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# Towards an Integrated Framework of Group Awareness Support for Collaborative Learning in Social Media

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**Abstract:** In computer-supported collaborative learning, group awareness tools have been shown to be helpful regarding learning processes and outcomes. Previous research has focused on the support via cognitive and behavioural group awareness information, largely neglecting emotional group awareness information and often investigating these three aspects separately. To support large social media groups such as wiki communities, integrating different types of group awareness (GA) information may yield benefits, since these communities encounter several challenges. Although jointly presenting different GA information is assumed to be advantageous for collaborative learning, GA interaction effects including personality traits are still largely unexplored. In order to close this research gap, an integrated framework is proposed, which enables the systematic empirical investigation of (interaction) effects of different types of GA information on behavioural, cognitive, and emotional challenges in computer-supported collaborative learning, with a focus on wikis.

**Keywords:** Computer-supported collaborative learning, group awareness, social media, wikis

## 1. Introduction

Humans are inherently social creatures, even in contexts that appear to be primarily related to individual learning. Thus, research has highlighted the central role of social factors in achieving academic success (Wilcox, Winn, & Fyvie-Gauld, 2005). The increasing digital networking and importance of online social media in all areas of life, including individual and collaborative learning, entails new challenges for learners. Over almost 30 years of history, computer-supported collaborative learning (CSCL) has contributed significant research and innovative tools for facilitating learning processes (e.g., Miller & Hadwin, 2015). There seems to be a consensus that CSCL offers wide-ranging potentials for increasing the effectiveness and efficiency of learning and teaching processes, regardless of participants' time zone and location. Results range from positive effects on individual learning, through facilitating dyadic and small group collaboration up to more effective designs of collaborative tasks for large groups in massive open online courses (e.g., Jung & Lee, 2018). In CSCL research, social interaction is not solely observed as a method; Dillenbourg, Järvelä, and Fischer (2009) define it as the essence of cognition and as "the heart of CSCL" (p. 8). One example of widely used CSCL platforms are wikis. These are social media platforms with few social affordances to enable collaboration and therefore social interaction at virtually any point in time and between anyone (Chen, Jang, & Chen, 2015). Although such platforms offer new possibilities, they are also associated with difficulties, as computer-supported collaboration is not inherently advantageous. Learners must cope with further cognitive and social tasks beyond the requirements of individual learning by using digital media (Zheng, Niiya, & Warschauer, 2015), which are caused by the setting itself and the interaction of the learning material with the collaborative setting. To support learners coping with diverse requirements of learning with digital media, tools were designed and experimentally tested that combine established methods of support for individual learning processes. Such *Group Awareness Tools* (GATs) collect, transform, and present information about the learning partners (Bodemer, Janssen, & Schnaubert, 2018). In the following sections we provide an overview of the potentials of state-of-the-art CSCL research, as well as of some important challenges faced by learners in this field. Building upon existing CSCL and GAT frameworks, our objective is to introduce an integrated theoretical framework for

GATs, which can serve as a basis for future studies on the interplay of different types of GA information. Moreover, it intends to guide teachers and instructional designers in the reflective design of formal and informal learning environments that consider behavioural, cognitive and emotional aspects of social learning.

## 2. Potentials of Collaborative Learning and CSCL

Collaborative learning offers opportunities for elaborated learning processes and critical thinking (Johnson, Johnson, & Smith, 2000), such as a larger and broader knowledge base in groups. Every learner has a different amount of prior knowledge and different perspectives (Bell, 2004) that can benefit collaborative activities. During such activities it is possible to exchange heterogeneous knowledge, opinions and hypotheses, which offers a chance to recognise misconceptions in one's own thinking and to harmonise distributions of diverging knowledge. Furthermore, collaborative learning can also help to recapitulate knowledge through mutual explanation (Webb, 1991). In addition to increasing chances of collaborative learning, CSCL environments can further enhance the effectiveness and efficiency of learning processes. The continuous availability of learning materials and a relatively low threshold for collaborating without the need for face-to-face meetings can be highly advantageous (Walther & Bunz, 2005). As one example for a CSCL environment, wikis enable users to create socially shared artefacts as well as to share their knowledge on two rather distinct levels that relate to each other (e.g., Choy & Ng, 2007), in forms of firstly the article as a collaboratively created product and secondly corresponding talk pages for discussing article-related topics. Compared to other knowledge construction platforms evaluated in educational contexts, wikis enable users to perform in a way that influences the whole environment (e.g., Kimmerle, Moskaliuk, Oeberst, & Cress, 2015), which creates fertile ground for the multi-level occurrence of controversies and socio-cognitive conflicts (Bell, 2004). Controversies can be constructive when based on the exchange of contrasting viewpoints on a specific topic, which provides opportunities to trigger learning processes and foster higher learning outcomes (Johnson et al., 2000). Moreover, they might induce socio-cognitive conflicts within learners as well as between learners and wikis as social systems. This can be beneficial by triggering equilibration processes of accommodation and assimilation of new knowledge artefacts into one’s individual cognitive systems (Piaget, 1977). The combination of computer support and collaborative learning not only promotes these potentials but also poses challenges for learners.

## 3. Challenges in Collaborative Learning and CSCL

Effective learning processes and outcomes are not automatically produced by enabling computer-supported collaboration. Aspects of both computer support and collaboration, and especially in combination, bring their own challenges to learners (Zheng, Niiya, & Warschauer, 2015). Based on the current state of research, we identified three main challenges which serve as an indication of dominant challenges in CSCL and rather refer to large social media learning communities such as wikis. Addressing these challenges is essential to the success of CSCL.

### *3.1 Behavioural Challenge: Contributing*

The lack of behavioural motivation is often considered to be one of the greatest difficulties in online communities. However, the willingness to share knowledge is a prerequisite to CSCL’s success. The motivation to contribute or participate is not always present, especially in large social media groups where free riding and social loafing represent more common risks in collaboration (see Kimmerle & Cress, 2008). Following a series of wiki studies conducted at our lab, we found that many undergraduate students participate in joint collaborative knowledge construction and learning activities on wiki talk pages when instructed to do so, offering potentials for elevated wiki quality and improved learning processes. Otherwise, collaborators tend to show cooperative behaviours instead of engaging in valuable social interactions (Heimbuch, Ollesch, & Bodemer, 2018). This could be because

individuals' contributions to wiki discussions are not necessarily visible, which highlights the high value of increasing participatory motivation in the social interaction space for successful wiki learning.

### *3.2 Cognitive Challenge: Dealing with Meaningful Content*

Meaningful interactions between wiki collaborators are important in addition to CSCL settings' behavioural requirements, and difficulties achieving meaningful collaboration may occur without required motivation or skills among group members. Such difficulties can be rooted in the lack of understanding others' contributions that can manifest a cognitive challenge to learners. These problems arise when group members fail to pay sufficient attention to individual contributions as well as when such contributions are not sufficiently discussed (Näykki, Järvelä, Kirschner, & Järvenoja, 2014). Although this challenge applies to all CSCL domains, it is obvious that contributions conducive to cognitive learning are especially less simple to identify in larger communities which feature copious content. This can occur due to information overload, an unavoidable reality of larger online discussion forums growing to include hundreds to thousands of contributions (Buder, Schwind, Rudat, & Bodemer, 2015), or wiki talk pages that often lack salience of the aforementioned controversies at first glance (Heimbuch & Bodemer, 2017). Due to the limitations of working memory capacities, this lack means that those meaningful contributions are simply not perceived and therefore not read (see Bagherian & Thorngate, 2000). These processes of collaborative knowledge construction can be difficult and challenging by causing frustration during the learning process (Capdeferro & Romero, 2012), which emphasises the necessity to highlight cognitively relevant contributions and thus facilitate knowledge acquisition.

### *3.3 Emotional Challenge: Maintaining a Positive Group Climate*

The motivation and skillsets to maintain a positive group climate represent another essential aspect that is often neglected in the context of designing and evaluating CSCL settings. Group formation is viewed as a prerequisite to successful collaborative learning (Kirschner & Erkens, 2013) since relational issues can strongly influence interaction, task engagement, and learning (Näykki et al., 2014). If negatively balanced emotions or negatively connotated utterances occur during conflicts, group members become less motivated to solve their assigned tasks and tend to demonstrate inferior performances (Ayoko, Callan, & Härtel, 2008). Therefore, CSCL environments should be designed to be more "sociable" for their users (Kreijns, Kirschner, & Vermeulen, 2013). This emotional challenge is also inherently relevant for wikis, such as on Wikipedia where so-called "edit wars" are likely to occur and difficult to solve when many users with contradicting viewpoints attempt to work on the same knowledge artefacts (Yasseri, Sumi, Rung, Kornai, & Kertész, 2012). This underlines the necessity to support wiki users in solving such socio-emotional issues to help a group of individuals transform into a team.

## 4. Supporting Learning Processes in CSCL

The many degrees of freedom offered by CSCL lead to users perceiving a high degree of autonomy, which positively influence the individual learning motivation. Nevertheless, this freedom demands a high degree of self-regulation to overcome the aforementioned challenges (see Järvelä & Hadwin, 2013). Moreover, without further support this freedom offers only minimal structure and risks learners experiencing themselves as less competent, which in turn can negatively impact the learning motivation (Rienties et al., 2012). It is thus desirable to structure collaborative learning processes to promote the experience of competence. CSCL research offers different means of support that vary regarding their degree of coercion. For example, collaboration scripts can improve the effectiveness of collaborative learning by providing explicit guidance concerning the manner in which people should form groups, interact with each other and solve group tasks (Kollar, Fischer, & Hesse, 2006). However, this entails an often-discussed risk of overscripting. An alternative regards implicit structuring which provides less coercive guidance and is intended to enable desirable behaviour through visual context stimuli in order to achieve more effective collaboration (Janssen & Bodemer, 2013). Identifying the more effective guidance approach represents a heatedly discussed topic in the CSCL community (Wise & Schwarz, 2017). This controversy will not be discussed in this study due to a lack of universal consensus as well

as because this article focuses on GAT support, but instead we define Group Awareness and different types of GATs.

*Group Awareness* (GA) can be loosely defined as any information about the group possessed by a learner, such as knowledge about activities, skills of group members, or social activities within the group (Janssen, Erkens, & Kirschner, 2011). Prevalent GA is often regarded as an important prerequisite to meaningful collaborations in CSCL but cannot be taken for granted (Bodemer et al., 2018). GATs can be used to complement individuals' GA by providing information about specific properties of group (members), e.g., regarding their participation, knowledge, or feelings. This information can be collected, transformed, and presented in different ways (Bodemer et al., 2018). Although GATs are expected to benefit through stimulating productive interaction activities (Miller & Hadwin, 2015), behavioural, cognitive, and emotional challenges are not addressed by one single GA component due to the significant complexity of social interactions. When thinking about social interaction, it can be differentiated between a content space and a relational space of collaboration (Slof, Erkens, Kirschner, Jaspers, & Janssen, 2010). The content space contains the problem to be solved and interactions in this space refer to the task itself. Learners discuss ideas as well as opinions and thus gain a deeper understanding of the task in order to solve it. The content space contains not only cognitive but also metacognitive activities such as resolution strategies for the task (Janssen & Bodemer, 2013). Interactions in the relational space are activities concerning the social dimension of collaborations (Slof et al., 2010), which are important for the functioning of cognitive activity exchanges in the content space. Here, group members create a collective understanding of the discussed concepts in the content space. To become successful collaborators, both task fulfilment (content space) and team functioning (relational space) are essential in order for randomly assigned group members to become effective team players (Fransen, Weinberger, & Kirschner, 2013). The effects of different types of GA information on the two spaces are further examined by providing examples in the following paragraphs (see Figure 1).

*Behavioural GATs* (in the community also labelled as activity/(socio-)behavioural GATs) address the behavioural challenge by presenting the collaborators' activities, and they thus serve as a source of motivation for providing contributions in the social interaction space in general (Lin, Tsai, Hsu, & Chang, 2019; Kimmerle & Cress, 2008; see Figure 1a). Behavioural GA information has promising potential to increase participation rates in terms of motivational processes. This can be achieved by visually juxtaposing individuals' contributions against the group's contributions or average participation (Kimmerle & Cress, 2008). The possibility of self-presentation is crucial here, however single applications of behavioural GATs do not necessarily lead to increased cognitive performance as measured by means of message and project quality (Lin et al., 2019). Although there are already initial wiki approaches, e.g., to supplement MediaWiki with participation monitoring tools (Popescu, Anca, & Udrištoiu, 2014), they need to be systematically evaluated.

*Cognitive GATs* (in the community also labelled as knowledge GATs) provide content-related information about group members, such as their knowledge or opinions. These tools are promising for tackling cognitive aspects of learning (Janssen & Bodemer, 2013) and mainly address the cognitive challenge by facilitating the navigation and selection of meaningful content. Moreover, the presentation of partner knowledge facilitates grounding and partner modelling in the content space of social interactions (Bodemer et al., 2018). There is additionally potential to reduce unnecessary extraneous cognitive load (Chandler & Sweller, 1991) induced by the collaborative learning setting. Taking large learning environments as an example, cognitive GA information in the form of visual markers help learners to focus on meaningful content on large wiki talk pages in order to identify relevant controversies (Heimbuch & Bodemer, 2017; see Figure 1b; *blue markers label controversies in general, green markers stand for solved, and red markers for unresolved controversies*) or high-quality contributions in online forums (Buder et al., 2015), which could also be applied to the visualisation of collaborators' expertise/knowledge level in future studies.

*Emotional GATs* (in the community also labelled as social/(socio-)emotional GATs) are helpful tools to facilitate joint emotion regulation in the relational space of social interactions, to enhance mutual transactivity, and to create a positive group climate by increasing group members' awareness of other members' feelings (Eligio, Ainsworth, & Crook, 2012; see Figure 1c). Educational psychology currently predominantly focuses on cognitive and behavioural support. Socio-emotional issues are treated with a much lower priority in instructional designs, and to our knowledge there is no empirically tested tool that deals with joint emotion regulation in the field of wikis. Such tools could help to identify unfriendly posts on wiki talk pages or highlight self-assessed emotional states of wiki group members to

alert the group to emotional grievances. These represent initial design impulses, and a deeper investigation into the effects of emotional GA information on the emotional challenge is necessary.

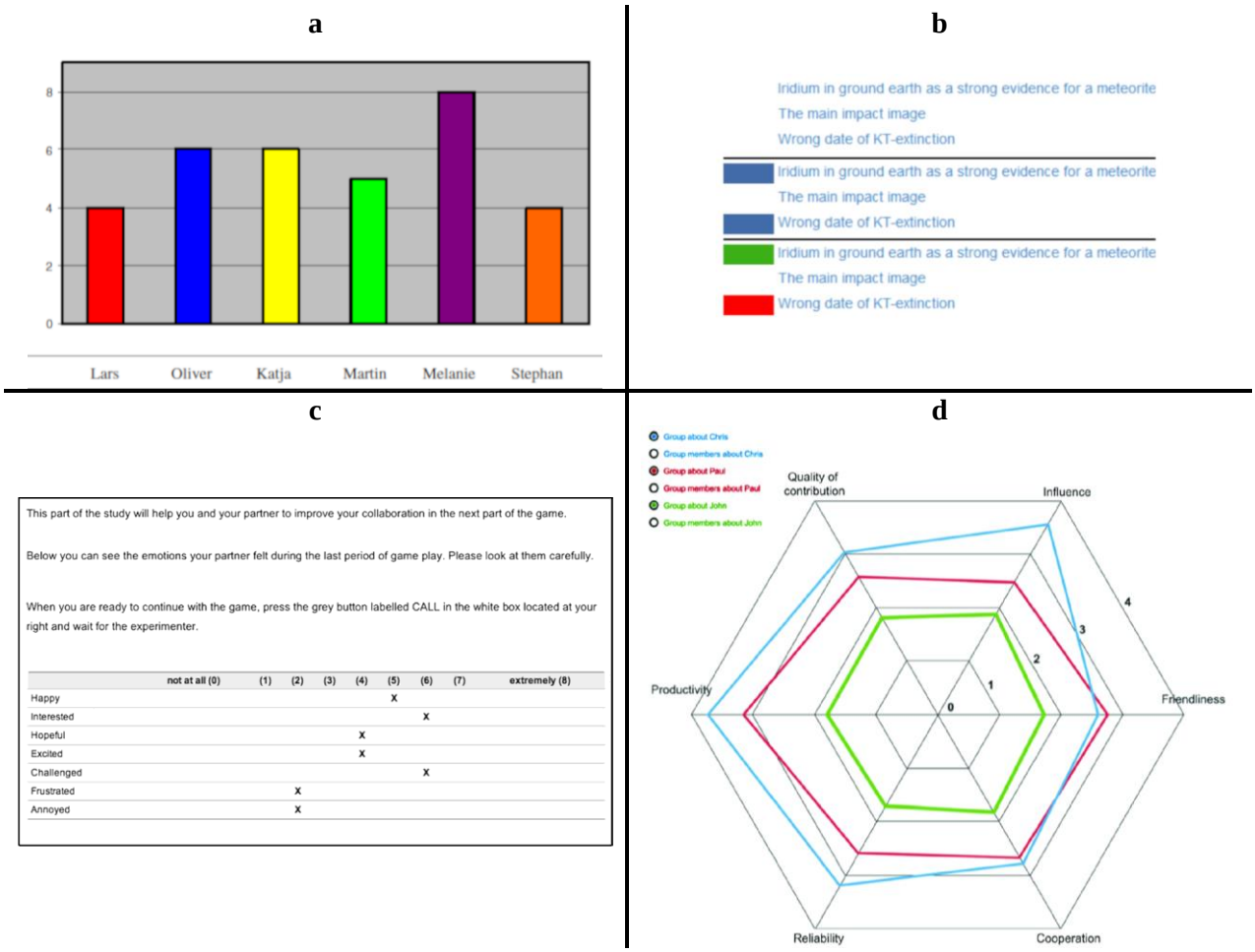


*Figure 1*. Examples of GAT support: a) Behavioural GAT: Kimmerle & Cress (2008); b) Cognitive GAT: Heimbuch and Bodemer (2017); c) Emotional GAT: Eligio et al. (2012); d) Combination of several tool aspects: Phielix, Prins, Kirschner, Erkens, and Jaspers (2011).

Lin, Mai, and Lai (2015) criticise that only a few studies examine the differences and overlaps between behavioural and emotional GA (social-context awareness) as well as cognitive GA (knowledge-context awareness) information. Their long-term study shows that while social-context awareness stimulates more quantitative peer interactions, knowledge-context awareness unexpectedly does not necessarily increase the quality of messages. They conclude that a combination of different types of GA information may be more effective. We agree that cognitive, behavioural, and emotional GA information may be required in order to achieve effective group performance (e.g., high wiki article quality). Consequently, GATs that provide more than one type of GA information are necessary such as the seldom exception of the RADAR tool (Phielix et al., 2011; see Figure 1d). It is one of the few GATs that reflect different aspects of collaboration and group functioning. This tool presents six self-assessed as well as peer-assessed group dimensions: influence, friendliness, cooperation, reliability, productivity, and quality of contribution. It could be shown that social performance such as group satisfaction is positively affected by communicating this information back to the group, however no effect on cognitive processes and learning outcomes could be observed (Phielix et al., 2011). Analogue to the GA information differentiation that we propose with this framework, influence and quality of contributions can be classified as cognitive GA information, friendliness and reliability as emotional GA information, and cooperation and productivity as behavioural GA information. Although the results of the RADAR tool are promising for GAT research, they have only been examined for smaller groups. In general, our literature review demonstrated that a significant portion of GAT research is not focused on social media communities like wikis and that research such as of Heimbuch and Bodemer (2017)

represents a rare exception. It is therefore important to investigate how larger social media communities can be supported with combined GA information as well as what types of group awareness information are most relevant in such settings. Moreover, the investigations regarding the RADAR tool only allow speculation about the reasons for the non-significant cognitive dependent variables and the different tool functions since the six dimensions have not been examined separately and systematically. Thus, a systematic investigation of different GA information is missing and necessary in GAT research.

## 5. An Integrated Framework of GAT Support

This section addresses existing conceptual considerations in the field of CSCL and GATs as well as how the proposed framework represents an extension. Kreijns, Kirschner, and Jochems (2003) presented a differentiated view of social and cognitive processes in CSCL, albeit without including GA but regarding the pitfalls in CSCL. The first discussed pitfall is to take social interaction for granted without stimulating it. In addition, the authors criticise the second pitfall or the fact that in many cases, instructors limit their actions to the content space of social interaction. Thus, it has been concluded that collaboration can only be successful if both cognitive and social processes are supported due to their mutual influence. An overview about how cognitive and social processes are stimulated or supported by means of GA information is provided by Bodemer and Dehler (2011). At that time, three types of GA had become distinguished: behavioural GA (e.g., Janssen et al., 2011), cognitive GA (e.g., Sangin, Molinari, Nüssli, & Dillenbourg, 2011), and social GA (e.g., Phielix et al., 2011). Based on an extensive literature review, another framework of GA support was set up in later years (Janssen & Bodemer, 2013). Considering the common use of terms in existing GA-related studies, the authors describe a division into only two GA components: cognitive (e.g., information about knowledge or opinions of group members) and social (e.g., information about participation or perceived friendliness of group members) GATs. Like Kreijns and colleagues (2013), they distinguish between two dimensions of social interaction, which are stimulated by different types of GATs. The framework presented by Janssen and Bodemer (2013) suggests that cognitive and social GA are prerequisites for the effectiveness of social interaction in the two spaces. Recently, Bodemer and colleagues (2018) analysed that a division into two types of GATs is still established at the first level in current research, whereas a more differentiated view on social GATs is supplied at the second level: a differentiation between tools collecting socio-behavioural information (such as information about the participation of group members), socio-emotional information (such as the perceived friendliness within a group), as well as socio-motivational information (such as the commitment of group members).

Regarding social media communities, we have identified a three-way division (see Section 4) based on the three challenges presented in Section 3. Accordingly, there is a need to more closely examine "social" GA information, since especially (socio-)emotional and (socio-)behavioural processes can achieve different effects but are often cumulated. Such a resumption of the three types of GA information is also suggested in a review by Ghadirian, Ayub, Silong, Bakar, and Hosseinzadeh (2016). The following section proposes an integrated framework, which could serve as a basis for new studies in the field of GAT research, especially regarding social media communities. This framework adopts a distinction between three types of GA information (Bodemer & Dehler, 2011) but replaces the term "social" with "emotional" since all types of GATs in the social media area contain a social component. Thus, the framework distinguishes cognitive, behavioural, and emotional GA information (see Figure 2). Despite the presence of promising separate findings on various GATs, this framework contributes by combining findings from different fields of GAT research considering a holistic and differentiated view regarding the effects of cognitive, behavioural, and emotional GA information on different challenges, learning, and social outcomes as well as group performance (see Figure 2). The illustrated framework clarifies that cognitive GA information entails mainly positive effects on interactions in the content space as well as on learning outcomes by addressing the cognitive challenge. Emotional GA information on the other hand mainly affects the emotional challenge of interactions in social interactions' relational space and, as a result, also entails positive effects on social outcomes. Furthermore, behavioural GA information heightens social interaction motivation in both spaces. The main message of this framework is that the interaction of all GA information may be crucial to consequent group performance. It should be noted that these considerations represent a beginning and need to be expanded or modified in the future, inter alia by highlighting interaction effects of different

GA functions, as the current framework only visualises linear effects. To our knowledge, there is no published study which systematically compares different types of GA information and their interaction effects in order to determine which (combination of) GA information is more fundamental than others in specific contexts (also see the review of Ghadirian et al., 2016). It is thus imperative to establish studies to investigate GA interaction effects in different contexts.

Kirschner and Erkens (2013) have already presented a framework to summarise the most prominent areas of CSCL research including GAT research. Despite parallels between our framework and that of Kirschner and Erkens, especially regarding the appeal to weigh emotional aspects (e.g., support of the well-being and satisfaction of group members) more strongly in CSCL settings, their issue is domain neutral. Our approach on the other hand focuses on the use of group awareness tools to support larger social media communities such as wikis. A further specific aspect of this framework is that it focuses not only on the objective information provided by a GAT but also on the influencing effect of "personal" GA, which is rarely considered in current research as most studies focus on the GA information collected by the tools rather than the actual GA. Already Bodemer and colleagues (2018) analysed that only few studies consider the actual GA as mediator variable or as manipulation check (e.g., Engelmann & Hesse, 2011; Sangin et al., 2011). Furthermore, no present study considers the subjective importance of GA information, which could help to predict whether specific tool information will be used as intended. A particular feature of the visualised framework is therefore the distinction between the information presented by the GAT and the actual person's GA, which depends on the individual's interaction with the GA information (see Figure 2). Especially when several GA information are combined, individuals may use some types of information more heavily than others during the collaboration. As an example, learners may not care about a learning community's knowledgeability level if there is a friendly group climate. It is also possible for individuals to draw their own conclusions based on presented GA information, and the visualisation of specific actions could thus be associated with much expertise (see Ogata & Yano, 2004), even if this might be a fallacy.

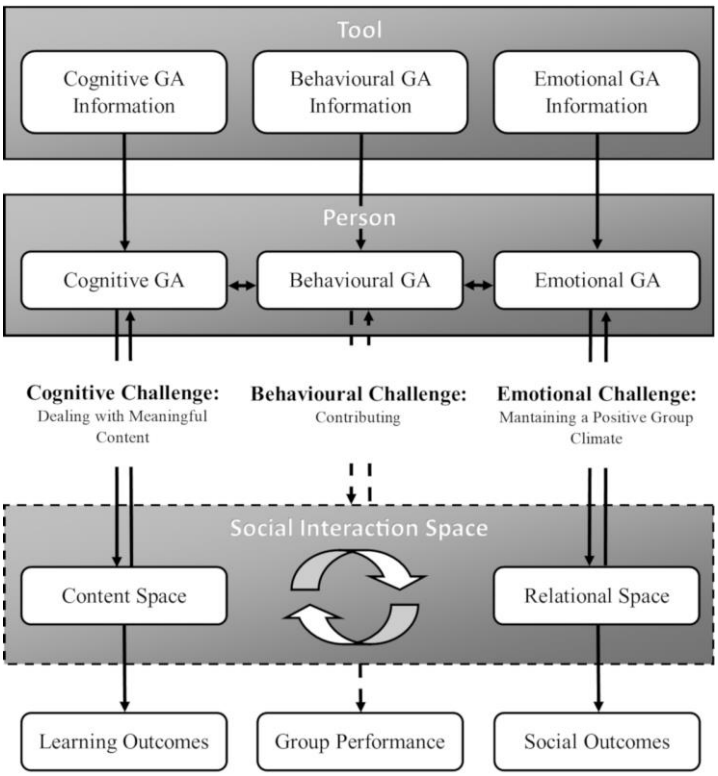


*Figure 2*. Framework for future studies regarding the interplay of GATs.

The effect of (socio-)motivational GATs (Bodemer et al., 2018) is not explicitly visualised in this framework. Motivational challenges are "related to different goals, priorities, and expectations within the group towards group activities" (Näykki et al., 2014, p. 2). Although different theories of motivation can be very relevant for understanding individual and collaborative learning processes, a complete discussion on this topic exceeds the scope of this article. Rather, we postulate that

motivational issues are addressed by each of the three types of GA information (see Sections 3 and 4). Behavioural GA information affects the general *motivation to contribute* (behavioural challenge), which requires no advanced abilities beyond basic writing and reading. Cognitive GA information addresses, besides the skill (as cognitive states may be difficult to detect in large social media settings) the *motivation to deal with meaningful content* (cognitive challenge). Finally, emotional GA information addresses, besides the skill (as emotional states may also be difficult to detect), the *motivation to maintain a positive group climate* (emotional challenge). In addition, studies have already empirically shown that the simple presentation of motivational states does not need to entail positive effects on outcomes such as increasing one's own motivation or knowledge (e.g., Schoor, Kownatzki, Narciss, & Körndle, 2014). This could be because a simple motivation presentation is highly unspecific, whereas cognitive, behavioural, and emotional GA information concern specific motivational effects.

## 6. Future Implications

With this framework we want to stress that even though there are already some enlightening and promising results for different types of GATs, it is time to develop a comprehensive full picture regarding their connections. There is a great imbalance in GAT research regarding the types of information provided. The clear focus lies on the support of cognitive GA (Ghadirian et al., 2016) followed by behavioural GATs, whereas the use of emotional GATs remains rather unexplored. To proceed, it is important to examine the positive and negative interaction effects of cognitive, behavioural, and emotional GA information on the respective challenges and outcomes. Although positive effects of cognitive GATs on learning outcomes can already be demonstrated in several contexts (Bodemer et al., 2018), it is likely that behavioural GA information has the potential to intensify these effects. This is based on the finding that explanations help to recapitulate previous knowledge (Webb, 1991). It is also possible that the presentation of cognitive group information leads to information being strategically withheld when learners perceive themselves as experts (Ray, Neugebauer, Sassenberg, Buder, & Hesse, 2013). Here, behavioural GA information could potentially enhance motivation for providing explanations in the social interaction space. However, the presentation of behavioural information could also entail negative effects on emotional challenges or the group climate if the tool visualises unequal participation (Strauß, Rummel, Stoyanova, & Krämer, 2018). There is a need for GATs that present different types of GA information in specific contexts. It is important to examine how this GA information support should look while considering cognitive variables such as mental effort, which could be affected by the interaction with tool information (see Janssen et al., 2011). In this paper, we have exemplarily referred to the area of wikis, however this framework is also transferable to other communities with the challenges being more applicable to larger learning platforms. Since many of the existing studies regarding GATs focus on smaller group collaborations (e.g., Kimmerle & Cress, 2008; Phielix et al., 2011), there is an urgent need in the field of CSCL and GATs to conduct additional research regarding social media platforms, because both students and faculties increasingly use social media in teaching and learning activities (Dabbagh & Kitsantas, 2012). Furthermore, it is important to consider the individual weighting of different GA information as well as the interaction with personality traits. A high tendency towards social comparisons could potentially strengthen behavioural GAT effects (Neugebauer, Ray, & Sassenberg, 2016), whereas need for cognition should influence the cognitive GAT effects. Moreover, a conflict avoidance tendency might affect the interaction with emotional GA information. These represent a few of many conceivable personality interactions that need to be addressed in future GA studies in order to advance this field of research. Laboratory as well as longitudinal field research (Wang, 2011) is needed to examine what kind of processes and outcomes are triggered by the single and combined visualization of GA information, how learners perceive and interact with the different tool information (e.g., by using eye-tracking or qualitative methods) and which role influencing personality variables play. Conducting such studies can help to design and apply adaptive GATs that consider the interplay of different types of GA information as well as support learners according to their specific personalities, which is considered one of the main challenges for future CSCL work (Wise & Schwarz, 2017). Nevertheless, it is not only a question of gaining new insights in the field of GATs, but also of inviting teachers, facilitators, and designers to consider this framework and future research regarding GA interaction effects in order to promote motivation and learning in formal and informal educational settings.

## References


Ayoko, O. B., Callan, V. J., & Härtel, C. E. J. (2008). The influence of team emotional intelligence climate on conflict and team members' reactions to conflict. *Small Group Research*, *39*(2), 121–149.

Bagherian, F., & Thorngate, W. (2000). Horses to water: Student use of course newsgroups. *First Monday*, *5*(8).

Bell, P. (2004). The educational opportunities of contemporary controversies in science. In M. C. Linn, E. A. Davis, & P. Bell (Eds.), *Internet Environments for Science Education* (pp. 233–260). Mahwah, NJ: Lawrence Erlbaum Associates.

Bodemer, D., & Dehler, J. (2011). Group awareness in CSCL environments. *Computers in Human Behavior*, *27*(3), 1043–1045.

Bodemer, D., Janssen, J., & Schnaubert, L. (2018). Group awareness tools for computer-supported collaborative learning. In F. Fischer, C. E. Hmelo-Silver, S. R. Goldman, & P. Reimann (Eds.), *International Handbook of the Learning Sciences* (pp. 351–358). New York, NY: Routledge.

Buder, J., Schwind, C., Rudat, A., & Bodemer, D. (2015). Selective reading of large online forum discussions: The impact of rating visualizations on navigation and learning. *Computers in Human Behavior*, *44*, 191–201.

Capdeferro, N., & Romero, M. (2012). Are online learners frustrated with collaborative learning experiences? *The International Review of Research in Open and Distance Learning*, *13*(2), 26–44.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, *8*(4), 293–332.

Chen, Y.-H., Jang, S.-J., & Chen, P.-J. (2015). Using wikis and collaborative learning for science teachers' professional development. *Journal of Computer Assisted Learning*, *31*(4), 330–344.

Choy, S. O., & Ng, K. C. (2007). Implementing wiki software for supplementing online learning. *Australasian Journal of Educational Technology*, *23*(2), 209–226.

Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education*, *15*(1), 3–8.

Dillenbourg, P., Järvelä, S., & Fischer, F. (2009). The evolution of research on computer-supported collaborative learning. In N. Balacheff, S. Ludvigsen, T. de Jong, A. Lazonder, & S. Barnes (Eds.), *Technology-enhanced Learning: Principles and Products* (pp. 3–19). Dordrecht, Netherlands: Springer.

Eligio, U. X., Ainsworth, S. E., & Crook, C. K. (2012). Emotion understanding and performance during computer-supported collaboration. *Computers in Human Behavior*, *28*(6), 2046–2054.

Engelmann, T., & Hesse, F. W. (2011). Fostering sharing of unshared knowledge by having access to the collaborators' meta-knowledge structures. *Computers in Human Behavior*, *27*(6), 2078–2087.

Fransen, J., Weinberger, A., & Kirschner, P. A. (2013). Team effectiveness and team development in CSCL. *Educational Psychologist*, *48*(1), 9–24.

Ghadirian, H., Ayub, A. F. M., Silong, A. D., Abu Bakar, K. B., & Hosseinzadeh, M. (2016). Group awareness in computer-supported collaborative learning environments. *International Education Studies*, *9*(2), 120.

Heimbuch, S., & Bodemer, D. (2017). Controversy awareness on evidence-led discussions as guidance for students in wiki-based learning. *The Internet and Higher Education*, *33*, 1–14.

Heimbuch, S., Ollesch, L., & Bodemer, D. (2018). Comparing effects of two collaboration scripts on learning activities for wiki-based environments. *International Journal of Computer-Supported Collaborative Learning*, *13*(3), 331–357.

Janssen, J., & Bodemer, D. (2013). Coordinated computer-supported collaborative learning: Awareness and awareness tools. *Educational Psychologist*, *48*(1), 40–55.

Janssen, J., Erkens, G., & Kirschner, P. A. (2011). Group awareness tools: It's what you do with it that matters. *Computers in Human Behavior*, *27*(3), 1046–1058.

Järvelä, S., & Hadwin, A. F. (2013). New frontiers: Regulating learning in CSCL. *Educational Psychologist*, *48*(1), 25–39.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2000). Constructive controversy: The educative power of intellectual conflict. *Change: The Magazine of Higher Learning*, *32*(1), 28–37.

Jung, Y., & Lee, J. (2018). Learning engagement and persistence in massive open online courses (MOOCS). *Computers & Education*, *122*, 9-22.

Kimmerle, J., & Cress, U. (2008). Group awareness and self-presentation in computer-supported information exchange. *International Journal of Computer-Supported Collaborative Learning*, *3*(1), 85–97.

Kimmerle, J., Moskaliuk, J., Oeberst, A., & Cress, U. (2015). Learning and collective knowledge construction with social media: A process-oriented perspective. *Educational Psychologist*, *50*(2), 120–137.

Kirschner, P. A., & Erkens, G. (2013). Toward a Framework for CSCL Research. *Educational Psychologist*, *48*(1), 1–8.

Kollar, I., Fischer, F., & Hesse, F. W. (2006). Collaboration scripts – a conceptual analysis. *Educational Psychology Review*, *18*(2), 159-185.

Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: A review of the research. *Computers in Human Behavior*, *19*(3), 335–353.

Kreijns, K., Kirschner, P. A., & Vermeulen, M. (2013). Social aspects of CSCL environments: A research framework. *Educational Psychologist*, *48*(4), 229–242.

Lin, J.-W., Mai, L.-J., & Lai, Y.-C. (2015). Peer interaction and social network analysis of online communities with the support of awareness of different contexts. *International Journal of Computer-Supported Collaborative Learning*, *10*(2), 139–159.

Lin, J. W., Tsai, C. W., Hsu, C. C., & Chang, L. C. (2019). Peer assessment with group awareness tools and effects on project-based learning. *Interactive Learning Environments*, 1-17.

Miller, M., & Hadwin, A. (2015). Scripting and awareness tools for regulating collaborative learning: Changing the landscape of support in CSCL. *Computers in Human Behavior*, *52*, 573–588.

Näykki, P., Järvelä, S., Kirschner, P. A., & Järvenoja, H. (2014). Socio-emotional conflict in collaborative learning—A process-oriented case study in a higher education context. *International Journal of Educational Research*, *68*, 1–14.

Neugebauer, J., Ray, D. G., & Sassenberg, K. (2016). When being worse helps: The influence of upward social comparisons and knowledge awareness on learner engagement and learning in peer-to-peer knowledge exchange. *Learning and Instruction*, *44*, 41–52.

Ogata, H., & Yano, Y. (2004). Knowledge awareness for a computer-assisted language learning using handhelds. *International Journal of Continuing Engineering Education and Life Long Learning*, *14*(4-5), 435-449.

Phielix, C., Prins, F. J., Kirschner, P. A., Erkens, G., & Jaspers, J. (2011). Group awareness of social and cognitive performance in a CSCL environment: Effects of a peer feedback and reflection tool. *Computers in Human Behavior*, *27*(3), 1087–1102.

Piaget, J. (1977). Problems of equilibration. In M. H. Appel & L. S. Goldberg (Eds.), *Topics in Cognitive Development* (pp. 3–13). New York: Plenum.

Popescu, E., Maria, C., & Udrițoiu, A. L. (2014). Fostering collaborative learning with wikis: Extending MediaWiki with educational features. In E. Popescu, R. W. H. Lau, K. Pata, H. Leung, & M. Laanpere (Eds.), *Advances in Web-Based Learning – ICWL 2014* (Vol. 8613, pp. 22–31). Cham: Springer International Publishing.

Ray, D. G., Neugebauer, J., Sassenberg, K., Buder, J., & Hesse, F. W. (2013). Motivated shortcomings in explanation: The role of comparative self-evaluation and awareness of explanation recipient's knowledge. *Journal of Experimental Psychology: General*, *142*(2), 445–457.

Rienties, B., Giesbers, B., Tempelaar, D., Lygo-Baker, S., Segers, M., & Gijselaers, W. (2012). The role of scaffolding and motivation in CSCL. *Computers & Education*, *59*(3), 893–906

Sangin, M., Molinari, G., Nüssli, M.-A., & Dillenbourg, P. (2011). Facilitating peer knowledge modeling: Effects of a knowledge awareness tool on collaborative learning outcomes and processes. *Computers in Human Behavior*, *27*(3), 1059–1067.

Schoor, C., Kownatzki, S., Narciss, S., & Körndle, H. (2014). Effects of feeding back the motivation of a collaboratively learning group. *Electronic Journal of Research in Education Psychology*, *12*(1), 191–210.

Slof, B., Erkens, G., Kirschner, P. A., Jaspers, J. G. M., & Janssen, J. (2010). Guiding students' online complex learning-task behavior through representational scripting. *Computers in Human Behavior*, *26*(5), 927–939.

Strauß, S., Rummel, N., Stoyanova, F., & Krämer, N. (2018). Developing a library of typical problems for collaborative learning in online courses. In J. Kay & R. Luckin (Eds.), *Rethinking Learning in the Digital Age: Making the Learning Sciences Count* (Vol. 2, pp. 1045–1048). London, UK: ISLS.

Walther, J. B., & Bunz, U. (2005). The rules of virtual groups: Trust, liking, and performance in computer-mediated communication. *Journal of Communication*, *55*(4), 828–846.

Wang, T. H. (2011). Developing web-based assessment strategies for facilitating junior high school students to perform self-regulated learning in an e-learning environment. *Computers & Education*, *57*(2), 1801–1812.

Webb, N. M. (1991). Task-related verbal interaction and mathematics learning in small groups. *Journal for Research in Mathematics Education*, *22*(5), 366-389.

Wilcox, P., Winn, S., & Fyvie-Gauld, M. (2005). 'It was nothing to do with the university, it was just the people': the role of social support in the first-year experience of higher education. *Studies in Higher Education*, *30*(6), 707–722.

Wise, A. F., & Schwarz, B. B. (2017). Visions of CSCL: Eight provocations for the future of the field. *International Journal of Computer-Supported Collaborative Learning*, *12*(4), 423–467.

Yasseri, T., Sumi, R., Rung, A., Kornai, A., & Kertész, J. (2012). Dynamics of conflicts in Wikipedia. *PLoS ONE*, *7*(6).

Zheng, B., Niiya, M., & Warschauer, M. (2015). Wikis and collaborative learning in higher education. *Technology, Pedagogy and Education*, *24*(3), 357–374.

## Appendix 1 – Acknowledgements

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