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UNCERTAINTY-REDUCING COOPERATION SCRIPTS IN ONLINE LEARNING ENVIRONMENTS

Abstract. Online learning courses can create new interaction situations for participants who have not previously worked with each other. Initially, there is some degree of uncertainty between participants in these interaction situations. According to the uncertainty reduction theory, low uncertainty increases the amount of discourse and decreases information seeking. Thus, uncertainty may influence online discourse and learning. However, the relation of uncertainty reduction to learning outcomes has not yet been investigated systematically. Cooperation scripts may reduce uncertainty, and therefore enhance learning. A cooperation script, which aims to reduce uncertainty at a cognitive level, was chosen for this study. The participants were 48 students in their first semester of Educational Sciences and they were randomly grouped into triads. The amount of discourse, information seeking and individual learning outcomes in two conditions (with uncertainty-reducing script and without uncertainty-reducing script) were investigated. The results indicate that the uncertainty-reducing script in fact increased the amount of discourse and decreased information seeking activities. The results revealed, however, that the unscripted and more uncertain condition led to better learning outcomes. These results are discussed against the background of the uncertainty reduction theory.

1. INTRODUCTION

People participating in online learning courses do not necessarily know each other and are not sure how to act in these new learning environments. In any initial interaction situation there is some degree of uncertainty (Berger & Bradac, 1985; Berger & Calabrese, 1975). A previous study (Mäkitalo, Pöysä, & Häkkinen, 2003) shows that uncertainty occurs when participants are not sure how others are feeling, reacting and thinking in online interaction situations. Immediate feedback and non-verbal cues are missing in online discourse (e.g., Järvelä & Häkkinen, 2002; Rochelle & Pea, 1999) which can increase uncertainty between participants. Uncertainty can appear at least at two different levels: at the socio-emotional and at the cognitive level (Mäkitalo et al., 2003). At the socio-emotional level uncertainty can occur, for example, when participants do not get immediate feedback on how others are reacting to their messages, whether they agree or disagree with one's suggestions. At the cognitive level, then again, participants might be uncertain about the content of their contributions: Are their contributions relevant in terms of the issue and with respect to other messages? Do the learning partners understand the content of the message?

In this paper, our aim is to investigate the phenomenon of uncertainty in discourses of online learning environments with the help of the uncertainty reduction theory (Berger & Bradac, 1985). The important point of this theory is that a high degree of uncertainty might hinder the participants to communicate effectively with each other with respect to attaining shared goals, e.g., solving a problem together. In the field of communication science, Berger and his colleagues (Berger & Bradac, 1985; Berger & Calabrese, 1975) have developed the uncertainty

reduction theory, seeking to explain how uncertainty affects communication in relationships. The important components of this theory, which we are applying to online learning, are (1) uncertainty, (2) the amount of discourse and, (3) information seeking. Berger and his colleagues indicate that as the amount of verbal communication in initial interaction situations increases, the level of uncertainty decreases. Further, as uncertainty is reduced, the amount of verbal communication increases. They also point out that information-seeking behaviour is increased in highly uncertain situations. As uncertainty declines, information-seeking behaviour decreases (Berger & Bradac, 1985; Berger & Calabrese, 1975).

In online learning environments, specific forms of discourse are considered important for learning. Not just any kind of discourse, but specifically the kind of discourse where participants ask certain types of questions, evaluate suggestions, elaborate explanations, hypothesise and summarise the on-going discourse, is seen to be effective for individual learning (King, 1999). On the one hand, uncertainty promotes uncertainty reduction strategies, e.g., information seeking, which might enhance learning. The uncertainty reduction theory states that uncertainty-reducing interactions enable participants to communicate more effectively with others and help to achieve shared interaction goals (Berger & Bradac, 1985). On the other hand, low uncertainty levels increase the amount of discourse, which might also promote learning (e.g., Cohen, 1994; Jeong & Chi, 1997; Rochelle, 1992). With respect to learning, we are applying the uncertainty reduction theory to explore interaction with uncertainty-reducing cooperation scripts.

Cooperation scripts have been considered as facilitators of collaborative learning activities (O'Donnell, 1999). Scripts can specify, sequence and assign collaborative learning activities in online learning environments (Kollar, Fischer, & Hesse, 2003; Weinberger, 2003). A script may, for instance, provide collaborative learners with a strategy to solve the task and may thus reduce uncertainty. On the basis laid by Berger and colleagues (Berger & Bradac, 1985; Berger & Calabrese, 1975), we assume that uncertainty declines at the cognitive level when the degrees of freedom decrease with respect to the necessary steps or concepts in problem solving processes. By scripting cooperation, we could reduce the number of alternative sub-task solutions in online learning environments, which should decrease uncertainty and therefore increase the amount of discourse and promote learning. In this case, the focus is on the cognitive level of uncertainty. Reducing the number of alternatives on the cognitive level by scripting we expect that participants would focus on the topic and therefore be able to reach a high quantity and quality of discourse which also should promote individual learning.

2. AIM OF THIS STUDY

In this study we test the following hypotheses:

The amount of discourse hypothesis

H1: The uncertainty-reducing script increases the amount of discourse.

According to previous studies, increased discourse improves learning. Berger and colleagues point out that when the number of alternatives increases, also uncertainty

UNCERTAINTY-REDUCING COOPERATION SCRIPTS

increases. Inversely, reducing the number of alternatives will decrease uncertainty. Based on these claims we are assuming that it is possible to reduce uncertainty by a specific task strategy, and therefore we expect higher amounts of discourse.

Information seeking hypothesis

H2: The uncertainty-reducing script decreases information seeking.

According to the uncertainty reduction theory, low uncertainty decreases information seeking. Berger and Bradac (1985) assume that in highly uncertain situations participants are seeking more information about the others. We, therefore, expect the uncertainty-reducing script to lessen information seeking.

The next two hypotheses focus on the effects of uncertainty with respect to the individual learning outcomes.

Effects of an uncertainty-reducing script on individual learning outcomes

Information seeking and individual learning outcomes hypothesis

H3a: Uncertainty should lead to uncertainty reduction activities, e.g., information seeking, and this is related to better learning outcomes.

For example, asking specific questions is believed to foster collaborative activities and therefore enhance learning (King, 1999).

Amount of discourse and individual learning outcomes hypothesis

H3b: The uncertainty-reducing script should lead to a higher amount of discourse and this is related to better learning outcomes.

This hypothesis is based on the assumption that the amount of discourse correlates positively with learning (e.g., Cohen, 1994). According to Berger and colleagues, when uncertainty decreases, interaction increases. They also suggest that when uncertainty level is low, interaction becomes more effective between participants.

3. METHOD

3.1. Participants

The participants of this study were 48 students in their first semester of Educational Sciences in an introductory course. The students were randomly grouped into triads ($n=16$) and each group was randomly assigned to one of the two experimental conditions. The first experimental condition was the uncertainty-reducing *script* condition. The second experimental condition was the *unscripted* uncertainty condition. Time-on-task was held constant in both conditions.

3.2. Learning environments in two experimental conditions

Students worked together by applying theoretical concepts of Weiner's attribution theory (1985) to problems, which were presented in the online environment. These three authentic cases were the central elements in the online learning environment. At first, students analysed the problems by writing their own initial analysis. Then they discussed about the analysis via online discussion boards within the group of three students, and at the end they wrote their own final analysis. In the online environment there were three online discussion boards, one for each problem. The

collaborative learning session lasted for 80 minutes. In the unscripted uncertainty condition students were not provided any support to solve the three cases. In the uncertainty-reducing script condition, participants were guided to apply theoretical concepts to problems with the help of prompts (see Figure 1). The prompts were aimed to support the participants' identification of the relevant problem information and adoption of the concepts of the attribution theory to problem information. These prompts included questions and proposals for pedagogical interference regarding the problem.

Case information, which can be explained with the attribution theory

Relevant terms of the attribution theory for this case:

- Does a success or a failure precede this attribution?
- Is the attribution located internally or externally?
- Is the cause for the attribution stable or variable?
- Does the concerned person attribute himself/herself or does another person attribute him/her?

Prognosis and consequences from the perspective of the attribution theory:

Case information which cannot be explained with the attribution theory:

Figure 1. Prompts of the uncertainty-reducing script to apply the concepts of Weiner's (1985) attribution theory to the problem cases.

3.3. Procedure

Students were placed in three separate rooms and they were communicating via the online learning environment. First of all, the students' prior knowledge was tested individually by means of a problem case. This test was used to control randomisation. Second, the students were given 20 minutes to read the text about Weiner's (1985) attribution theory. Third, the online learning environment was shortly introduced to the students. Fourth, an 80-minute collaboration phase started. At the end of the session the students took a post-test based on another problem case measuring their knowledge.

3.4. Data sources and instruments

The written discussion data consisted of the 16 groups' discussions (including three problem solving cases) from eight groups of two different conditions. Two coders reached an acceptable agreement in identifying the units of analysis (87%). The data was aggregated and analysed at the group level. We used word counts in order to measure the amount of discourse. Information seeking was analysed with the help of the 'Coding system of a multi-level analysis of knowledge co-construction'

UNCERTAINTY-REDUCING COOPERATION SCRIPTS

(Weinberger, Fischer, & Mandl, 2002). The post-test based on a problem case measured individual learning outcomes. Applicable knowledge was measured with the amount of adequate relations between theoretical concepts and case information. The effects were tested with a t-test for unpaired samples for statistical significance.

4. RESULTS

Next, we present the main results based on the proposed hypotheses. Table 1 shows the absolute numbers with respect to the amount of discourse, information seeking, and individual learning outcomes.

The amount of discourse hypothesis

H1: The uncertainty-reducing script increases the amount of discourse.

The amount of discourse was higher in the uncertainty-reducing script condition than in the unscripted condition (see Table 1). A t-test revealed a significant main effect for the uncertainty-reducing script ($t(14)=-2.67$; $p<.05$). The results indicate that the uncertainty-reducing script increased the amount of discourse, and therefore the results support this hypothesis.

Table 1. Means and standard deviations for the amount of discourse, information seeking, and individual learning outcomes for the unscripted and scripted groups

<i>Variables</i>	<i>Groups</i>	<i>Unscripted</i>	<i>Scripted</i>
		<i>M (SD)</i>	<i>M (SD)</i>
Amount of discourse		17.44 (4.95)	24.85 (6.10)
Information seeking		6.75 (5.85)	3.00 (3.38)
Individual learning outcomes		10.75 (6.20)	5.00 (2.00)

Information seeking hypothesis

H2: The uncertainty-reducing script condition decreases information seeking.

The results show that learners sought information in the uncertainty-reducing script condition less often than in the unscripted uncertainty condition. These results support the hypothesis; the information seeking scores should be lower in the uncertainty-reducing script condition (see Table 1). A t-test revealed a marginally significant main effect of the uncertainty-reducing script ($t(14)=1.57$; $p<.10$).

Effects of an uncertain-reducing script on individual learning outcomes

There were significant differences between the learning outcomes in the unscripted uncertainty condition compared to the uncertainty-reducing script condition ($t(14)=2.50$; $p<.05$). The results show that individual learning outcomes reached higher scores in the unscripted uncertainty condition than in the uncertainty-reducing script condition (see Table 1). These results seem to support the hypothesis, which indicates that uncertainty leads participants to use uncertainty reduction activities, e.g., information seeking, and therefore lead to better learning outcomes.

Information seeking and individual learning outcomes hypothesis

H3a: Uncertainty should lead to uncertainty reduction activities, e.g., information seeking and this is related to better learning outcomes.

The results support this hypothesis. High uncertainty increases information seeking and the results also reveal that the unscripted uncertainty condition leads to better learning outcomes than the uncertainty-reducing script condition.

Amount of discourse and individual learning outcomes hypothesis

H3b: The uncertainty-reducing script should lead to higher amount of discourse and this is related to better learning outcomes.

The results show that the uncertainty-reducing script increases the amount of discourse, but the results also show that the scores for individual learning outcomes were lower in the uncertainty-reducing script condition than in the unscripted uncertainty condition. Therefore, the results do not support the hypothesis that high amount of discourse would be connected to better learning outcomes.

5. CONCLUSION

The first hypothesis concerning the amount of discourse is supported by the results. The amount of discourse increased in the uncertainty-reducing script condition as was suggested by the uncertainty reduction theory. Also the second hypothesis was supported by the results. Information seeking decreased in the uncertainty-reducing script condition. With respect to individual learning outcomes, the results support the hypothesis which claims that uncertainty should lead to uncertainty reduction activities, e.g., information seeking, and therefore to better learning outcomes.

The results of the first and the second hypotheses are supporting the ideas of the uncertainty reduction theory. According to the uncertainty reduction theory, low degrees of freedom with respect to the necessary steps or concepts in problem solving processes will decrease uncertainty, which fosters high amount of discourse. The uncertainty reduction theory also states that a high uncertainty level leads the participants to use uncertainty reduction activities such as information seeking in order to reduce uncertainty. Based on the results, we can assume that by using the uncertainty-reducing scripts, designers can influence discussions that will more easily take place in online learning environments (e.g. Suthers, Hundhausen, & Girardeau, 2003).

The results concerning individual learning outcomes indicate that the students who worked in the unscripted uncertainty condition had better learning outcomes. This does not support the idea that the amount of discourse would be closely connected to better learning outcomes. Apparently, the quality of discourse is more important than it's quantity with respect to learning outcomes. This seems to include that discourse should provide for some degree of uncertainty, in order to facilitate specific critical interactions, such as information seeking. In the uncertainty-reducing script condition participants may have been too certain about the quality of their contributions. According to Cobb (1995), interaction should be multivocal, containing more than one perspective in order to reach an effective level of interaction (e.g., Clark, 2000). It might also be that the prompts used in the scripted conditions constrain too much the students' degree of freedom to participate into

UNCERTAINTY-REDUCING COOPERATION SCRIPTS

discourse (e.g. Sawyer, 2004). In collaborative learning, information seeking can enhance discourse and take it to higher levels (King, 1999). These results raise the question in what ways uncertainty can facilitate and hinder learning. Further studies are needed to explore uncertainty in different kinds of script conditions, for example scripts that facilitate information seeking or other uncertainty reduction activities.

A major goal of our study was to shed light on the relationship between discourse and learning in online learning environments. The uncertainty reduction theory assumes that there is always some degree of uncertainty and uncertainty is typically perceived as a barrier to more successful interactions. One of the critical points of this theory is that it assumes that everyone feels uncertain. Furthermore, it does not provide any tools to measure the level of uncertainty directly. Further steps will include the development of a tool for measuring uncertainty. Expanding the uncertainty reduction theory to online learning, our study shows that some degree of uncertainty may actually enhance learning. For designers of scripts, it might be important to know that a certain level of cognitive uncertainty in some conditions is beneficial to collaborative activities and learning. Thus, further studies are needed to explore, for example, socio-emotional uncertainty-reducing scripted conditions (e.g., Weinberger, 2003; Wosnitza & Volet, 2003). More vital problems concerning interaction in online learning environments may occur at the social level rather than at the technical level, for example, or even at the cognitive level as our study suggests (see also Gunawardena, 1995). In practice, teachers and mentors can help students recognise the barriers of uncertainty they may face when participating in online learning environments.

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