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Interplay between group awareness and internal scripts: How information about knowledge and controversies triggers the activation of problem-solving script components

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Abstract: Collaboration scripts and group awareness are two prominent factors for beneficial learning processes in CSCL. However, research mostly focuses on each factor independently. To inquire their mutual interaction, we investigate how different types of group awareness information affect the selection and configuration of collaboration script components. 167 participants were provided with either awareness information on knowledge distribution, controversies or no information on a potential learning group. They then selected activities they would want to conduct from a set of script components. Analyses showed that learners select a wide variety of strings of script components. More particularly, learners with information on controversies focus on negotiation-script components and learners with information on knowledge distribution on coordination-script components. This provides first indications of differential effects of group awareness information on script configuration. The integration of research on collaboration scripts and group awareness may provide more insights into psychological learning mechanisms in CSCL.

Introduction

Collaboration scripts and group awareness (GA) are prominent factors for beneficial learning in CSCL (Buder et al., 2021; Vogel et al., 2021). While there is extensive research to understand their individual impact on learning outcomes (e.g., Janssen & Bodemer, 2013; Radkowitsch et al., 2020; Vogel et al., 2017), the underlying processes and the interaction between both collaboration scripts and GA are less understood. There are several attempts to combine research on GA and collaboration scripts and in general, the combination is deemed promising. However, these mostly focus on the integration of GA tools and external collaboration scripts rather than on studying the intricate nature of GA and internal collaboration scripts as cognitive processes. Our study thus provides a first attempt to measure the effects of GA information on internal collaboration scripts. Although effects of GA tools on collaboration processes are at the heart of GA-based collaboration research, effects on individual internal collaboration scripts are largely unknown. This study has a particular focus on this relationship between GA support and the activation of internal collaboration script components.

When learners engage in social learning, they activate a cognitive schema (i.e. collaboration script) representing the social processes necessary for successful learning. These internal collaboration scripts contain hierarchically-ordered script components (Fischer et al., 2013). To engage successfully in social situations, it is important that all participants have activated the script components appropriate to their role and in harmony with scripts others have activated (Vogel et al., 2021). The internal script components a person activates in a specific social situation may be influenced by various pre-requisites, such as their domain-specific knowledge and social skills. The Script Theory of Guidance (Fischer et al., 2013) makes clear assumptions about the structure of internal scripts, their mechanisms, and formation. The range of the content of scripts and their components is as diverse as the group compositions, goals, and strategies towards these goals that exist in CSCL (Radkowitsch et al., 2020; Vogel et al., 2017). Nevertheless, there are goals and strategies in social learning situations that warrant specific script components to emerge. For collaborative problem-solving, Liu and colleagues (2015) introduced three core mechanisms, namely coordination, information sharing, and negotiation. Script components activated during coordination include meta-cognitive strategies for successful learning processes, such as goal settings or regulation of motivation. Information sharing during collaborative problem-solving and learning is required to establish a common ground and maintain a joint understanding of the problem (Roschelle & Teasley, 1995). Negotiation is needed to mutually scrutinize ideas enabling the achievement of the best possible solution for the problem (Kollar et al., 2007). There are many specific activities for each of the three core mechanisms, such as criticizing or refining arguments for negotiation, asking meta-cognitive questions or distributing tasks for coordination, or explaining one's knowledge for information sharing. The unique configuration of script components is thereby determined by individual pre-requisites, but also the (social) learning situation (Fischer et al., 2013).

GA research assumes that the salient perception of collaboration partners is necessary for goal directed and effective collaborative learning and interaction processes. Further, information about the cognitive status of fellow learners (i.e. cognitive GA information) is assumed to guide collaborative learning processes by triggering beneficial learning practices like discussing conflicting assumptions (e.g., Bodemer, 2011). Cognitive GA tools may thereby provide information on the content or extent of knowledge of the learners. One prominent mechanism of presenting information about the content of knowledge is the detection of diverging assumptions, which may trigger socio-cognitive conflicts and conflict resolution attempts. Empirical research confirms that learners with information on conflicts or controversies focus on those during collaboration (e.g., Schnaubert & Bodemer, 2019). GA information about the extent of knowledge on the other hand is assumed to support knowledge exchange processes and has been shown to guide learners in offering explanations or asking questions during collaborative learning (e.g., Dehler et al., 2011; Erkens & Bodemer, 2019). Thus, cognitive GA information has repeatedly shown to affect collaborative learning practices and is used to structure communication and interaction processes. While it is assumed that different types of cognitive GA information activate different collaboration scripts or script components, empirical evidence is scarce (e.g., Strauß & Rummel, 2021). To better understand these mechanisms, we conducted a pseudo-collaborative study implementing different GA information and assessing effects on the script components representing learners' internal collaboration script. We expect information about controversies to lead to a focus on negotiation (H1) and information about the extent of knowledge to a focus on information sharing (H2).

Empirical Study

The sample (N = 167) of our online experiment consisted mostly of university students (86.2%; M_{age} = 26.03; SD_{age} = 6.91); 64.1% were women, 35.9% were men. We asked learners to imagine a collaborative situation in which they were to solve a number of tasks with two peers. We then provided them with GA information and asked them to select and arrange activities they expected to perform during collaboration. Participants were randomly assigned to one of three GA conditions: GA_{con} (n = 61) was provided with information about consensus / controversies within the task topics (content-based information), GA_{ext} (n = 56) was provided with information about each learner's extent of knowledge with regard to each task, and GA_{no} (n = 50) received no GA information. For GA_{con}, information was generated by an algorithm that randomly assigned controversies and consensus. The information was presented by using color-coded rectangles (based on Heimbuch & Bodemer, 2018). The information for GA_{ext} was generated randomly for each bar graph in a range between 30% and 70%. The information was visualized by horizontal bar charts as they are a typical way to represent knowledge-related GA information based on metric data (Schnaubert et al., 2020). The script components used were constructed based on literature regarding the collaborative problem-solving skills (Liu et al., 2015). We designed 26 descriptions of social activities / script components in the areas of information sharing (6), negotiation (10), and coordination (10). Learners were asked to select as many activities as they would need to represent the expected social process in the given situation and to arrange them.

Results

Overall, participants selected around 11 script components (M = 10.99, SD = 6.12). A Kruskal-Wallis-test showed no difference regarding the mean number of components selected between groups ($\chi^2(2) = 0.357$; $p = .837$). Relativized with regard to number of available script components for each category, they mostly selected coordination script components (M = .48, SD = .25) and information sharing (M = .45, SD = .29), but also negotiation (M = .35, SD = .27). Friedman-test for paired samples confirmed the difference to be highly significant ($\chi^2(2) = 44.626$; $p < .001$). Bonferroni corrected post-hoc comparisons showed significant differences between the relativized number of negotiation components chosen and information sharing (z = .548; $p < .001$) as well as coordination (z = -.629; $p < .001$) script components, but not between the latter categories (z = -0.81, $p > .999$).

To test our hypotheses, we analyzed whether learners with GA information focus on different types of script components by comparing relative occurrences of information-sharing-, negotiation- and coordination-script components (number of specific components selected / overall number of components selected) between conditions. Results of Kruskal-Wallis-tests confirmed significant differences between groups for coordination-($\chi^2(2) = 7.922$; $p = .019$) and negotiation-script components ($\chi^2(2) = 6.428$; $p = .040$), but not for information-sharing-script components ($\chi^2(2) = 0.162$; $p = .922$). Bonferroni-corrected pair-wise comparisons attributed these differences to differences between the two GA conditions with GA_{con} rather focusing on negotiation-script components (M_{GAcon} = .33; SD_{GAcon} = .15 vs. M_{GAext} = .27; SD_{GAext} = .14; z = -22.398; p = .036) and GA_{ext} rather on coordination-script components (M_{GAext} = .48; SD_{GAext} = .15 vs. M_{GAcon} = .43; SD_{GAcon} = .17; z = 23.720; p = .024). No statistically significant differences between the control condition (negotiation: M_{GAno} = .29; SD_{GAno} = .15; coordination: M_{GAno} = .46; SD_{GAno} = .14) and the two GA conditions were found.

Discussion and outlook

Our first analyses showed that overall, participants selected roughly ten components regardless of GA information provided, indicating no general effect on the number of activities planned. In general, a smaller percentage of the provided negotiation components was chosen compared to the other categories. This may indicate that information sharing and coordination are deemed more relevant for an unspecified task, but may also be due to the specific components provided. Further, we found learners with different types of knowledge-related GA information to differ in the distribution of script components they select. Learners provided with information on controversies selected more negotiation and less coordination components than learners provided with information on the extent of each learners' knowledge. We further analyzed patterns of script components and found only small numbers of congruent strings of selected script components between participants.

Our results confirm that GA information may affect which script components are deemed relevant when planning a collaborative activity. Learners with GA information on controversies focus more on negotiation and less on coordination while learners with information on the extent of knowledge focus more on coordination, possibly at the expense of negotiation. This supports the distinction between collaborative activities in emerging internal scripts (Liu et al., 2015; Radkowitsch et al., 2020). Such a distinction was also observed by Li and colleagues, who found that learners using a GA tool including content-related knowledge information seem to focus stronger on negotiating meaning and constructing new knowledge whereas learners without GA information rather focus on sharing and comparing information (Li et al., 2021). Our hypotheses assumed a "controversy-effect" on negotiation. Yet, we did not expect the "knowledge-extent-effect" to affect coordination, but information sharing. When considering the design of the GA information, this seems less surprising. The information on the extent of knowledge was structurally different from the information on controversies, as it was learner-based and not group-based. Group awareness tools may have differential effects based on the level of information provided (learner- vs. group-level; Dehler et al., 2011). Tools providing information on individuals may primarily foster comparison processes. Tools providing group-level data seem to support mostly the detection or quick classification of group properties (Schnaubert, et al., 2020). The distinction between individual- and group-level information may affect how learners approach a social situation (e.g., how willing they are to share information; Kimmerle & Cress, 2008). By providing information on knowledge distributions we enabled the detection of individual differences potentially triggering coordination-activities like trying to gain a common understanding of the task or discussing individual strength and weaknesses. Thus, with GA_{ext} providing information about the distribution of knowledge in the group and GA_{con} providing group-level information only, the information level is a confounding factor.

Limitations of the study include the fixed set of script components provided, but also the relative measure used as dependent variable. We were interested in the type of activities learners focused on and thus compared relative occurrence rather than absolute values. This has consequences for our interpretation. First, while we assume that GA information activates specific script components, results may also stem from suppression effects. For example, the perception of a social situation may inhibit or compensate for specific activities. Within our study, the mean values of the control condition always lay between the other two conditions, which may be a first indication of activation as well as suppression effects at work. However, as the comparisons with the control condition did not unveil any significant differences, we cannot make a strong case for either activation or suppression effects based on the existing data.

Our study gives first indications of differential effects of cognitive GA information on script activation. It could show that the type of GA information provided affects how learners approach a task with information on controversies fostering a focus on negotiation and information on knowledge distributions rather encouraging coordination. This has implications for research on GA as well as collaboration scripts. First, it provides further indications that GA does not only facilitate specific collaborative learning processes, but may also trigger specific activities. Further, it shows that these processes not merely emerge in a collaborative situation, but that individuals asked to plan their collaboration may also take the information into account. From a script perspective, it is important to keep in mind that GA may affect internal scripts. While the idea that GA affects how learners approach a collaborative task is not new, the effects specific cognitive GA information may have on the configuration of collaboration script components and also their more sustainable higher-level re-organization is understudied. The integration of research on collaboration scripts and GA is thus a complex yet fruitful endeavor and may provide new insights into psychological learning mechanisms in CSCL (Schnaubert & Vogel, 2022).

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