The white board as a tool for the manipulation of recently acquired concepts

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Abstract
This study investigates how using a white board when constructing explanations from experience and from an animated resource differs from providing the same explanations without a white board. The study is based on video and audio recordings of participants in two conditions, white board and no white board, explaining how cell phones work, first without a resource, and then twice after the use of an animated resource. The results of this study suggest that using a white board when explaining both known and newly acquired information is different than explaining the same information without a white board. This finding is demonstrated through the length of time the participants spoke, the number of words they spoke, and in the types of phrases they communicated. Additionally, it was found that a relationship between initial knowledge and the resource may impact what types of speech participants engage in.

Introduction
This study began as an investigation into the use of gestures when constructing explanations that represent an integration of new knowledge and existing knowledge. The design of the study has created data that may still support this inquiry. However, while the end goal is to join in the observation of gestures as a way to observe sign or spatially based forms of cognition, this initial study seeks first to quantify more broadly spatially mediated concept development.

To this end, this study looks at how the use of a white board changes both the duration and quality of speech when participants are tasked with explaining a how cell phone functions in a variety of explanation conditions.
General Description of the Experiment

White boards are often used in design-oriented environments to facilitate collaboration between team members. The philosophy of use is to have a representation that everyone can see and interact with at the same time. In this context, it is easy to see the white board as a tool that helps to facilitate shared understanding through reciprocal explanation and representation. With the removal of the team from the environment, a new question is generated as to what sort of benefit an individual gains in using the white board to assist in constructing explanations and representations? More broadly how do the activities of explanation and representation facilitate integration of new resources into previously held knowledge.

Methods

Participants

Twelve Stanford School of Education graduate students participated in this study. Two of these initial participants became pilot subjects due to initial design issues surrounding the use of experienced teachers in this study. The fact that some of the participants are experienced teachers required wording of the description of the request for an explanation of how cell phones work to be constrained to outside of a highly engaged classroom model of explanation for the findings to be comparable to non-teacher participants. In the future, it may be of value to specifically select either all teacher or non-teacher samples. Additionally, the majority of the participants are familiar with the use of a white board for communication and illustration purposes.

The three explanations for each participant were video recorded. It was decided for the scope of the study to remove the shortest and longest explaining participants from each condition. It was found, however that their explanation lengths were consistent with the length finding represented by the remaining groups. This reduction resulted in two comparison groups of four participants each.
**Materials**

The materials for this study included a white board and markers, a two minute animated resource from Brainpop.com delivered via Tablet PC, and paper and pen for participants to use to take notes if they wished during the resource presentation. The animated resource, “How Cell Phones Work” is part of a large library of cartoon-style animations geared towards middle school students. The style of the resource is narrative and light hearted. The content of the resource is neither comprehensive nor pedagogically sound. In the case of this study, the weaknesses of the resource appropriately required the participants to engage in synthesis and comprehension tasks.

**Design**

In this study, two factors are being considered. The first condition is the comparison of two groups of participants, one group that has the option to use a white board when giving their explanations of how cell phones work and one group that is not given that option. The second factor under consideration is the comparison within and across groups of the changes in explanation that occur due to both resource use and previous practice.

<table>
<thead>
<tr>
<th>Condition One: Option to use white board during 3-5 minutes explanation</th>
<th>1. Explanation without resource</th>
<th>2. Explanation after seeing resource once</th>
<th>3. Explanation after seeing resource twice</th>
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<tr>
<th>Condition Two: No option to use white board during 3-5 minute explanation</th>
<th>1. Explanation without resource</th>
<th>2. Explanation after seeing resource once</th>
<th>3. Explanation after seeing resource twice</th>
</tr>
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In this design, I am comparing the performance of condition one and two across three explanation conditions. The purpose of the three explanation conditions is as follows:

1. Explanation without resource
The goal of the initial explanation is to gain an understanding of the participants’ current knowledge about cell phones. It is also hoped that by eliciting the participants’ existing knowledge about cell phones, the addition of the resource in subsequent steps will cause dissonance between what is believed and what is consumed, such that participants must make choices about how to integrate their existing retrieved and professed knowledge with that of the resource.

2. Explanation after seeing resource once.
The goal of the second explanation is to see how the participants integrate their previous knowledge with the information provided by the resource. The choice of the somewhat misleading resource and the elicitation of the initial explanation are designed to push the participant to have to do more than simply recite the resource explanation.

3. Explanation after seeing resource twice
The assumption with the third explanation, is that the participants will demonstrate how they have transferred and integrated their previous knowledge of how cell phones work into a new comprehensive explanation that utilizes the information presented in the resource.

The purpose of the white board and no white board conditions in this study is to look at how large scale drawing and note making in real time explanation might influence the assimilation of a visual and animation driven resource.
Procedure

The study procedures were conducted verbally with each individual participant in a closed room with a video camera.

1. The participant is told that he or she is part of a study considering the usefulness of a just-in-time resource for learning.
2. The study is outlined to the participant, so that they know that they will explain three times and view the same resource twice.
3. EXPLAIN 1: The participant is then asked to stand and explain how cell phones work for 3-5 minutes. The participant is also told “to feel free to be wrong or make things up if you need to. The goal is just to convey what you know. If you end early that is fine.” 
   In the white board condition there is access to and an invitation to use white board if the participant desires.
   a. Participant can have up to 5 minutes to gather their thoughts before starting.
4. Video tape participant giving 3-5 minute explanation on how cell phones work
5. Participant views 2 minute resource animation on how cell phones work, and can have up to 5 minutes to gather any thoughts. He or she is also welcome to take notes, but cannot take notes up with them to speak. 
   During this time, if it is the white board condition, erase white board from first explanation.
6. EXPLAIN 2: The participant is then asked to stand and explain how cell phones work for 3-5 minutes.
7. Video tape participant giving 3-5 minute lecture on how cell phones work
8. Participant views 2 minute animation again, can have up to 5 minutes to gather their thoughts. During this time, if it is the white board condition, erase white board from first explanation.
9. EXPLAIN 3: The participant is then asked to stand and explain how cell phones work for 3-5 minutes.
10. Video tape participant giving 3-5 minute lecture on how cell phones work
11. Debrief
**Coding**

The three explanations of each of the eight participants were transcribed for coding. In order to facilitate initial comparisons between the white board group and the no white board group, a coding scheme was developed that did not consider either gestural data or the drawings the participants created on the white board. In further phases of this study, a more detailed analysis of this data may be considered. The initial coding scheme for this experiment enumerates the following characteristics:

*Length of time for each explanation*

Participants were informed that they should provide explanations that ranged from three to five minutes or until they ran out of things to say. Regardless of this instruction, individual participants in both conditions set an internal time for the length of their explanations and did not generally vary far from this setting in each of their explanations.

*Number of words spoken in each explanation*

The use of the number of words spoken to measure differences between two conditions might be considered rather imprecise. The goal here however is simply to use this comparison as a tool to identify potential trends. The other aspect of this measure that might allude to its temporary utility is the relationship that gesture and drawing play in the data of this study. The focus on transcripts in these measures ignores for the time being the potentially rich communicative aspects of this documentation.

*Purpose of phases used in each explanation*

An important aspect of this coding system is the classification of phrases and word groupings into three main types:

- **Related to resource concepts**
  These are explanations that are directly aligned with the text of the animated resource.

- **Self-reflective statements**
  These are statements used by the participant to communicate levels of
knowing, curiosity, and interest. These statement may also identify lack of alignment between what the participant knows and is learning.

- **Alternative concepts or analogies**
  These statements are beliefs held by the participant that may be contrary or supplementary to the animated resource

**Gesture overviews**
To gain an overview of the participants’ activities, videos of the groups were composited into large 1400x800 pixel QuickTime movies. Here is was possible to see that the gestures of the no white board group evolved over the three explanations, going from non-existent to arm-length gestures in the third explanation. During this exercise it was also found that a gesture-based approach at this early time would prove difficult as the visual comparisons between the white board group and the no white board group on the level of surface features is too broad to provide data-driven guidance towards further explorations. (*see appendix for sample gesture overviews*)

**Results**

**Overview**
The results of this study suggests that using a white board when explaining both known and newly acquired information is different than explaining the same information without a white board. This finding is demonstrated through the length of time the participants spoke, the number of words they spoke, and in the types of phrases they communicated. Additionally, it was found that a relationship between initial knowledge and the resource may impact what types of speech participants engage in.
While participants were instructed to spend three to five minutes explaining how cell phones work, it was found that individuals generally have an idea of how long they should take and stayed within a range of that time in all three explanations. The exception to this was found with participants who had a low match with the resource in their initial explanation. Overall, it was found that the group in the white board condition spent 70% more time on their explanations than the group who did not use the white board.
White board:
Length of time in seconds for each explanation

No white board:
Length of time in seconds for each explanation
Number of words spoken and words per second

To further quantify the participation by both groups, the words spoken in each explanation were counted. The white board group spoke a great deal more than the no white board group, but given that they also spoke for longer, it is worth noting that the no white board group spoke more words per second, likely reflecting that they were not involved in the drawing activities conducted by the white board group.
Number of word phrases associated with the animated resource, self-reflection or alternative concepts

Transcripts were coded for three types of information:

1. Associated with the animated resource
   This code includes any concept that reflects the information in the animated resource. In some cases, participants provided explanations in their first round which mapped to information in the resource.

2. Reflection on self and current understanding
   This code includes any self-oriented commentary of the participant. It also includes speech utilized for social and generally communicative purposes.

3. Alternative or additional concepts
   This code includes concepts regardless of “correctness” that the participant expresses that are related to cell phones but not reflected in the animated resource.
Of particular interest in the “Percentage of phrase types in explanations” graph are the following:

1. Participants rapidly adopt the terms and frameworks presented in the resource. From the first explanation to the second, the use of other concepts falls while the use of the resource references increases.

2. Self-reflective phrases in the second explanation cycle are significantly higher than self-reflective phrases in the no white board condition. This relationship first alluded to in the first explanation cycle remains true in the third as well.

3. The statements of the no white board condition increasingly focus on the content of the resources through the three explanation cycles.
The above graph on the previous page can be further broken down to enable consideration of each area:

![Graph of Percent time spent talking about concepts from resource](image1)

- **Percent time spent talking about concepts from resource**
  - Explain 1
  - Explain 2
  - Explain 3

![Graph of Percent time spent speaking reflectively about concept understanding](image2)

- **Percent time spent speaking reflectively about concept understanding**
  - Explain 1
  - Explain 2
  - Explain 3

![Graph of Percent time spent introducing other concepts or extending concepts of resource](image3)

- **Percent time spent introducing other concepts or extending concepts of resource**
  - Explain 1
  - Explain 2
  - Explain 3
A final finding of interest is the potential relationship between the animated resource and the participant’s initial explanation. It was found that a possible determinant of how much an individual talked about the resource in subsequent explanations was how much their initial explanation reflected the resource. In the case of the two participants, one from each group, whose initial explanations did not match the resource at all, their second explanations highly reflected the use of the resource, with the third explanation in both cases moved back down towards a balance of resource, self-reflection, and alternative concepts.
Discussion

While it was found that the white board group engaged in a higher proportion of self-reflective and alternative concept type speech, it is uncertain at this time that these activities yielded a deeper understanding of how cell phones work. It is possible that the additional exploration and reflection left the white board group more confused than before, whereas the no white board group, which moved further towards recitation of the animated resource may have less confusion as a result of the experience. The study design did not include any type of post test measures as the veracity of the cell phone model was not of primary importance. It may be possible, however, to further investigate the existing video and audio data for further clues as to the role both the resource and the explain conditions had on the conceptual integration of existing knowledge with new and somewhat incomprehensible new knowledge.

General Discussion

Does drawing while explaining improve understanding of newly introduced concepts or does it simply introduce different task demands? Watching the video footage of both groups, what came to mind was the differences between watching a news program and a cooking show. While the no white board group did gesture and move about more than those on the nightly news, they were relatively still and rigid, On the other hand, the group using the white board took on a more host-like and interpersonal approach to their explanations. Maybe a white board is simply something to do with your hands while you figure things out?

I am left with awareness that there are qualitatively different interactions going on, within both groups, and along the explanation continuum. I am interested in looking at more people engaged in activities such as explaining and I am interested in further developing a framework for comprehending the more complex phenomena this study presents.