

## **The impact of scaffolding on characteristics of mental models during information-seeking activity**

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**Abstract:** With the development of e-learning and MOOCs, knowing how to improve information-seeking activity in video-based environments seems to be a major challenge in the coming years. Previous research has shown benefits of scaffolding information-seeking in videos. We hypothesize then that scaffolding helps information-seeking by providing an external, usable conceptual model. Without scaffolding, users have to construct their own mental model, which is costly and time-consuming but serves therefore as an internal representation. In the current study, students completed a search task and were divided into two conditions, with or without scaffolding. Then they completed a localization task. Results show that scaffolding has positive effects on search outcomes, but also that individuals who benefited first from scaffolding are less effective on the localization task than participants without scaffolding. The hypothesis of a usable but external model provided by scaffolding is then supported.

### **Introduction**

Individuals are continually searching for information, and it makes information-seeking (IS) ability critical in both professional and personal areas (Wopereis, Brand-Gruwel, & Vermetten, 2008). This IS activity consists in locating a particular piece of information among other while having an explicit goal in mind (Guthrie & Mosenthal, 1987). According to some authors (e.g. Merkt & Schwan, 2014), this process leads to improved learning but very few studies have been conducted in this area. With the increasing importance of videos in education (Delen, Liew, & Willson, 2014; Giannakos, 2013), the IS activity is likely to be more and more important.

Recent research has shown the positive effects of scaffolding (i.e. aid or support for a better understanding of the document; Azevedo & Hadwin, 2005) on the quality of IS activity in a video-based environment (e.g., Cojean & Jamet, 2017; Merkt & Schwan, 2014). Two levels of possible activities need to be scaffolded: micro-activities (i.e., user control over the continuous flow of information; Merkt, Weigand, Heier, & Schwan, 2011) and macro-activities (i.e., structural representation of the document; Sanchez, Lorch, & Lorch, 2001).

The results of Cojean and Jamet (2017) suggest that the mental model of the user, which is the basis for the success of the localization process (Sharit, Hernández, Czaja, & Pirolli, 2008), is constructed by the users themselves during the IS activity when there is no scaffolding presented. Indeed, this construction is reflected in the improvement of performance during the task: their performance becomes as good as that of the participants with scaffolding. On the contrary, users with scaffolding have very good performance throughout the task, indicating that scaffolding provides them a conceptual model they can rely on (Cojean & Jamet, 2017). This conceptual model seems to remain an external representation, therefore very little difficulty is perceived by participants.

The current experiment aimed to study the characteristics (internal vs. external) of the mental models of users during an IS activity, depending on the presence or absence of scaffolding. More precisely, an internal and self-constructed mental model should help users to be more effective in a prediction activity over time (according to

the definition of a relevant mental model, e.g. Borgman, 1986), and this is the expected result when participants do not benefit from scaffolding. On the other hand, an external mental model provided by scaffolding should no longer be an active representation when scaffolding is missing.

## Method

### Participants

50 students (43 women) at the University of Brittany took part in the study ( $M_{age} = 19.31$  years,  $SD = 1.11$ ). They received a cinema ticket for their participation. Participants were randomly and evenly distributed among the two experimental groups (25 subjects per group).

### Materials

All participants were given a video-based learning environment whose topic was “Water in the Universe” (Doressoundiram, 2012). The video lasted 13 minutes, and the participants could use the pause button and browse the video as much as they wanted by using a timeline displayed below the video. A screen recorder was used during the whole task to record their IS activities.

### Procedure

The experiment was lead in accordance with the principles of the Declaration of Helsinki for the protection of human subjects.

### Search Task

First part of the study was a search task. Participants were assigned to one of the two conditions: with or without scaffolding (i.e. table of contents and markers on the timeline, see Fig. 1). Participants were asked to seek information in a video-based environment and answer nine questions. For each question, participants were limited to 5 min to find the answer. They had to indicate the response and the moment in the video when it was provided. Then they completed a post-task questionnaire about perceived difficulty.



Fig. 1. Screenshots of the video-based environment for the information seeking task in the conditions without (1) or with (2) scaffolding.

### Localization Task

A second part of the study was a localization task. For this portion of the study, all participants had no scaffolding, plus the inability to rewatch the video (see Fig. 2). The eight questions asked were about information in the video, and participants had to give an answer if they knew it, and to indicate on the presented timeline where they thought they could find the answer if the video had been viewable.

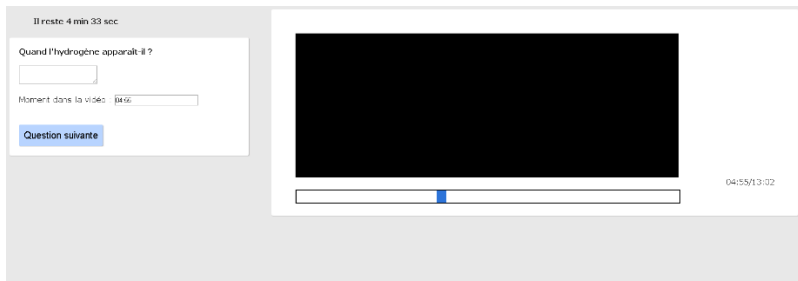


Fig. 2. Screenshot of the video-based environment for the localization task.

## Results

Concerning the evolution of response time among the nine questions in the search task, to take into account the nonindependence of data, we used linear mixed models (Gueorguieva & Krystal, 2004). Results showed a significant effect of the condition,  $\chi^2(1, N = 425) = 32,139, p < .001$ . Descriptive statistics indicated that response times were shorter in the scaffolding condition than in the no-scaffolding condition (see Fig. 1). We also analyzed how the amount of time allocated to the search activity changed over the course of the task. Results showed an additive effect of question rank,  $\chi^2(1, N = 425) = 10.664, p = .001$ , as well as an interaction between the two levels of scaffolding and question rank,  $\chi^2(1, N = 425) = 6.524, p = .011$ . Descriptive statistics showed that response times decreased over time for the no-scaffolding condition, and that the difference between the two conditions seemed to disappear over time (see Fig. 3). These results are consistent with results observed in the study conducted by Cojean and Jamet (2017).

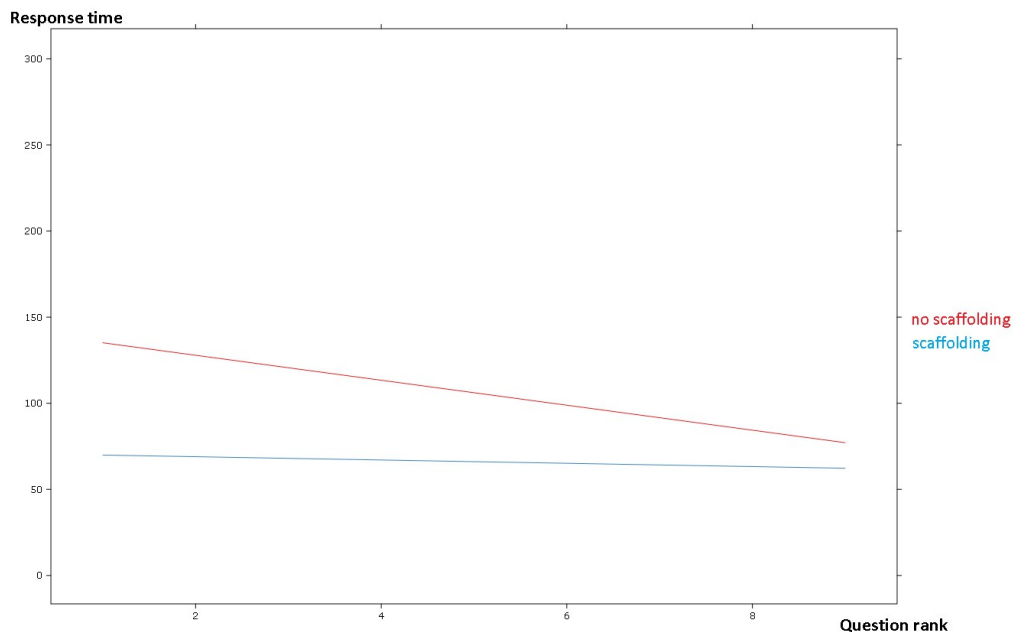


Fig. 3. Diagram showing response times (in s) according to question rank in the two experimental conditions.

Furthermore, ANOVAs revealed a main effect of condition on perceived difficulty ( $F(1, 48) = 4,742, p = 0,034$ ) and on accuracy of localization in the localization task ( $F(1, 48) = 6,891, p = 0,012$ ). Descriptive statistics showed that participants who benefited from scaffolding perceived less difficulty in the information-seeking activity

than participants who did not benefit from scaffolding. However, they did more errors in the localization task when the scaffolding and the video were no longer available (see Table 1).

| Condition      | Perceived difficulty |           | Error in relevance of localization (seconds) |           |
|----------------|----------------------|-----------|--|-----------|
|                | <i>M</i>             | <i>SD</i> | <i>M</i>                                     | <i>SD</i> |
| Scaffolding    | 2,53                 | 0,98      | 129,62                                       | 37,68     |
| No-scaffolding | 3,19                 | 1,14      | 103,27                                       | 33,14     |

**Table 1.** Descriptive statistics for perceived difficulty after step 1 and localization in step 2

## Discussion

The aim of this study was to replicate previous results on the positive effects of scaffolding on information-seeking in videos and to focus on the characteristics of the mental models relied on by users during this activity. The present results confirm previous findings and show that participants without scaffolding are more effective than participants with scaffolding during the localization task. It supports the hypothesis that the scaffolding helps users thanks to an external conceptual representation of the video but is no longer useful when it's removed. On the contrary, the absence of scaffolding during the search task leads to the construction of an internal mental model, which is costly for the user to create but leads to a better understanding of the video. Future research should focus on the reasons why the scaffolding provided (i.e. proposed conceptual model) in video-based environments is not internalized during information seeking activity, and how it could be to improve performance during a learning activity.

## Acknowledgments

This work was supported by the CominLabs laboratory of excellence funded by the French National Research Agency (ref. ANR-10-LABX-07-01).

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