Re-Design and Evaluation of an Anchored Discussion System

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Abstract

This paper investigates the re-design and evaluation of an existing anchored discussion system. The purpose of the re-design is to focus social construction of knowledge on relevant information from online academic texts. We developed three prototype software environments: teacher-based attention guidance, peer-oriented attention guidance, and control condition. The evaluation of the re-design involved a longitudinal quasi-experiment with two small groups of doctoral students. The control group had no access to attention guidance. Treatment group students initially received teacher guidance then switched to a peer scaffolded environment. Results show that teacher-based attention guidance helped treatment group students to select relevant information and discuss it with higher quality interaction patterns. Moreover, when treatment group students switched to peer-oriented attention guidance, they maintained focus on central domain principles and their interrelations. However, the socio-cognitive process for discussing the importance of candidate areas did not differ between peer-oriented attention guidance and control conditions.

1. Introduction

Collaborative learning (CL) offers an individual the possibility for a deep and active processing of a subject matter by participation in shared knowledge construction. A key element in the success of this popular educational approach is social interaction [1]. Social interaction is beneficial for achieving broader and deeper understanding of a topic [2]. This beneficial effect often arises when students articulate, reflect on, and negotiate different perspectives [3,4].

Computer supported collaborative learning (CSCL) environments can facilitate social construction of knowledge by stimulating learners to externalize and discuss different viewpoints [5]. An annotation-based asynchronous discussion system is one valuable CSCL environment, which can support and enhance social interactions. These systems are sometimes referred to as anchored discussions because messages are not only organized chronologically, but are also clearly linked to a specific content element within the learning material [6, 7]. Many experimental studies provide compelling empirical evidence that the interaction-oriented design of anchored discussions can improve students’ collaborative processing of academic texts. For example, Guzdial and Turns [6] showed that anchored discussions stimulate sustained on-topic learning conversations. Brush, Barger, Grudin, Borning, and Gupta [7] obtained similar results and further demonstrated that anchored discussions promote focused messages. Next, Suthers [8] reported on the design of a “linked artifact-centered discourse” system that supports construction of a shared context. Further, Mühlpfordt and Wessner [9] found that shared context helps learners to reciprocally ensure and keep track of the mutual understanding in an ongoing discussion. Finally, premised on the concept of mutual understanding, Van der Pol, Admiraal, and Simons [10] indicated that anchored discussions afford more efficient and meaning-oriented collaboration.

Despite the positive results obtained by these previous studies, there are still many issues concerning collaborative processing of academic texts with anchored discussions. A pressing issue, as stressed by Peters and Hewitt [11], is that students may not engage in discussions that deal with important points such as understanding of central domain concepts, principles, and their interrelations. The factors that give rise to this issue are twofold. First, the possibility of annotating every detail in the learning material can distract students’ attention from engaging in social construction of knowledge focusing on relevant information [12]. Second, there is consistent evidence that students with low domain-specific prior knowledge require instructional support in differentiating relevant from irrelevant information (for a review see [13]). Therefore, it is still unclear how best to use anchored discussion systems to help facilitate online collaborative text comprehension.

To address the issue at hand, this paper describes re-design and evaluation of an anchored discussion system. The purpose of the re-design is to focus social construction of knowledge on relevant information from academic texts. We propose that attention-guiding cues in an anchored discussion system will help students to identify and collaboratively process relevant information with higher quality interaction patterns. The evaluation of the re-design involves a
longitudinal quasi-experiment that uses two small groups of first year doctoral students studying learning and pedagogical theories for fifteen weeks.

The paper proceeds as follows. Section two presents a theoretical framework based on attention guidance in social construction of knowledge. Section three explains the re-design of an anchored discussion system. Section four focuses on research questions and hypotheses. Section five describes the methodology of this research to evaluate if the attention-guiding cues in an anchored discussion system support and enhance collaborative processing of academic texts. Section six provides the main results. Section seven discusses the findings and draws conclusions.

2. Theoretical Framework

The epistemological position in our study is that social interaction provides an opportunity to articulate and perhaps to modify one’s own ideas in response to feedback from other members of a learning group. Two theoretical stances that were introduced by Mayer and colleagues [e.g., 14] serve as the underpinning of this epistemological position: active responding and active processing. The first stance, active responding, holds that students obtain deeper understanding through socially-mediated activities, which they may not obtain alone [15]. For example, students can ask questions to monitor their comprehension [16], elaborate already stated ideas to enhance knowledge construction [17], and negotiate different viewpoints to develop a shared understanding [18]. The second stance, active processing, highlights that these socially-mediated activities help learning if they lead to higher level cognitive processing of the learning contents. Therefore, the active processing stance argues that it is not the activities per se that foster learning but the cognitive processes that can be elicited by the social interaction (see [19] for an overview of research findings from cognitive and educational psychology).

However, the potential of social interaction for students with low domain-specific prior knowledge depends on how well they are able to process essential information. According to Renkl and Atkinson [20], the possibility of processing every detail including irrelevant information and seductive details (see Garner, Gillingham, and White, [21]) can direct students’ attention away from central domain concepts, principles, and their interrelations. Drawing on this perspective, Mandl, Gruber, and Renkl [22] found that students have a tendency to lose focus and acquire “malprioritized concepts” when they participate in social interaction. Consistent with this notion, Kalyuga [23] maintained that active but unfocused processing can reduce the benefits of social interaction in knowledge construction. Under such conditions, students may perceive and comprehend information from irrelevant parts of a text, resulting in poor learning and performance. This is especially important when the research on the effects of collaborative learning is highly inconclusive [4] because deciding which parts of a text contain relevant information and thus deserve attention may prevent students with low domain-specific prior knowledge from engaging in learning-related activities. Against this background, Wittwer and Renkl [24] make the point that social interaction should not only elicit active processing of learning contents but also focus attention on important topics.

Attention-guiding cues can focus students’ attention on specific parts of complex learning material in order to support social construction of knowledge. We consider attention-guiding cues as visual stimuli that capture attention in an involuntary or obligatory fashion without adding extra content information. Recent studies have shown that attention guidance helps students to process the central aspects of the learning materials [25, 26]. This suggests that attention guidance may have important effects on social interaction during collaborative text comprehension. But, for this to happen, attention-guiding cues have to be carefully designed to minimize the demand on students’ visual search processes. To move towards this direction, the following section will explain the re-design of an anchored discussion system.

3. Re-Design of an Anchored Discussion System

We developed three prototype software environments by re-designing Van der Pol et al.’s annotation tool [10]. We specifically chose to re-design this tool because it has a user-friendly interface that provides a tight coupling between the learning material and its related discourse [e.g., 27, 28, 29]. All three of the prototypes are tailored towards fine-grained annotation of HTML pages through an annotation bar to the right of the learning material. Furthermore, annotations serve as anchors for threaded discussions by making use of the structural information of a page, such as page number and text selection range. Therefore, all three prototypes have the advantage of making it easier to annotate a document then connect each annotation with its related discussion. The main difference among the three prototypes is the nature of their attention-guiding cues.
3.1. Control Software Environment

The first prototype (Figure 1) has three new functional characteristics compared to the original annotation tool. The first two functional characteristics aim to further strengthen the link between annotated text and discussion. More specifically, the first functional characteristic lights up both the annotated text and corresponding portion of the discussion in red when either element is under the mouse cursor. The second functional characteristic embeds the key idea for making an annotation directly in the relevant context that elicited it by inserting a sticky message. In order to prevent the learning material from becoming cluttered with students’ key ideas, we designed sticky messages to appear only under the mouse cursor. The main idea behind the third functionality is to help students externalize their thoughts by using the terms from the learning material. Therefore, the third functionality allows students to copy the terms from an annotated text and paste them into their contributions.

This prototype serves as the control condition because it does not support attention-guiding cues.

3.2. Teacher-Based Attention Guidance Software Environment

The second prototype (Figure 2) includes a teacher interface for attention-guiding cues. In the teacher interface, the teacher can dynamically give attention-guiding cues based on the class learning objectives by using the importance bar to the left of the learning material. The importance bar works by increasing the font size of the selected text from the learning material. Font size as demonstrated in tag cloud design science research is an effective visual property to capture attention [e.g., 30]. From this perspective, the second prototype represents the importance of each sentence with a corresponding font size. There are two different font sizes in the second prototype: default and big. On the one hand, the default font size (10px) represents the medium level of importance. On the other hand, the big font size represents a high level of importance determined by the teacher. In order to determine which big font size captures attention in an involuntary or obligatory fashion, we created several font sizes ranging from 10px to 25px. We did not go above 25px because of the limited size of the frame that displays the learning material. We asked pilot study participants to choose the font size that exerted the most visual influence on their attention guidance. Based on their input, we set the big font to be 150% larger than the default font size.

3.3. Peer-Oriented Attention Guidance Software Environment

The third prototype (Figure 3) extends the importance bar functionality to the students in order to collaboratively decide pivotal points for discussion. This difference points to a scaffold role rotation from teacher to peers, in which students receive the benefit of additional points of view, but must also compensate for the loss of the teacher’s authoritative voice by more carefully assessing their peers’ responses. The importance bar works in the same manner as the second prototype, except that there are now two big font sizes: big and bigger. The big font size allows a student to capture peer attention on candidate important areas. The primary concept behind the...
bigger font size is to show peer consensus on salient facts about a document. When a peer student selects a sentence or sets of sentences already marked with the bigger font size and clicks on the importance bar, the corresponding part of a text is marked with the bigger font size. In order to be consistent with the font size, we set the bigger font size to be 150% larger than the big font size. Due to the limited size of the frame that displays the learning material, we did not go above the bigger font size. However, we recorded the number of times that students clicked on the importance bar for a portion of a text that already had the bigger font size. It is also worth noting that we designed the system in a manner that prevented the same student from marking a portion of a text repeatedly and thus artificially inflating its importance. We took this approach to eliminate the potential for a single student to bias the group’s consensus on important areas.

4. Research Questions and Hypotheses

To date, research has not focused systematically on examining collaborative processing of academic texts with appropriate attention-guiding cues. Therefore, it is unclear to what extent students’ annotations focus on important points. Furthermore, there has been little experimental research on the ways students collaboratively discuss important points in a text. Taking into account the aforementioned considerations, the goal of this study is to investigate the value of attention-guiding cues on collaborative text comprehension. Based on the above goal, this study focuses on the following two research questions and their accompanying hypotheses:

I. What are the effects of teacher-based attention-guiding cues on social construction of knowledge in online interactions?

An important starting point in social construction of knowledge is to select relevant information. When dealing with complex learning material, this cognitive process is guided partially by domain-specific prior knowledge and partially by instructional methods embedded in the learning environment. Research has shown that students with low domain-specific prior knowledge are less likely to differentiate relevant from irrelevant information [13, 31]. This implies that students may not be allocating the greater proportion of their attention to essential information. This could be problematic, as students may miss information necessary to understand central concepts, principles, and their interrelations. Being able to see teacher-based attention-guiding cues in a persistent medium has the potential to facilitate the cognitive process of selecting relevant information. From the attention-guiding perspective, a substantial number of studies have found that visual cueing is an effective method to guide the search for specific information and to simplify decisions students have to make about which information is relevant [14,26,27]. This leads to the first hypothesis.

H1a: Teacher-based attention guiding cues will increase the number of student annotations on relevant information from academic texts.

The success of social knowledge construction depends upon forming a focused and coherent discourse. However, online discussions in general tend to branch into many parallel conversations, not all of which necessarily focus on what is relevant in a text [e.g., 11]. This makes it difficult to decide which ideas are important to further develop in order to gain a deeper understanding of the learning material. In fact, messages focusing on relevant information must compete for students’ attention against a potentially larger number of messages focusing on irrelevant information or seductive details, a challenge commonly referred to as split attention. Assuming that the number of replies students are willing or able to post is limited, split attention may undermine the educational value of interactions between students during collaboration [32]. One strategy to overcome this challenge is to inform all students about salient topics in a text [6]. We think that displaying teacher-based attention-guiding cues in a visually prominent manner can foster coherent discourse focused on relevant information because attention guidance has been shown to enhance communication among group members [33]. This leads to the following hypothesis:

H1b: Teacher-based attention guiding cues will increase the number of student annotations on relevant information from academic texts.
**H1b:** Teacher-based attention guiding cues will facilitate higher quality interaction patterns focusing on relevant information from academic texts.

**II.** Will students continue to carry out discussions on relevant information when they switch from a teacher-based attention guidance software environment to one which is peer-oriented?

The underlying assumption of the foregoing argumentation is that an expert’s hints can support students with low domain-specific prior knowledge to identify and collaboratively process key information from complex learning material. As students become more capable in differentiating relevant from irrelevant information, they may no longer need this support; therefore, the support itself may be removed. This type of support has been identified in CSCL literature as scaffolding [34]. An important aspect of scaffolding is the ongoing diagnosis of students’ abilities that leads to a careful calibration of support. This requires the software system to change over time as its users become more competent. Replacing the teacher-based attention guidance software environment with the peer attention guidance software environment is one way to accomplish this calibration. We suggest that if students receive help to internalize the tasks that they are trying to accomplish, they can function independently as a small group in constructing a shared understanding of the essential information from the learning material. Thus, we hypothesize:

**H2:** Students will continue to carry out discussions on relevant information when they switch from a teacher-based to a peer-oriented attention guidance software environment.

**5. Method**

The evaluation included two stages: a) pilot study – conducted to determine which big font size captured student attention in an involuntary or obligatory fashion, b) main study to answer the research questions. Participants in the pilot study were eight first year doctoral students enrolled in a blended-format Principles of Information Systems and Technology Research seminar. One of the learning goals in this seminar was to introduce students to the community of information systems and technology research, its participants, the topics they investigate, and the approaches they use. Six discussion themes were run consecutively through the Fall 2010 semester for a period of one week each. These discussion themes were mediated by the teacher-based attention guidance software environment. Each theme reflected a specific research article from the Management Information Systems Quarterly journal. The main researcher conducted face-to-face interviews and adjusted the big font size at the end of each discussion theme. According to these interviews, students processed the parts of a text with 150% larger font size first, even if those parts were no more likely to be important than any other part.

The main study was a longitudinal quasi-experiment with a treatment and a control group. We had no reason to expect initially relevant difference between the groups. Control group students had no access to attention guiding cues. The longitudinal nature of the study allowed researchers to calibrate the attention guidance support for treatment group students based on an ongoing diagnosis. This allowed us to switch the treatment group students from a teacher-based to a peer-oriented attention guidance condition in order to test H2. Participants were first year doctoral students from two sections of a blended-format seminar in Learning and Pedagogical Theories. The seminar took place in the Spring 2011 semester. The total sample consisted of 24 students (12 per section). During the experiment, the participating students read six consecutive chapters from the Constructivist Instruction: Success or Failure book and discussed them online. Each chapter was covered in a two-week online discussion round. Participation in the online discussions was compulsory for all students. The minimum participation requirement was to post two messages per chapter and respond to at least two fellow students’ messages for that chapter. When using the peer attention guidance software environment, every student in the treatment group was additionally asked to use the importance bar at least once in order to collaboratively decide important areas for discussion. The main data included the transcripts of 12 electronic discussions. We describe below the methods of analyses used to answer the research questions.

**5.1. Analysis of Selecting Relevant Information**

Annotations as pointed out by Yeh and Lo [35] provide a clear indicator of where students’ focus their attention in the learning material. To examine whether attention guiding cues support selecting relevant information from academic texts, we counted the number of times students annotated relevant information at the end of each two-week online discussion round. For the analysis of the teacher-based attention guiding cues, we selected the first five discussion themes. We depicted graphically the trends found over the course of these discussion themes for
each group. The total number of annotations focusing on relevant information reflected the sample size within each group. Means demonstrated the average number of student made annotation on relevant information. Standard deviation is used to measure heterogeneity of differentiating relevant from irrelevant information. Difference between teacher-based attention guiding cues and control condition is analyzed using an independent $t$-test (two-tailed). Based on the $t$-value for the difference between the means of two independent samples, the last discussion theme is chosen to assess whether treatment group students maintain focus on relevant information when they switch to peer attention guidance.

5.2. Analysis of Discussing Relevant Information

Peer discourse interaction analysis on relevant information comprised two phases: quantitative content analysis for extracting meaning from individual students’ statements (micro level) and sequential analysis for describing interaction patterns during group discourse (macro level). We adopted a coding schema concerning collaborative knowledge building developed by Li and Huang [37]. The unit of content analysis was each complete message posted in the asynchronous online discussion. This choice allowed the coders to work with the unit, as it had been defined by the author of the message. Messages were coded as sharing, questioning, elaborating, negotiating, or producing. Sharing involved presenting initial individual interpretation of the learning material to other group members. Questioning facilitated the discovery and exploration of dissonance or inconsistency among ideas, concepts, or statements. Elaborating meant expanding ideas from earlier in the discussion. Negotiating specified comparing and contrasting different perspectives for a deeper understanding of the learning material. Producing entailed proposing new ideas or explanations on topics where differences in perspectives existed.

Although content analysis sheds light on the quality of isolated individual messages, it does not allow us to understand how social interaction can yield co-creation of knowledge. Therefore, we examined how messages within a discussion thread focusing on relevant information relate to one another. Sequential analysis was carried out on the coded data via the Discussion Analysis Tool (DAT) [32]. Every message and its replies form a unit of interaction in DAT. There are two assumptions behind this rationale. First, meaning does not reside in any one message. Second, meaning emerges from examining the relationship between inherently interconnected messages that dynamically affect one another. Based on these assumptions, DAT offers two metrics to analyze and identify patterns in message-response sequences. The first metric, transitional state diagram, provides a picture of the overall structure or flow of the group discourse and how individuals contribute to this structure or flow. DAT calculates transitional probabilities by tallying the frequency of responses for each message type. In the diagram, darker lines represent interactions that are most likely to occur. The second metric, mean response scores, determines how many times a given type of message is able to elicit a particular type of response. By using mean scores, statistical methods like $t$-tests can be computed to determine to what extent the observed differences between experimental and control conditions are reliable.

6. Results

The presentation of the results is organized in three main parts, each corresponding to a hypothesis tested in our study. First, we present the effect of teacher-based attention guiding cues on selecting relevant information from academic texts. Thereafter, we show the coding of students’ communicative activities and the flow of each group’s discourse focusing on the relevant information. Finally, we present treatment group’s communicative activities after they switch from a teacher-based to peer-oriented attention guidance software environment.

6.1. Selecting Relevant Information

With regard to H1a, we examined the trends in selecting relevant information by counting the number of students’ annotations over the duration of five consecutive discussions. We computed the percentage of annotations focusing on relevant information as a proportion of the total number of annotations for each discussion. Table 1 summarizes the differences in selecting relevant information between the teacher-based attention guiding cues and no cues. On the one hand, there were a total of 71 student annotations in the teacher-based attention guidance software environment. The number of annotations focusing on important areas ranged from 7 to 14 per discussion, with a mean of 10.4 and standard deviation of 2.70. On the other hand, control software environment had 82 student annotations in total. The number of annotations on important areas ranged from 3 to 8 per discussion, with a mean of 5.8 and standard deviation 1.92. See Table 1 for details.
Table 1. Results of Student Annotations

<table>
<thead>
<tr>
<th>Condition</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher-Based Attention Guidance</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Software Environment</td>
<td></td>
</tr>
<tr>
<td>Number of Annotations on Important Areas</td>
<td>9 12 10 7 14</td>
</tr>
<tr>
<td>All Annotations per Discussion</td>
<td>14 17 12 9 19</td>
</tr>
<tr>
<td>Percentage of Annotations on Important Areas</td>
<td>0.64 0.70 0.83 0.78 0.74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control Software Environment</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Annotations on Important Areas</td>
<td>3 8 6 5 7</td>
</tr>
<tr>
<td>All Annotations per Discussion</td>
<td>9 19 17 16 21</td>
</tr>
<tr>
<td>Percentage of Annotations on Important Areas</td>
<td>0.33 0.42 0.35 0.31 0.33</td>
</tr>
</tbody>
</table>

Figure 4, based on data from Table 1, shows the trends for selecting relevant information. Observing Figure 4, we can see that, when students received teacher-based attention guiding cues, they made more annotations on important areas. Specifically, there was an increase in the percentage of annotations on important areas from discussion 1 to discussion 3 for treatment group students. In contrast, control group students decreased the percentage of their annotations on important areas from discussion 2 to discussion 4. Consistently, during discussion 5, both groups more or less maintained the percentage of their annotations on important areas from discussion 4. This can be interpreted as students’ ability to select relevant information from assigned chapter readings reached a stable state in discussion 5. We analyzed the difference between the trends by comparing two groups’ mean scores for selecting important areas. An independent sample t-test yielded a significant difference for selecting relevant information in favor of H1a, $t(79) = 8.09, p < 0.001$.

6.2. Discussing Relevant Information

With regard to H1b, the results of the analysis incorporate two parts: classifying individual messages and examining how messages within a sequence are related to one another. The data set for testing H1b was the transcripts of the five discussions as mentioned above. Two trained coders independently coded a total of 364 messages and then came together to discuss discrepancies. Because of the potential for ambiguity in applying the coding scheme, 10% of the discourse data was used for training the two coders. The inter-coder reliability (agreement) was 83%, indicating that the content analysis was adequately reliable. Table 2 lists the content of the messages based on the categorization of each message.

Table 2. Content Analysis of Five Discussions

<table>
<thead>
<tr>
<th>Knowledge Category</th>
<th>Teacher-Based Attention Guidance Software Environment</th>
<th>Control Software Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>Sharing</td>
<td>66</td>
<td>38</td>
</tr>
<tr>
<td>Questioning</td>
<td>52</td>
<td>30</td>
</tr>
<tr>
<td>Elaborating</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>Negotiating</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Producing</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>174</td>
<td>100</td>
</tr>
</tbody>
</table>

Students in the control condition shared more information than those in the treatment condition ($Z = 3.50, p < 0.01$). There was no significant difference in the frequency of questions between the groups ($Z = 0.25, p > 0.05$). Further, students who received teacher-based attention guiding cues contributed more elaboration and negotiation messages to the discourse ($Z = 2.02, p < 0.05, Z = 2.575, p < 0.01$, respectively). Finally, regardless of the condition, there was no
significant difference in the frequency of production messages ($Z = 0.2, p > 0.05$).

Since sequential analysis focuses on observing the sequence of consecutive messages, we calculated the frequency of each message category immediately following another message category. Transitional state diagrams as pictured in Figure 5 and 6 are visual illustrations of the flow of discourse from each group where the circles show different codes from the discussion and the arrows depict the transitional probabilities between codes. In these diagrams, thicker arrows represent interactions that were more likely to occur. On the one hand, the diagram for the teacher-based attention guidance software environment indicates that sharing information was most often followed by elaboration of that information which was then followed by questions. Moreover, questions often elicited negotiations. Finally, responses to negotiations were most likely to be categorized as production of new ideas on topics where differences in perspectives existed.

On the other hand, the diagram for the control software environment indicates that sharing of information elicited more information and questions but fewer elaborations. Furthermore, elaborations were often followed by questions which rarely led to negotiations. The relationship between negotiations and production of new ideas was consistent with the teacher-based attention guidance software environment. However, it is worth noting that “producing” was rarely coded in both conditions. Table 3 provides mean response scores for a closer examination of the differences between the transitional state diagrams. We found significant differences in the mean number of elaboration replies to information sharing, $\tau(137) = 2.56, p < 0.05$. In addition, the mean number of negotiations posted in reply to questions was significantly different, $t(84) = 2.76, p < 0.01$. These results support H1b.

### 6.3. Switching from Teacher-Based to Peer-Oriented Attention Guidance

With regard to H2, we first tested the effect of peer-oriented attention guidance on selecting relevant information. During the last discussion, 11 of the 16 student annotations in the peer-oriented attention guidance condition focused on teacher-determined important areas, compared to 6 of 21 student annotations in the control condition. See Discussion 6 in Figure 4 for details. A $z$-test for two proportions indicated a significant difference between the two conditions ($Z = 2.10, p < 0.05$). Follow-up analyses investigated both the proportion of specific message types and the transitional probabilities. In the last discussion, there were 61 messages (39 for the peer-attention guidance condition and 22 for the control
condition). There were no significant differences between the two conditions concerning either the proportion of specific message types or sequential relationships. These results partially confirm H2.

7. Conclusion

The purpose of the present study was to examine the value of two types of attention-guiding cues on collaborative text comprehension. According to this purpose, we developed three prototype software environments by re-using the most crucial design insights of Van der Pol et al. ’s annotation tool [10]. In a longitudinal quasi experiment, we compared teacher based and peer-oriented attention guidance conditions with a control condition. The results obtained confirm H1a, as teacher-based attention guiding cues increased the number of student annotations on relevant information. Specifically, the findings provide evidence that expert-based visual cueing is one way to direct novice students’ attention to central domain principles in a text. This result is consistent with the attention-guiding perspective that emphasizes the difficulty and potentially high extraneous cognitive load of selecting relevant information from complex learning materials [25]. For the discussion building on expert cued areas, we found higher quality interaction patterns. This result confirms H1b, which was proposed according to the notion of split student attention between messages focusing on relevant and irrelevant information. H2 proposed that treatment group students would carry out discussions on relevant information after they switched to peer-oriented visual cueing. Although we found that these students maintained their attention on central domain principles, we found no evidence of a socio-cognitive process for negotiating the importance of candidate areas. Perhaps a longer period of time would be necessary to test H2 further. Therefore, our future study will examine the effects of peer-oriented attention guidance during a longer period in which students collaborate on a complex learning task. In sum, these promising results demonstrate that incorporating teacher- and peer-scaffolded anchored discussions into existing course management systems can have very significant impact on students’ online learning conversations.

8. References


