indicated that younger students (Mdn = 23) showed higher RSPM scores than the older students (Mdn = 24), U = 11,250, p = 0.003. Grade point average (Mdn = 3.41) was greater for the students in the higher score than the students who were in the low score (Mdn = 3.05), U = 5850, p = 0.005. Results also showed that these students visited more pages (Mdn = 15) and unique pages (Mdn = 7) than the students in the low score group who visited the pages (Mdn = 13) and unique pages (Mdn = 6) to accomplish the tasks. However, no statistically significant difference was found between the RSPM high—low score groups based on the students' disorientation scores.

Research Question 2: Is there a statistically significant difference between the tasks with different complexity in terms of students' disorientation scores?

Five different tasks were given to the students and their navigation processes were recorded via the logs. Each task was aligned based on the number of links to accomplish the task. To investigate the research question, one-way analysis of variance (ANOVA) was applied to disorientation scores for each task difficulty. The results are given in Table 5.

Table 5. One-way ANOVA Test results of disorientation scores

		Sum of squares	df	Mean square	F	Sig.
Disorientation	Between groups	9.96	4	2.49	30.16	0.001
	Within groups	28.07	340	0.08		
	Total	38.03	344			

According to Table 5, analysis of variance shows a main effect of tasks given to the students on students' disorientation scores [$F_{(4,340)}$ = 30.2, p = 0.001]. Therefore, task difficulty level or the optimal path length affected student disorientation. In order to compare the tasks with different complexity levels, *post hoc* analyses were used. Turkey's HSD was applied for the multiple comparisons to provide specific information on which disorientation means were significantly different from each other in the five-tasks. The results are given in Table 6.

Table 6. Tukey's HSD results of tasks based on disorientation scores

(*I*) tasks	(*J*) tasks	Mean difference (*I–J*)	Standard error	Sig.	95% confidence interval	
					Lower bound	Upper bound
Task 1	Task 2	0.1741*	0.05	0.00	0.04	0.31
	Task 3	0.2771*	0.05	0.00	0.14	0.41
	Task 4	0.5190*	0.05	0.00	0.38	0.65
	Task 5	0.3061*	0.05	0.00	0.17	0.44
Task 2	Task 1	−0.1741*	0.05	0.00	−0.31	−0.04
	Task 3	0.10	0.05	0.22	−0.03	0.24
	Task 4	0.3449*	0.05	0.00	0.21	0.48
	Task 5	0.13	0.05	0.06	0.00	0.27
Task 3	Task 1	−0.2771*	0.05	0.00	−0.41	−0.14
	Task 2	−0.10	0.05	0.22	−0.24	0.03
	Task 4	0.2419*	0.05	0.00	0.11	0.38
	Task 5	0.03	0.05	0.98	−0.11	0.16
Task 4	Task 1	−0.5190*	0.05	0.00	−0.65	−0.38
	Task 2	−0.3449*	0.05	0.00	−0.48	−0.21
	Task 3	−0.2419*	0.05	0.00	−0.38	−0.11
	Task 5	−0.2129*	0.05	0.00	−0.35	−0.08
Task 5	Task 1	−0.3061*	0.05	0.00	−0.44	−0.17
	Task 2	−0.13	0.05	0.06	−0.27	0.00
	Task 3	−0.03	0.05	0.98	−0.16	0.11
	Task 4	0.2129*	0.05	0.00	0.08	0.35

The analysis showed a significant difference* between Task 1 and the other tasks. The disorientation score was higher in Task 1 [*M* = 0.92, standard deviation (SD) = 0.24] than all the other tasks including Task 2 (*M* = 0.74, SD = 0.23), Task 3 (*M* = 0.64, SD = 0.28), Task 4 (*M* = 0.40, SD = 0.30) and Task 5 (*M* = 0.61, SD = 0.37). The results also showed that students' disorientation score in Task 2 (*M* = 0.74, SD = 0.23) was lower than Task 1 (*M* = 0.92, SD = 0.24) but higher than Task 4 (*M* = 0.40, SD = 0.30). In addition, the disorientation score in Task 3 also showed a significant difference with Task 1 and Task 4. Mean values of the disorientation score in Task 3 were lower than Task 1, but higher than Task 4. The Disorientation score of Task 4 showed the significant lower score (*M* = 0.40, SD = 0.30) when compared with all other tasks. Differences between the disorientation scores of the students are given in Figure 1.
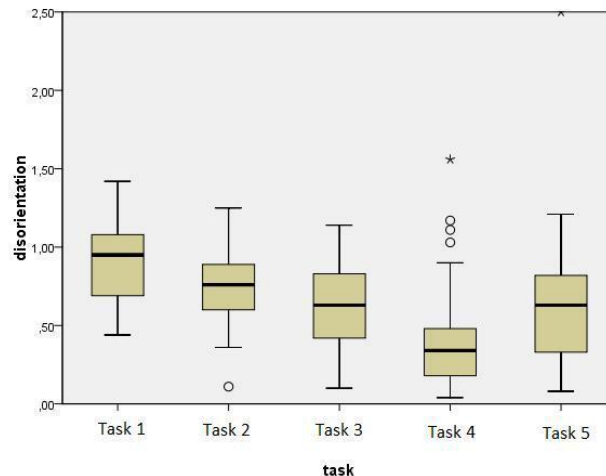

Figure 1. Distribution of disorientation scores based on task complexity

Regarding the figure, the optimum way to accomplish the task given has no effect on the disorientation score. Task 4 showed the lowest disorientation score when compared with all the other tasks.

5. Discussion

The Internet has been an important medium for learners to manage their learning processes and support lifelong learning. Learning management systems, massive online courses, educational wikis are designed in hypertext format, which has a more participative environment for building and sharing information (Albion, 2008). In these environments, students navigate on their own to reach objectives (learning) or seek information (searching). The hypertext environment, which has a non-linear structure, enables users or students to access a large amount of information quickly and freely (Qin & Rau, 2009). On the other hand, users are sometimes faced with a common and serious problem like disorientation, which is defined as the feeling of being lost in web-based environments (Guyer, Atasoy & Somyurek, 2015; Puerta Melguizo et al., 2012; Shih et al., 2012).

Reducing disorientation is an important issue for hypertext navigation and comprehension of texts (Janez & Rosales, 2016). Previous studies aimed to understand the reasons of this feeling and showed that individual differences (Ruttun & Macredie, 2012; Schoppek & Fischer, 2017; Slone et al., 2016) were an important factor. However, in the literature, no study was found which investigates the relation between cognitive ability and the disorientation process.

For this purpose, we designed a Wiki environment as a network structured hypertext environment and recorded students' navigation processes in a search task in order to measure disorientation scores based on an algorithm developed by Smith (1996). The tasks were grouped according to task complexity level, which is stated as the optimal navigation path leading to target information (Van Oostendorp et al., 2009). We also applied RSPM online and the scores were recorded in the database. Although the complexity of the task affected the amount of cognitive support (Sunawan & Xiong, 2017; Traff, 2013), no correlation was found between the Raven scores and disorientation scores. These results were not supported by Zhang et al. (2007) who found no moderating effect of task complexity on brain–intelligence relationship. In our study, the tasks were divided into five categories considering path length and for the searched questions, students' log data and disorientation scores were analysed. We also found that while the task was getting more complex, the disorientation score of the participants decreased. This result was contrary to our hypothesis which states that the students are more likely to be disoriented for the tasks with higher complexity. The biggest factor for this result was the perceived difficulty of the task. In a search task given, visiting the link first seen instead of a visual search for the rest of the page may cause changes on disorientation scores. During the application, we observed that the students changed their behaviours based on their perceived difficulty on the questions and they tried to visit more pages. For instance, the first question was about a Rorschach Test and the more complex tasks were about psychotherapy and psychoanalysis. We believe that the Rorschach Test was a more difficult subject for the students when compared to psychoanalysis. For that reason, the students felt faced with a more difficult question and they did more navigation in the environment although the answer was directly given in a link called 'Rorschach Test' in the main page. This may explain the difference between the disorientation scores and task complexity. These findings are also supported by previous studies which showed that the perceived difficulty was affected by task complexity (Traff, 2013; Zhang et al., 2007).

The other issue may be the disorientation formula. In the algorithm developed by Smith (1996), the optimum path length is an important variable and it affects the disorientation scores directly. The initial questions that present low-level task complexity were directly connected with the min page or the secondary level. This issue may cause important changes and bias for the calculation of the initial questions. In the literature, it was stated that subjective opinions including Likert-type questionnaires might be misleading to measure disorientation (Akcapinar et al., 2012; Guyer et al., 2015). However, there may be disadvantages for using formulas if the optimum path was included in the algorithms.

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6. Recommendations

Although the Raven's is not a pure measure of cognitive ability (Gignac, 2015), it is highly correlated with cognitive ability, and this study needs to be repeated with other variables based on individual differences and intelligence tests. Investigating the main issues causing student disorientation can enable teachers, instructional designers and developers to create efficient hypertext or adaptive environments to provide more efficient search processes for students.

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