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Online collaborative learning in dyads: Effects of knowledge distribution and awareness

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ABSTRACT

Research on collaborative learning traditionally assumes a certain degree of symmetry between the learning partners in terms of both their learning-relevant traits and their individual learning outcomes. However, if one collaborative partner is clearly more able, skilled, or knowledgeable than the other partner, then it remains unclear who profits more from the collaboration. The present study aimed to explore this issue by manipulating symmetry in prior knowledge within small groups of online learners (dyads) and measuring their problem-solving efficiency and incidental learning gain on an individual and dyad level. Awareness of this symmetry/asymmetry was manipulated, too, to discern it as a potential moderator. Dyads with symmetrical and asymmetrical prior knowledge performed equally well on most measures. Moreover, on average, the more and the less knowledgeable partners in the asymmetrical conditions had equal learning gains. However, while in dyads with symmetrical knowledge learning gains were correlated between the partners, in the asymmetrical dyads they were not. Awareness of symmetry/asymmetry did not act as a moderator, but, overall, dyads with awareness of each other's knowledge learned more from each other than dyads without such awareness. The benefit of awareness was, however, specific to the learning content exposed via awareness. We conclude that researchers and practitioners should be careful when choosing or assigning collaborative partners to each other, as only for partners with symmetrical prior knowledge can a symmetrical increase in knowledge be expected. We further discuss the implications of these findings for research on knowledge awareness and collaboration.

1. Introduction

In recent years students in presence and online based education have been increasingly encouraged to work together, exchange knowledge and to collaborate on their learning tasks. Collaborative learning, amongst other things is considered to promote student involvement and communication skills (Lin, 2006). Collaborating towards a common goal is firmly believed to lead to more sophisticated thought processes and insights regarding the to-be-learned material (e.g., Gabbert, Johnson, & Johnson, 1986). The increased implementation of instructional practices that enable students to learn together in school curricula is considered a success story (Johnson & Johnson, 2009; for a more recent discussion on challenges for teachers, see Prieto, Sharma, Wen, & Dillenbourg, 2015). Substantial research effort has been put in the question how to coordinate and how to manage collaborative learning (see for example Stegmann, Wecker, Weinberger, & Fischer, 2012; for a comprehensive theory on guidance in computer-supported collaborative learning, see Fischer, Kollar, Stegmann, & Wecker, 2013). What merits careful consideration in this context, however, is that genuinely collaborative learning situations are exceedingly rare. By its definition, "collaborative" learning is characterized by symmetry of knowledge between the learning partners (Dillenbourg, 1999; Keppell, Au, Ma, & Chan, 2006; see also Lai, 2011). Symmetry of knowledge hereby means that knowledge, albeit possibly heterogeneous, is present in each collaborating partner to an equal extent, i.e. pieces of knowledge equally relevant to a learning task or issue are symmetrically distributed between the learning partners. Outside of the lab collaborating with an equal partner might occur only rarely, however. Typically, learners differ, not only with respect to prior knowledge, but also in beliefs, habits,

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and aims (Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2012). The issue of asymmetrically distributed knowledge is even more far-reaching in, increasingly prevalent, online learning scenarios, where the wide accessibility of collaborative platforms necessarily leads to an increment in the disparity of the learners' attributes, and their knowledge backgrounds. Of course learning scenarios involving heterogeneous group compositions can still, in the broadest sense, be considered collaborative (Dillenbourg, 1999). Nevertheless, there is a clear difference between arguing that collaborative learning is beneficial in general and arguing that collaborative learning is beneficial only when knowledge in the learning group is distributed symmetrically. If an asymmetrical knowledge distribution within a learning group leads to one partner profiting exclusively, or even at the expense of the other partner, from the learning activity, then clearly collaborative learning does not constitute a success story for everybody.

1.1. Who benefits from collaboration when knowledge is distributed asymmetrically?

It is rather difficult to gain an unequivocal picture from the literature on whether asymmetry in knowledge within a group leads to either the more or the less knowledgeable learner profiting from the collaboration to a greater extent. Thus advantages for the less knowledgeable learner have been noted, when the more knowledgeable peer assumes the role of a tutor (Chi, Siler, & Jeong, 2004). Conversely, for the more knowledgeable partner, a less knowledgeable partner provides opportunity to rethink and review whatever is in the focus of discussion and to reorganize and reframe their knowledge, which can also be advantageous (e.g., Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Renkl, 1997).

Empirical research directly addressing the influence of varying levels of knowledge of the learners within a group on individual learning outcomes is somewhat scarce, particularly in online collaborative settings. Traditionally, the subject is investigated in the school setting by pairing students of different abilities. Webb (1991), reviewing a number of studies on the topic, finds better individual outcomes in asymmetrical groups of high and low ability students than in symmetrical high ability groups. A later study, however, finds that high ability students perform equally well working in symmetrical or asymmetrical groups or indeed when working alone (Webb, Nemer, Chizhik, & Sugrue, 1998). This finding is echoed by research showing that low ability students paired with high ability students profit from the collaboration at no cost to the high ability student (Hooper & Hannafin, 1988).

However, the picture is made somewhat more complex by findings showing that when medium ability students are paired with either high or low ability students it is always the partner with the higher ability that profits most (Denessen, Veenman, Dobbelsteen, & Van Schilt, 2008). Other studies outright contradict the conclusions of Webb (1991), observing that high-achieving students in symmetrical dyads work more collaboratively, generate more cognitive conflict and resolution, and produce better quality work compared to high-achieving students working with a low-achieving classmate (Fuchs, Fuchs, Hamlett, & Karns, 1998). Lou et al. (1996), examining the effects of within-class grouping on student achievement, also found that symmetrical ability grouping was more effective compared to asymmetrical ability grouping. With respect to groups of class size, Adodo and Agbayewa (2011) found that symmetrical ability level grouping was superior for enhancing learning outcomes.

In summary, research comparing symmetrical and asymmetrical distributions of knowledge within the learning group, with knowledge defined by the relative level of ability displayed by learners in a school setting, has yielded equivocal results. Some findings suggest that asymmetrical knowledge in groups is beneficial for both the high and the low ability student and overall superior to certain symmetrical knowledge pairings (e.g., Webb, 1991). Others (e.g., Lou et al., 1996) argue that symmetry in knowledge level is essential for successful collaboration to occur.

What further limits the value of these studies for answering the question of whether collaboration in asymmetrical knowledge settings is beneficial for each collaborative partner is that ability and knowledge level are not necessarily synonymous. A student low on scholastic ability might, amongst other things, have a low potential for learning, i.e. low intelligence, a low level of procedural knowledge, i.e. knowledge about how to accomplish or to best approach a learning task, or a low level of propositional knowledge, i.e. hold little information about the material employed in a learning task. It seems important to disentangle these different factors that might each contribute to an asymmetry of knowledge in a collaborative setting.

It is also important to note that whether symmetrical or asymmetrical knowledge pairings will yield benefits for the group and/or the individuals within it likely depends on the learning outcomes that are desired. Thus, one desired outcome might be acquisition of new knowledge, an (incidental [if the collaborators do not anticipate that acquisition of knowledge is the desired outcome]) learning gain, by each individual group member. A symmetrical distribution of knowledge seems advantageous then, helping partners to communicate on the same level, and to reciprocally exchange their knowledge. In contrast, if new knowledge needs to be negotiated or the solution to a problem needs to be found, an asymmetrical distribution of knowledge might give more possibilities to think in different directions, to analyze the problem situation from different viewpoints, and to profit from multiple perspectives (cf. e.g. Dillenbourg & Hong, 2008). Indeed, Webb (1995) goes as far as to argue that especially on well-defined tasks, where a clear solution can be provided by a single competent individual, the input of less knowledgeable group members might detract from finding this solution. In such scenarios it is actually more advantageous for the problem solving efficiency of the group if less knowledgeable group members engage in behaviors that are considered maladaptive for their individual learning, like free riding or social loafing.

1.2. Identifying discrepancies in knowledge levels between partners collaborating online

The issue of whether collaborative learning works ideally when knowledge is distributed symmetrically between the partners is further encumbered by the prevalent lack of awareness of the learning partner's knowledge level. This is not a trivial issue with numerous studies emphasizing that knowing what the respective other knows supports an effective and efficient communication (e.g., Wittwer, Nückles, & Renkl, 2010). When interacting over a long period of time collaborating partners can begin to appreciate each other's knowledge level by establishing a Transactive Memory system (Wegner, 1986) that is an understanding about who knows what within the group. Gaining such an understanding is effortful, however. Without it, the collaborative effort is often plagued by biases (Nickerson, 1999), whereby people tend to infer the knowledge level of the others based on their own knowledge level. In online learning scenarios the restrictions imposed on the ability to perceive and exchange nonverbal cues, like facial expressions, further obstruct the learning partners' ability to adequately judge each other's knowledge and abilities (Buder, 2011; Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003). Even though this issue is becoming increasingly smaller since the advances in video telephony (e.g., Skype), limits upon the online transmission of