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Learning in a sheltered Internet environment: The use of WebQuests

Eliane Segers*, Ludo Verhoeven

Behavioural Science Institute, Radboud University Nijmegen, Spinoza Building, 5th floor, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands

Abstract

The present study investigated the effects on learning in a sheltered Internet environment using so-called WebQuests in elementary school classrooms in the Netherlands. A WebQuest is an assignment presented together with a series of web pages to help guide children's learning. The learning gains and quality of the work of 229 sixth graders participating in either a free-search Google condition or a closed-search WebQuest condition were compared. The closed-search condition showed the highest learning gains for boys. Children's information processing and linguistic skills generally influenced their learning gains and did not interact with condition. A difference in the quality of writing for the two conditions was also found with the language quality being higher in the free-search condition.

Keywords: Information Communication Technologies; Learning environment; Google search; Internet; WebQuest; Writing

1. Introduction

There is a widespread belief that Information Communication Technologies (ICT) offer many possibilities to facilitate learning (Verhoeven, Segers, Bronkhorst, & Boves, 2006). At the start of the 21st century, an awareness of new forms of literacy has also emerged. Such terms as informational literacy (Kafai & Bates, 1997; Leu & Kinzer, 2000) and web literacy (Sutherland-Smith, 2002) have been introduced to refer to a wide range of abilities directly related to ICT. Critical is the ability to find the desired information among the vast amount of information available on the Internet, the ability to integrate information coming from multiple sources, and the ability to effectively use this information to solve problems (Leu & Kinzer, 2000).

Given the increased integration of ICT into school curricula, the combining of literacy instruction with network technologies and the more general reading and writing instruction and subject learning of children seems inevitable. This results, however, in complex learning situations in which it is important to provide sufficient instruction to keep children focused and on task (McEneaney, 2000). Moreover, the role of ICT is fundamentally different under these circumstances from the drilling of skills using conventional computer-aided instruction systems. Rather than the presentation of a clearly articulated package of easy-to-follow tasks, identification of the relevant tasks themselves and how to perform them is often what the child must learn to do and integrate into his or her life. The adoption of this more constructivist approach to the use of ICT in schools involves a focus on the learner as opposed to the materials to be learned. When used in such a manner, it is generally believed that ICT can clearly promote children's learning (Dalgarno, 2001).

Upon its introduction in 1991, the World Wide Web quickly invaded the school system (van Kessel, Hulsen, & van der Neut, 2005). Children today typically surf the Internet to find information for presentations or other assignments, both at school and at home. Whether this is a completely positive development or not has been widely discussed, and both the possibilities and drawbacks of the World Wide Web have been heavily debated. Among the possibilities of the Internet are the following: it allows children to create their own learning experiences; it can provide multiple perspectives on things; and written, audio, and video input can also be simultaneously provided along with Internet access. Among the drawbacks of the Internet are that the hypertext structure forces many

* Corresponding author. Tel.: +31 24 3615901; fax: +31 24 3616211.
E-mail address: e.segers@pwo.ru.nl (E. Segers).

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choices upon the user and may therefore create cognitive overload at times (Duke, Schmar-Dobler, & Zhang, 2006). Cognitive overload can also be caused because text, pictures, sound, and movies are presented simultaneously (Mayer, 2001), and learners must split their attention between these different sources and integrate them for comprehension (cf. Schnotz & Kürschner, 2007). Children can also get lost in hyperspace; and users can encounter major difficulties with the search for information at times. In addition, the information found via the Internet may not always be reliable and it is often not suited to the ages or reading levels of young children. These difficulties may make it difficult for children to stay focused on the task at hand and, thereby, actually hinder the child's learning process. Along these lines, Kuiper, Volman, and Terwel (2005) recently published an extended review of educational web use and pointed out a number of possibilities and drawbacks of using the Internet in education.

There is agreement that computer-based interventions and instruction must be theory-driven (Schacter & Fagnano, 1999), and this probably also holds true for the use of the World Wide Web. It is unclear whether young children freely surveying the Internet with respect to a certain topic, is an optimal learning situation. The use of the World Wide Web in education could profit from a layer of structure between the child and the Internet, and this layer may consist of a so-called sheltered learning environment in which the child is helped to navigate the web. An example of such a theory-driven layer of structure is a WebQuest. The notion of a WebQuest was developed in 1995 by Bernie Dodge, and the use of WebQuests has been spreading around the world since that time. Teachers appear to embrace the use of WebQuests because they seem to provide exactly the structure that is needed for children to successfully work with the web. Furthermore, a WebQuest can be created by the teachers themselves, and thus be integrated in the topics of interest at each point in the curriculum.

1.1. WebQuest

A WebQuest typically consists of a series of web pages that thus provide some structure for the learning process. The WebQuest usually starts with an introduction to a particular topic and some background knowledge on the topic (Dodge, 1997). The next page describes the task to be done. Sources of information are then listed, which are most often links to web pages needed to perform the task. The fourth page describes the process to follow in order to accomplish the task. The description of the process is broken down into individual steps and followed by a guidance page that often presents questions about the information presented in the different web pages. The WebQuest ends with a conclusion, which usually summarizes the learning experience. Dodge (1997) refers to the dimensional learning theory of Marzano (1992) with its roots in cognitive science as the theory underlying the WebQuest concept.

Marzano's (1992) theory is based on the assumption that the process of learning involves the interaction between five types or dimensions of thinking that can be roughly construed as metaphors for the way in which the mind works during the process of learning. The dimensions are as follows: (1) development of positive attitudes and perceptions about learning; (2) acquisition and integration of knowledge; (3) extension and refinement of knowledge; (4) meaningful use of knowledge; and (5) development of productive strategies. Marzano's (1992) model also draws upon Bloom's taxonomy of educational objectives (Marzano & Kendall, 2007), which describes six levels of cognitive processes: knowledge acquisition, comprehension, application, analysis, synthesis, and evaluation. Higher-order thinking skills (HOTS) involve the latter three cognitive processes and are assumed to be stimulated by most WebQuests (Marzano & Kendall, 2007). Web-related activities that appeal to only the former three cognitive processes are considered web exercises (cf. March, 2004).

For the learner, a WebQuest provides an information space for the active exploration of the web, and in our opinion, it can best be construed as a form of dialectic constructivism in which constructivism and instructivism go hand-in-hand (Moshman, 1982). The WebQuest serves to organize the learning process (cf. Chalmers, 2003) and provides the child with a significant degree of learning autonomy without excluding the role of the teacher or denying the necessity of guidance. The *author* of a WebQuest is responsible for the content and theoretical background of the WebQuest (i.e., placement on the continuum from instructivism to constructivism), however, and this should be kept in mind during the interpretation of the results of studies using WebQuest as an intervention. A well-designed WebQuest should be able to adhere to the principles of the Cognitive Load theory (Sweller & Chandler, 1991), and ask for a high germane cognitive load, whereas irrelevant cognitive activities are diminished as far as possible by selecting appropriate sources and presenting the task such that schema acquisition and automation take place (for an overview see Schnotz & Kürschner, 2007).

In a few recent studies, the use of WebQuests has been specifically examined and compared to other forms of instruction. Gaskill, McNulty, and Brooks (2006), for example, compared the use of WebQuests to conventional instruction in two intervention studies. In the first study, WebQuest and conventional instruction conditions in the study of science were compared in a high school history setting and the conventional instruction condition was found to produce higher learning gains than the WebQuest condition. In the second study, university students in a WebQuest condition were found to gain just as much knowledge as university students in a conventional instruction condition. Differences between the conventional instruction conditions in the two aforementioned studies could well explain the discrepant results, but it is also important to note that the comparison of teacher-based versus computer-based interventions does not appear to be very fruitful. As Reinking (2001) argues, it is not likely that the computer is going to disappear from schools, which means – in our opinion – that it is more fruitful to study just how the computer environment can best be used to contribute to education, and be integrated into classroom instruction rather than compare computers to teachers.

In a qualitative study involving six fifth-grade students (i.e., five girls and one boy), Ikpeze and Boyd (2007) addressed some of the problems, mentioned earlier, that children can encounter when working with the Internet. The same problems, such as information overload, may also hold for the use of WebQuests and are therefore of relevance here. One advantage of the WebQuest detected by Ikpeze and Boyd (2007) was that it appeared to help bridge the gap between content literacy and technological literacy. Children were not just learning to deal with technology, but were using the technology to enhance their learning. The importance of the teacher was also highlighted although the authors did not take any gender differences into consideration.

Yet, in another study, Kanuka, Rourke, and Laflamme (2007) examined five different communication methods in a multiple case design, which included the use of WebQuests. The participants were university students, and it was found that in both the WebQuest and debate methods of communication, the students posted more messages reflecting the highest level of cognitive involvement. Unfortunately, the learning gains demonstrated by the students were not assessed.

With an eye to future research, Verhoeven et al. (2006) recently considered several potential problems of WebQuests, based on a pilot study. First, children can encounter problems with determination of the exact nature of the assignment. The assigned task is often to create something for the ''real world'' such as a newspaper article or, in the case of the present study, a travel brochure. However, many children do not know what a travel brochure is, which makes prior instruction by the teacher necessary. More information or perhaps a concrete example should be given within such a WebQuest in order to make the assignment clear to the children. A second potential problem that can arise in connection with the use of WebQuests is that the children have to answer questions via consideration of several Internet sources. Many children can be overwhelmed by the amount of information to be searched. Children often simply start reading at the top of a page and have not yet learned to skim a text for its relevance or to find more specific information (i.e., the information needed to answer a question). To shed more light on the possibilities of WebQuests in primary education, it seems mandatory to take into account children's cognitive capacities and linguistic abilities. In a research review on the possibilities of the Web as information resource in K-12 education, Kuiper et al. (2005) concluded that children's cognitive capacities and linguistic abilities should be seen as crucial factors. Moreover, gender is considered to be a differential marker of learning success as well in that boys tend to browse more than girls (Scachter, Chung, & Dorr, 1998).

1.2. The present study

In the present study, the benefits of using WebQuests to promote children's learning were examined with primary school children in the Netherlands. Children were given an assignment in which they had to write a travel brochure describing an extensive trip through ancient Rome while searching for information on the Internet. One group received a WebQuest intervention in a more closed sheltered environment and the other group did the same WebQuest but could search for their own sources of information. The task was structured for both groups. The study is different from the earlier described studies on WebQuests, in that two conditions (free search: Google; closed search: WebQuest) were changed *within* one WebQuest instead of comparing a WebQuest to another type of learning material. An effect can therefore not be ascribed to other differences between the two conditions. Furthermore, the learning effects are, for the first time, studied in a quasi-experimental design, in which statistical analyses can be used to measure the effects. In the Google free-search condition, children were left to search for themselves whereas in the WebQuest closed-search condition, children were presented a series of relevant Internet links. To study individual variation, the role of gender, cognitive capacities and linguistic abilities was determined. Moreover, children's attitudes and perceptions towards the computer were explored. In doing this, we also attempted to investigate the first dimension of Marzano's theory of learning, both before and after the intervention in the present study.

In sum, in the present study an attempt was made to provide answers to the following questions:

1. What is the effect of a sheltered Internet environment on children's learning, and do these effects differ in a free-search versus closed-search condition and then in relation to their gender, cognitive capacities, and linguistic abilities?
2. How do the task differences, demonstrated learning gains, and child characteristics relate to the quality of the children's performance on the assignment?
3. How do the children's attitudes towards the computer and their perceptions of their computer skills change after the use of the two Internet environments?

1.2.1. Hypotheses

Our first hypothesis was that the freedom given to children by a search engine such as Google will produce higher learning gains and qualitatively better assignments because the children can search for their own texts and pursue more their own interests (Hypothesis 1).

Given the fact that it has previously been found that boys tend to browse more than girls and take little time to read, we expected boys to profit less from this condition than girls (Hypothesis 2).

Furthermore, for children with limited cognitive capacities and lower linguistic abilities, the structure of providing Internet links was hypothesized to constitute a very useful alternative. Therefore, we expected that these children would benefit *more* from a clearly delimited or ''sheltered'' search condition than children with higher cognitive abilities (Hypothesis 3).

With reference to the final research question, it was hypothesized that learning via the Internet would have a positive influence on children's attitudes towards the computer and skill perceptions (Hypothesis 4).

2. Method

2.1. Participants

The study took place in the Netherlands. In 1997 in the Netherlands, some 20% of elementary school teachers used the Internet to teach. In 2004, this percentage was 91%. In 1997, there was one computer for every 20 children in elementary school; in 2004, there was one computer for every eight children available in elementary schools and most of the computers also had access to the Internet (van Kessel et al., 2005).

Participants were 229 sixth-grade children from eight elementary schools in the eastern part of the Netherlands. The mean age of the children at the outset of the study was 12;1 years (SD = 5.61 months, range = 10;10–13;7). A total of 116 boys and 113 girls participated from 10 different classrooms of schools in small towns or villages in the eastern part of the Netherlands. The schools were all so-called stratum 2 schools (Wijnstra, 1988), indicating they have a low percentage of children from ethnic minorities and most children with an average social economical status. No information about the SES of the individual children was available. Of the participants, 7% had at least one parent who was not born in the Netherlands; these children were equally distributed across the two conditions.

The schools were randomly assigned to one of the two search conditions (i.e., closed versus free search) in a quasi-experimental design, so that children within a school could not interact about the different conditions. Six groups with a total of 116 children were assigned to the closed-condition (59 boys, 57 girls), and four groups with a total of 113 children were assigned to the free-search condition (57 boys, 56 girls). The children in the two conditions did not differ in language abilities, computer skills, or attitudes towards the computer (for a description of the tests see Section 2.2).

In the final repeated measures analyses, some children were left out ($n = 19$) because they were not present during one of the two measurements, or because their travel brochure was not handed in.

2.2. Materials

2.2.1. The CITO test

At the end of elementary school in the Netherlands (i.e., during sixth grade), the CITO test – a national standardized test used by 85% of all Dutch elementary schools (www.cito.nl) – is administered to gain insight into the cognitive and linguistic abilities of children who are usually about 12 years of age. In the present study, the subtest for Information Processing Skills was adopted as a measure of cognitive abilities. This subtest examines how the children handle textbook information; handle other sources of information; read; and comprehend diagrams, tables, graphs, and so forth in 40 questions. The subtest for Language was adopted as a measure of the children's linguistic abilities. This subtest examines such abilities as Dutch spelling, writing, reading comprehension, and vocabulary in 100 questions. The mean score of the 229 children in Information Processing Skills was 28.68 (SD = 6.36). The mean score on the Language subtest was 73.62 (SD = 13.49).

2.2.2. Digit Span

The Digit Span subtest from the WISC-R (WISC-R projectgroep, 1986) was used to assess the children's short-term auditory memory and their concentration. The subtest involves two parts. In the first part, the experimenter utters a number of digits, which the child then has to repeat in the same order. This part of the subtest consists of 12 items ranging from 3 to 8 digits. In the second part of the subtest, the child must reverse the order of the digits uttered by the experiment leader. This part of the subtest consists of 12 items ranging from 2 to 7 digits. For each part of the subtest, testing is terminated when the child fails to repeat two consecutive sequences of digits correctly. Children receive one point for each correctly repeated item, and zero points for an incorrectly repeated item. The average score of the children in this test was 11.34 (SD = 1.12). Due to absence, three children were not assessed.

2.2.3. ICT Monitor

The ICT Monitor is a questionnaire with 21 items (www.ict-onderwijsmonitor.nl). The questionnaire was administered to the children to assess their use of computers at school and at home, their perceptions of their computer skills, and their attitudes towards the computer. For the present study, two of these items were used. The first subscale consisted of 5 yes/no questions about attitudes towards the computer (e.g., "I like to work on the Internet", "I think I can learn a lot by using the computer") were scored with 1 for a Yes answer and 0 for a No answer. This resulted in a sum score ranging from 1 to 5. In relation to the small number of items the reliability can be called reasonable (Cronbach's $\alpha = 0.64$) as assessed in a nationwide study in 2000 (Dutch Ministry of Education, Culture and Science, 2002). The average score at pretest was 4.40 (SD = 1.19) and at posttest 4.15 (SD = 1.31).

The second subscale assessed the perception of computer skills. Six yes/no questions were related to the use of MS Word (e.g., "I can insert a picture in the text"), and 4 yes/no questions were related to the use of Internet (e.g., "I can make bookmarks"). This subscale turned out to be sufficiently reliable (Cronbach's $\alpha = 0.80$; Dutch Ministry of Education, Culture and Science, 2002). In the analysis, a score for the use of MS Word and a score for the use of Internet were used. The average score at pretest for MS Word was 5.42 (SD = 0.95) and at posttest 5.57 (SD = 0.78), for Internet these were 3.44 (SD = 0.83) and 3.69 (SD = 0.59).

2.2.4. Knowledge test

To assess children's knowledge of the topics in the WebQuest both before and after the intervention, the children were asked to write down as many words or short phrases as they could within a period of 30 min on nine topics addressed in the WebQuest (i.e., Roman houses and architecture, Roman leaders, Roman dressing, Roman education, Roman daily life

and free time, Roman religion, Roman eating and drinking, Roman streets, and Roman inventions). Group instruction for the Knowledge test was initially provided with the aid of a similar example for the country of Germany and German people, which was worked out a priori with the experimenters. The Knowledge test was scored by one experimenter. Two points were assigned for a word or phrase that could be considered "Roman," such as "coliseum," "Caesar," "Augustus," "concrete" and so on. One point was assigned for a word or phrase that showed partial "Roman" knowledge, such as "types of dress." Zero points were assigned to words not "Roman". A second experimenter scored 18 knowledge tests as well, and a Pearson's r of 0.98 showed that the scoring was done reliably.

2.2.5. Intervention

The intervention consisted of a series of computer lessons in which the children had to work through the Dutch WebQuest entitled "A virtual journey to Rome" (see www.webquest.nl). The WebQuest was based upon the English WebQuest entitled "All roads lead to Rome" (see http://www.esc2.net/TIEYear3/projects/rome/default.htm). The children had to write a travel brochure (2–3 pages) in which a trip to ancient Rome was described. The trip had to last 5 days, and on each day a different topic had to be addressed. The children could choose among the following topics: homes and architecture, heads of state, clothing, education, daily life and leisure time, gods and religion, eating and drinking, streets and roads, and inventions.

The WebQuest consisted of the following sections: *introduction*, *task*, *process guidance & resources*, *evaluation of task performance*, and *brief conclusion*. In the introduction, children were made enthusiastic about the idea that it would be wonderful if it would be possible to travel to ancient Rome, and were told that by doing this WebQuest, they would learn more about ancient Rome and the people who lived in those days. In the task section, it was explained that they were going to make a travel brochure for a travel agency offering a trip to ancient Rome. In the process section, it was explained that they had to choose five topics and think of things they needed to know about these topics in order to write the travel brochure. Information was also given about how to write such a brochure. In the guidance & resources section, example questions were given as well as links to web pages in the closed-search condition, and a link to Google in the free-search condition. In the evaluation section, children were asked to evaluate their own work, by looking again at the content of their brochure, the design, their writing style, spelling and grammar and the length of the text. The conclusion repeated the learning goal. To write the travel brochure, it was not necessary or obligatory to answer the example questions, but the experimenters reported that most of the children did so. All children wrote the brochures individually in school.

In the closed-search condition, all parts of the WebQuest were presented to the children, which meant that the children were also provided with the links to relevant web pages (i.e., resources) to perform the WebQuest. A total of 25 links were provided, ranging from 1 to 5 per topic. These links were available during the entire intervention, and linked to pages with information about the topics, suited for the children. In the free-search condition, the *resources* part of the WebQuest was replaced by simply a link to the Dutch Google web page.

The children in both conditions received classroom instruction in which the assignment was also clarified. They were given information about WebQuests, about the assignment of writing a travel brochure, and about the idea of writing one if you could go back in time. The instructions were provided by research assistants who all were instructed by the authors to give similar instructions in all groups. The children in the free-search condition also received additional information on the use of Google to search the web at this time; they were instructed about the use of keywords and how to combine search terms. The Internet use of the children was not monitored during the intervention.

2.2.6. Scoring of the quality of work

The quality of the brochures was assessed using a standard Scoring Form designed on the basis of the evaluation part of the WebQuest. In this evaluation part, children could self-evaluate their work on several topics, each on a three-point scale. The topics were content, travel brochure, design, writing style, spelling, and length of the text. The computer then calculated a total score and gave a rating (very good, good, satisfactory, unsatisfactory). In the present study, the Scoring Form used a structure presented in Rijlaarsdam, Oostdam, and Bimmel (1995). The Scoring Form consisted of three parts: language quality (i.e., spelling, punctuation, grammar, missing words); text quality (i.e., use of own words, concise, proportion text and pictures, structure total text, structure per day), and pragmatic quality (i.e., five topics addressed, clear travel brochure, 5 days, planning of the day, information per activity, lay-out, information on each topic, name of the journey/title, suitability of illustrations). All of the brochures were scored by an experimenter who had no information about the two different search conditions. The scoring of the textual quality and pragmatic quality forms two subjective scales. To test interrater reliability a second experimenter, therefore, scored 26 of the brochures and reached substantial agreement with the first observer on sumscores of both scales, that is, for textual quality intraclass correlation (ICC) was 0.61 and for pragmatic quality it was 0.77.

2.3. Procedure

The CITO test is always administered nationwide in February in the final grade of elementary school in the Netherlands. This was about 3 months prior to the intervention with the sixth-grade children in the present study. The Digit Span test was administered individually outside the classroom. The ICT Monitor and Knowledge test were administered in the classrooms prior to the start of the intervention.

The intervention was conducted in separate rooms within the different schools. Some of the schools had special computer rooms available for this purpose, which meant that

Table 1
Mean scores (and standard deviations) for all measures as a function of condition and gender.

	Closed-search		Free-search	
	Boys	Girls	Boys	Girls
CITO information processing	28.92 (5.83)	28.81 (6.81)	29.46 (5.99)	27.52 (6.80)
CITO language	73.27 (12.71)	74.88 (14.97)	73.79 (12.04)	72.55 (14.34)
Digit Span	10.76 (2.82)	11.36 (3.39)	11.95 (3.40)	11.38 (2.81)
Attitude computer pretest	4.58 (1.06)	4.31 (1.13)	4.46 (1.09)	4.23 (1.53)
Attitude computer posttest	4.47 (1.27)	4.33 (1.22)	4.30 (1.15)	4.02 (1.40)
Skills word pretest	5.42 (1.10)	5.43 (0.89)	5.53 (0.85)	5.32 (0.96)
Skills word posttest	5.41 (0.95)	5.58 (0.76)	5.76 (0.52)	5.71 (0.58)
Skills Internet pretest	3.34 (0.93)	3.54 (0.74)	3.67 (0.61)	3.23 (0.93)
Skills Internet posttest	3.59 (0.62)	3.62 (0.56)	3.80 (0.50)	3.91 (0.62)
Knowledge test pretest	16.39 (11.57)	13.61 (8.90)	24.29 (14.32)	19.41 (12.51)
Knowledge test posttest	29.80 (19.93)	28.20 (15.48)	26.28 (18.33)	27.87 (15.51)
Quality of work language	2.82 (0.65)	3.14 (0.64)	2.96 (0.64)	3.15 (0.68)
Quality of work textual	2.74 (0.39)	2.83 (0.43)	2.74 (0.49)	2.83 (0.50)
Quality of work pragmatic	2.79 (1.05)	2.87 (1.14)	3.29 (1.00)	3.00 (1.02)

all the children could work at the same time. In other schools, the children had to work in different sessions. The intervention was conducted across a period of 3 weeks in four to seven sessions and a total of about 5 h in each school. The first session was preceded by the instructions. An experimenter was present during at least two of the sessions per school, and the teacher was always present. The children were allowed to ask questions but were given only minimal help as we did not want teacher or experimenter differences to influence the results. Teachers were instructed not to provide any more instruction.

The Knowledge test was again administered 1 day after the last computer session.

3. Results

3.1. Descriptive statistics

Table 1 provided an overview of the descriptives of all measures for boys and girls in the closed-search and free-search condition.

Given that the data were collected in a quasi-experimental design, the possibility of differences between the relevant groups of children at pretest was therefore examined. The students in the closed-search versus free-search condition did not differ from each other with regard to their CITO performances. However, the students in the free-search condition showed higher Knowledge test scores at pretest ($M = 21.87$, $SD = 13.61$) than the students in the closed-search condition ($M = 15.00$, $SD = 10.37$), $t(219) = 4.23$, $p < 0.001$, Cohen's $d = 0.57$. The boys also did not differ from girls with regard to their CITO performances, but the boys showed higher Knowledge test scores at pretest ($M = 20.31$, $SD = 13.54$) than the girls ($M = 16.45$, $SD = 11.16$), $t(219) = 2.31$, $p = 0.022$, Cohen's $d = 0.31$. Inclusion of the children's pretest Knowledge test scores as covariates in all subsequent analyses thus rules out the possibility of differences in their learning gains being due to initial differences in their knowledge levels.

3.2. Learning gains

A paired samples t-test on the Knowledge test results showed a significant effect of the intervention for the entire group in terms of a learning gain from pretest to posttest, $t(209) = 9.89$, $p < 0.001$, with a medium to high effect size Cohen's $d = 0.66$. In what follows, learning gain is used as dependent variable "Learning gain" was defined as the Knowledge test score at posttest ($M = 28.170$, $SD = 12.71$) minus the Knowledge test score at pretest ($M = 18.27$, $SD = 17.31$).

Bivariate correlations were calculated between the various measures of the children's cognitive and linguistic abilities, their Knowledge test scores at pretest, and their learning gains (Table 2). Significant correlations were found in particular between the two CITO subtests and learning gain and also between the children's pretest knowledge and learning gain. The scores for the CITO subtests and the children's Knowledge test scores at pretest were therefore included in the subsequent analyses of variance as covariates. Furthermore, it was checked whether the ability to use the Internet was related to the learning gain. This could especially be of influence in the free-search condition, so therefore correlations were calculated for each condition separately. As it turned out, in both conditions there was no significant correlation between Internet skills and learning gain ($r < 0.1$).

A General Linear Model univariate analysis was conducted with learning gain as the dependent variable, gender (boy, girl)

Table 2
Correlations between various measures of cognitive and linguistic abilities, Knowledge test score at pretest, and learning gain.

CITO language subtest	1.00				
CITO information processing subtest	0.78**	1.00			
Digit Span test	0.21**	0.15*	1.00		
Knowledge test score at pretest	0.40**	0.35**	−0.01	1.00	
Learning gain	0.17*	0.15*	−0.04	−0.20**	1.00

*$p < 0.05$; ** $p < 0.01$.

and condition (free search, closed search) as the independent variables, and the two CITO subtest scores and the Knowledge test scores at pretest as covariates. Significant effects were found for Knowledge test score at pretest, $F(1, 203) = 7.16$, $p = 0.008$, partial $\eta^2 = 0.03$, for gender, $F(1, 203) = 4.03$, $p = 0.046$, partial $\eta^2 = 0.02$, and for condition, $F(1, 203) = 18.57$, $p < 0.001$, partial $\eta^2 = 0.08$. The interaction gender by condition was nonsignificant, $F(1, 203) = 3.44$, $p = 0.065$. Repetition of the analyses with only the boys or the girls to explore the possible interaction with condition showed the boys to have significantly lower learning gains in the free-search condition than in the closed-search condition ($p < 0.001$) while the girls showed no significant differences ($p = 0.100$). In fact, a paired samples t-test revealed no significant learning gain for the boys in the free-search condition, $t(48) = 0.51$, $p = 0.609$, Cohen's $d = 0.12$. These effects are depicted in Fig. 1.

3.3. Quality of assignment

Table 1 presents the means and standard deviations for language, textual and pragmatic quality of the travel brochures produced in the two conditions.

The quality of the travel brochures produced by the children did not relate to their learning gains; no significant correlations were found between learning gain and the judgments of linguistic, textual and pragmatic quality. Significant correlations were, however, found between the overall quality of the travel brochures produced by the children and all of the measures collected prior to the intervention: CITO language subtest ($r = 0.41$, $p < 0.01$), CITO Information Processing Skills subtest ($r = 0.35$, $p < 0.01$), Digit Span ($r = 0.24$, $p < 0.01$), Knowledge test scores at pretest ($r = 0.17$, $p < 0.05$). A one-way ANOVA also revealed significant differences in the travel brochures produced in the two conditions with respect to language quality, $F(1, 202) = 4.36$, $p = 0.038$, Cohen's $d = 0.29$, with higher scores in the free-search condition ($M = 3.14$, SD = 1.02) than in the closed-search condition ($M = 2.83$, SD = 1.09). No differences occurred with respect to the quality of the text, $F = 0.04$, ns, or pragmatic quality, $F = 0.78$, ns.

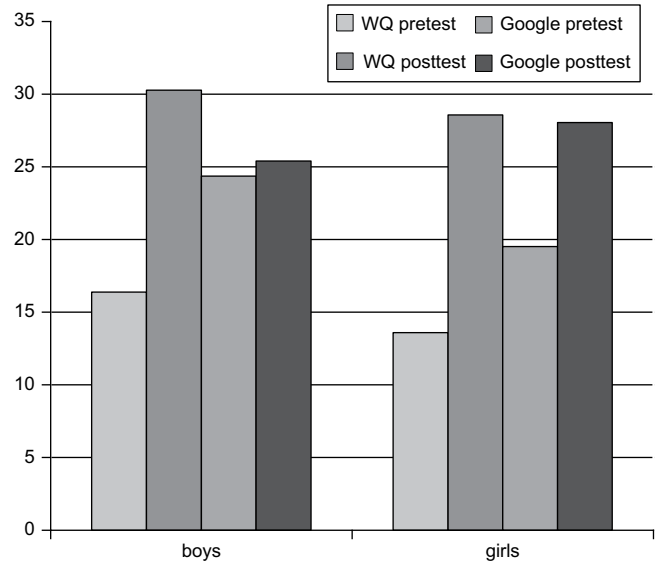

Fig. 1. Knowledge test sores at pretest and posttest for boys ($n = 105$) versus girls ($n = 105$) in closed-search and free-search condition.

3.4. Children's attitudes towards the computer and perceptions of computer skills

Possible changes of the attitude of children towards the computer were assessed by a General Linear Model multivariate repeated measures analysis with time (pretest, posttest) as within subjects factor and gender (boy, girl) and condition (free search, closed search) as between subjects factors revealed slightly more positive attitudes before ($M = 4.40$, SD = 1.19) versus after ($M = 4.30$, SD = 1.30) the intervention, $F(1, 167) = 5.59$, $p = 0.019$, partial $\eta^2 = 0.03$, no interaction of time by condition, $F = 1.39$, ns, or time by gender, $F < 1$, ns, and no third-order interaction, $F = 1.13$, ns. There were, however, main effects of gender, $F(1, 167) = 7.18$, $p < 0.01$, partial $\eta^2 = 0.04$, indicating a more positive attitude for boys than for girls (see Table 1) and of condition, $F(1, 167) = 4.18$, $p < 0.01$, partial $\eta^2 = 0.02$. Children in the free-search condition had more positive attitudes than children in the closed-search condition (see Table 1). The reader should note, however, that a substantial amount of children in the free-search condition did not fill in this questionnaire after the intervention (59 out of 113). Moreover, the scores at pretest showed almost a ceiling effect ($M = 9.64$, SD = 0.92), which suggests a very positive attitude towards the computer already at the start of the experiment, and to cautiously interpret the results.

Concerning computer skills, the children were found to assign themselves higher scores *after* the intervention for both the use of word (six yes/no questions), $F(1, 169) = 7.00$, $p < 0.01$, partial $\eta^2 = 0.04$, and the use of the Internet (four yes/no questions), $F(1, 168) = 14.23$, $p < 0.01$, partial $\eta^2 = 0.08$. No effects of gender or condition were found in both analyses, but for Internet skills a three way interaction time by gender by condition was found, $F(1, 168) = 5.63$, $p = 0.02$, partial $\eta^2 = 0.03$. This interaction can be explained by the fact that girls indicated to have achieved more Internet skills in the free-search condition than in the closed-search condition ($p < 0.01$), whereas boys reported equal gains in both conditions.

4. Discussion

The aim of the present study was to further explore sixth-grade children's learning within a sheltered learning environment, thereby contrasting a closed-search versus free-search condition and taking gender into account. Our first hypothesis was that the freedom given to children by a search engine such as Google would produce higher learning gains and qualitatively better assignments because the children can search for their own texts and pursue more their own interests. Given the

fact that it has previously been found that boys tend to browse more than girls and take little time to read, our second hypothesis was that boys would profit less from this condition than girls. Positive effects of working in a sheltered learning environment in general were found. We indeed found an interaction between gender and condition. The boys studied here benefited in particular from working in a more sheltered learning environment (i.e., the closed-search condition) while the girls showed more or less equivalent learning gains in the closed-search and free-search condition within the sheltered environment. We found a difference in the quality of the writing for the two conditions with the language quality being higher in the free-search condition, but this was not related to a difference in learning gain. The quality of the children's WebQuest work was found to correlate not only with their cognitive and linguistic abilities but also their Knowledge test scores at pretest. The main part of the first hypothesis, namely that the free-search condition would provide higher learning gains, thus has to be rejected, whereas the basic rationale of the second hypothesis can be accepted.

The third hypothesis was that children with limited capacities would benefit *more* from a clearly delimited or ''sheltered'' search condition than children with higher cognitive abilities. No differences between the two conditions were found, but both the linguistic and cognitive capacities of the children were found to play a role in their learning gains with the higher ability children generally learning more.

The fourth hypothesis was that learning via the Internet would have a positive influence on children's attitudes towards the computer and skill perceptions. We found that the children's attitudes towards the computer slightly diminished in both conditions. Their perceptions of their own computer skills, however, showed significant gains, and girls indicated to have achieved more Internet skills in the free-search condition than in the closed-search condition. The fourth hypothesis can thus only partly be accepted.

The part of the first hypothesis that a free-search condition would provide higher learning gains was not confirmed. Probably, children were still not able to fully pursue their own interests, since they had to choose out a set of given topics, just as children in the closed-search condition. The finding that the boys showed no significant learning gains in the free-search condition is in line with the literature that shows them to browse a lot and take little time to read the pages they see (Kuiper et al., 2005; Scachter et al., 1998). The closed-search condition, moreover, likely has given the boys enough guidance to stay on track (cf. McEneaney, 2000), whereas girls do not seem to need this much guidance to stay focused. It is important to note that, in general, the lower achieving children showed lower learning gains than the higher achieving children. The problems experienced by lower achieving children while going through the Internet pages recommended in the WebQuest closed-search condition or found by themselves in the Google free-search condition may have overshadowed any additional advantage for this group to benefit more than others from a more structured, closed-search condition (cf. Kuiper et al., 2005). In future research, thus, the actual information-gathering process should also be considered, as well as differences in cognitive load.

Short-term memory, as measured by the Digit Span task, was not associated with any differences between the two different search conditions. This finding shows that having to search for learning resources on their own may not produce a greater cognitive load than being provided with the learning resources. The overload sometimes associated with learning from pages on the web is probably more closely linked to the content of the web pages themselves. Web pages that simultaneously present text, pictures, sounds, animation, and so on can be very distracting and thus create greater cognitive overload than web pages that rely upon a presentation with only one or two modalities and do not present more input than is necessary (cf. Mayer, 2001; van Gog & Paas, 2008). However, in the present study we did not measure whether there were any differences in germane or extraneous load, and further research on this topic is necessary to unravel this issue of instructional efficiency.

The higher language quality in the free-search condition is difficult to interpret. Arguing that children spend more time on this in the free-search condition would also hold for other aspects of the quality of work, but we did not find any differences there. Children in the free-search condition perhaps were better spellers by coincidence, but we did not test this. It is noteworthy though, that the quality of the work did not differ on a textual or pragmatic level. Combining this with the fact that boys learned less in the free-search condition might suggest that they were very well able to find and use the relevant information for their work, but that they spent less time on deeper learning because they browsed further on the Internet. Boys in the closed-search condition also had this opportunity, but probably did not browse further. In an earlier pilot study (Segers & Verhoeven, 2003), we found that children tend to not go beyond the pages that are provided to them in an assignment, even when it is not forbidden.

The fact that the children's attitudes towards the computer slightly diminished after the intervention can be explained by the fact that doing an assignment via the computer for school is different, and could have caused them to encounter more problems than when using the computer for leisure activities. The scores, however, were almost at ceiling both before and after the intervention. Children evidently have a very positive attitude towards the computer. The attitude of boys was more positive than the attitude of girls, which is similar to results in other studies (Colley & Comber, 2003). In other words, this aspect of the children's learning and thinking from the perspective of Marzano (1992) does not need much cultivation.

4.1. Limitations of the study

There are several limitations on the present study that should be acknowledged at this point. The first is that we were not able to follow the Internet search behavior of the children during the intervention. Such information can certainly provide greater knowledge of the learning process. We do not

know, for example, just how the children navigated the Internet for completion of the WebQuest assignment or the extent to which use was made of the supporting questions provided as part of the WebQuest.

Furthermore, the Knowledge test used in the present study was associative in nature. In order to assess children's knowledge, a multiple-choice test might have been a useful addition.

We also acknowledge the small effect-sizes of the differences between boys and girls, and the reader should thus interpret these results with caution. Moreover, since it was a quasi-experimental design, the effects of the role of the different teachers cannot be completely ruled out, although this issue was addressed in the procedure.

The extent to which the WebQuest actually appealed to the higher-order thinking skills of the children in this study (i.e., Bloom's HOTS or analysis, synthesis, and evaluation) is also not known.

Finally, and as mentioned in Section 1, the content of a particular WebQuest depends upon the author(s) in the end. We think that the WebQuest in the present study may have had more explicit instruction than originally intended by the concept of a WebQuest (cf. March, 2004). It is possible that the questions may have given *too* much guidance and that the children also felt obliged to answer the questions. In other words, the WebQuest constituted a very well-defined assignment for both of the Internet search conditions in the sense that the task to be performed was clearly articulated and the conduct of the task largely shaped by the questions to be answered. In other studies, the differences between relatively well-defined versus loosely defined WebQuests have been taken into consideration and found indeed to lead to significant learning differences with higher learning gains for WebQuests with ill-defined assignments than for WebQuests with well-designed assignments (Segers, Droop, Damhuis, & Verhoeven, 2007).

It would be interesting for future research to study the effects of ill-defined and well-defined assignments on a continuum ranging from completely open to completely closed, embedded in a continuum of WebQuests differing in the degree of freedom to search the Internet. When the process of knowledge construction (i.e., the actual building of knowledge) is observed in these studies, we will be able to gain further knowledge about differences between children and the cognitive processes involved in learning from the Internet.

4.2. Conclusion

To summarize, the results of the present study show that boys learn more in a sheltered learning environment than in a less sheltered free-search environment, and that girls have equal learning gains in both types of the sheltered environment. The effect size of learning from a WebQuest was moderate to high, thus demonstrating the feasibility of introducing a layer of structure between the child and the Internet. A WebQuest can be seen to help organize the learning process, and is in line with the theory of dialectic constructivism.

With regard to the implications of the present findings for actual practice, we believe that a layer of structure between the child and the Web is a useful addition to education. Many teachers have little knowledge about the use of ICT in their educational program. Some end up with focusing on the teaching of computer skills, with about one third of the teachers in The Netherlands rarely or never using the Internet (Kuiper, 2007). The use of a WebQuest can thus indeed bridge the gap between content literacy and technological literacy. Along these lines, Verhoeven et al. (2006) called for a more integrated approach in which learning to search for meaningful information and processing this information is part of the more general educational curriculum and, consequently, there should be other activities in addition to computer/Internet activities. Segers, Damhuis, and Droop (2006), for example, described the embedding of Internet learning activities in a classroom project that also included instruction by the teacher, classroom and group discussions, the reading of texts, and so on. A promising addition to the idea of a WebQuest, moreover, is to establish a common knowledge base, which can then serve as an anchor for the pursuit of a WebQuest in which problem-solving behavior is enhanced (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990). Students can thus build upon a shared information base with information gathered from the Internet, and the integration of classroom activities with the use of the Internet can thus make traveling on the Web a meaningful experience.

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