Learning and Instruction 34 (2014) 1–10

Contents lists available at ScienceDirect

Learning and Instruction

journal homepage: www.elsevier.com/locate/learninstruc

Outcome feedback during collaborative learning: Contingencies between feedback and dyad composition

Christa S.C. Asterhan*, Baruch B. Schwarz, Noa Cohen-Eliyahu

School of Education, The Hebrew University of Jerusalem, Mt Scopus, Jerusalem 91905, Israel

ARTICLE INFO

Article history:
Received 6 October 2013
Received in revised form
15 July 2014
Accepted 21 July 2014
Available online 12 August 2014

Keywords:
Collaborative learning
Feedback
Dyad composition
Proportional reasoning

ABSTRACT

The role of outcome feedback in collaborative learning settings has received little empirical attention. We examined whether outcome feedback improves learning gains in singleton and dyadic learning conditions, while specifying different dyadic pairing options. In a randomized experiment, 496 ninth-graders solved challenging tasks that required fully developed proportional reasoning to be solved correctly. Based on individual pretest performance, each student was assigned to one of three levels of proportional reasoning competence ($Wrong_1$, $Wrong_2$ and Right) and randomly assigned to either work alone or with a ($Wrong_1$, $Wrong_2$ and Right) peer. Half of the dyads and singletons were given the opportunity to empirically test their solutions and received outcome feedback from an objective testing device. The results indicated that when collaboration is considered as a general condition, learners in dyads and singletons profited equally from outcome feedback. When different dyadic compositions are specified, however, the combination of collaborating with a "Right" partner *and* receiving outcome feedback proved to be particularly powerful. Outcome feedback did not improve learning in any of the other conditions. Furthermore, and contrary to the "two-wrongs-make-a-right-effect", interaction between two different "Wrong" students did not yield larger gains than other pairing options. The outcomes are discussed in light of existing theories and research.

1. Introduction

Research has demonstrated powerful effects of feedback for student achievement in individual learning settings (see Hattie & Timperley, 2007; Kluger & DeNisi, 1996, for meta-analyses and overviews). Outcome feedback provides a judgment about the accuracy of the learner's response. It is one of the simplest and most common types of feedback in educational settings and, compared to control conditions in which no outcome feedback is provided, it is generally associated with positive outcomes (e.g., Kluger & DeNisi, 1996). In contrast to the vast amount of research on feedback in individual settings, outcome feedback is only rarely considered in the collaborative learning literature. In the present study, we investigate the effects of outcome feedback during dyadic and individual learning activities on students' learning gains. We first discuss the literature on feedback in collaborative settings, and then introduce why the effects of feedback are expected to be dependent on dyadic composition, that is: how dyads are formed based on initial cognitions and competencies.

1.1. Feedback and collaboration

Much of the research on collaborative learning has been based on the idea that peer interaction can be a powerful means for learning if and when peers engage in collaborative sense-making processes (e.g., Chi, 2009; Chi & Menekse, in press). This is evident, for example, when learners explain their thinking to a peer partner (e.g., Coleman, 1998; Van Boxtel, van der Linden, & Kanselaar, 2000; Webb, Troper, & Fall, 1995), transact on each other's ideas (e.g., Teasley, 1995), recognize conflicts between their own understanding and other perspectives (Doise, Mugny, & Perret-Clermont, 1975; Howe, 2009), and try to resolve differences through collaborative reasoning (Asterhan & Schwarz, 2007, 2009; Chan, Burtis, & Bereiter, 1997; Howe, Tolmie, Duchak-Tanner, & Rattay, 2000). However, during these collaborative sense-making activities, the correctness of newly developed understandings and problem-solving strategies is often not objectively tested or evaluated by an expert resource. Participants, then, often have no way of knowing whether their solutions are correct other than to rely on

* Corresponding author. Tel.: +972 25882072.
E-mail addresses: asterhan@huji.ac.il (C.S.C. Asterhan), baruch.schwarz@mail.huji.ac.il (B.B. Schwarz), noacoe@gmail.com (N. Cohen-Eliyahu).

http://dx.doi.org/10.1016/j.learninstruc.2014.07.003
0959-4752/

their own and their partner's capacities. This may partly explain why even though many studies have reported positive effects of collaboration, such effects are frequently small and learning outcomes suboptimal, especially for complex topic domains. Similar to individual learning settings, feedback on outcome correctness could then be expected to augment the benefits of peer dialogue, since it provides important information about the particular knowledge that is collaboratively constructed.

How could feedback about outcome correctness be integrated best during collaborative learning? Teachers may scaffold peer discussion by prompting them to engage in sense-making dialogue (Gillies, 2003; Webb, 2009) and gently steer them in certain directions. However, research has also shown that authority and adult evaluations of topic content may undermine the shared meaning-making process that is at the heart of collaborative learning (Hogan, Nastasi, & Pressley, 2000; Webb, 2009). A midway should then be found between no feedback at all and authoritative feedback. Such a midway may be provided by activities that allow children to test the correctness of their solutions autonomously with the help of an objective testing device, such as a calculator, scales or other equipment. Peer dialogue and outcome feedback can be alternated in a dialogue–feedback–dialogue sequence: First, children would be required to formulate conceptual knowledge into testable predictions and come to an agreement about which predictions to test. Then they would test and subject these predictions to empirical evaluation (Howe et al., 2000). In those instances where their predictions are disconfirmed, learners may be confronted with compelling evidence that they should reconsider the ideas and explanations that led them to these predictions, thereby creating conflict even when two learners agree on their predictions. Alternatively, in those cases where their predictions are confirmed, the explanation that led to the prediction would be validated. Subsequent sense-making dialogue is needed to interpret the outcomes, particularly in case of conflict. This combination of collaborative sense-making and outcome feedback is likely to be more powerful than either one alone (Tudge, Winterhoff, & Hogan, 1996), especially on tasks for which sense-making dialogue has been shown to be critical, such as conceptual change in complex science and mathematical domains (Asterhan & Schwarz, 2009; Schwarz, Neuman, & Biezuner, 2000). Some have postulated that groups may also be better able to deal with and make use of negative feedback than individuals (e.g., Tindale, 1989).

Yet what is the empirical evidence on such effects? The research available is sparse and has thus far solely focused on groups that consist of two peers (dyads): Schwarz and Linchevski (2007) have shown that ninth-graders who collaborated in dyads and received outcome feedback from a testing device improved their performance on proportional reasoning tasks, whereas singletons who did not receive feedback did not improve. However, the separate effects of feedback and collaboration could not be examined in this study. The separate and combined effects of feedback and dyadic collaboration have been explored in other research, albeit with mixed results: For example, in a study on learning from worked-out examples in college settings, Krause, Stark, and Mandl (2009) reported that outcome feedback equally improved performance of students that either worked alone or in homogenous dyads. In an earlier study, Ellis, Klahr, and Siegler (1993) explored the effects of outcome feedback and dyadic collaboration on fifth-graders' use of mathematical rules for decimal fractions. Their results demonstrated that collaborative conditions resulted in superior learning gains *only* when children had access to outcome feedback. Two studies by Tudge and colleagues (Tudge & Winterhoff, 1993a; Tudge et al., 1996) also focused on elementary school students' mathematical reasoning. In direct contrast to Ellis et al. (1993), they found an advantage for dyadic collaboration over individual conditions when children did *not* receive any outcome feedback (Tudge et al., 1996), and an advantage for individual conditions when feedback was provided (Tudge & Winterhoff, 1993a).

Thus, notwithstanding the theoretical rationale for combining collaboration and outcome feedback from equipment, the empirical research is sparse and the evidence available thus far leads to quite different predictions: Based on Tudge and colleagues' research, students would be expected to profit more from feedback when they work alone rather than with a peer partner, whereas based on the study by Ellis and colleagues, they would benefit particularly from the combination of peer collaboration and outcome feedback. According to Krause and colleagues, collaboration does not add anything to the positive effects of feedback.

At closer inspection, however, it appears that each of these studies considered different types of dyadic compositions: Pairing with a partner of an equal, lesser or higher competency level (Tudge et al., 1996), pairing with similar or dissimilar partners of an equal competency level (Ellis et al., 1993) or no specification of dyadic composition at all (Krause et al., 2009). These differences may, then, be responsible for the disparate findings in the literature to date.

1.2. Effects of dyadic composition in collaborative learning

Dyadic composition is based on the student's initial cognitions or levels of competence on the particular concept or problem-solving strategy under investigation. For example, wrong–right dyad configurations (W–R pairs) are made up of one student who has demonstrated a correct understanding of the topic domain prior to the interaction and another who has demonstrated an incorrect understanding of it. Wrong–wrong dyad configurations (W–W pairs) consist of two students with an incorrect prior understanding. These different dyadic configurations in peer collaboration have been the object of many studies by scholars from both the Vygotskian tradition (e.g., Forman & Cazden, 1985; Rogoff, 1998; Tudge et al., 1996) and the Piagetian tradition (e.g., Ames & Murray, 1982; Doise et al., 1975; Doise & Mugny, 1979; Perret-Clermont, 1980). Both theoretical frameworks predict that learning from interaction is not likely to be superior to that from individual learning settings when partners have the same initial cognition, and that a difference of some kind is needed. However, they predict differently *which* type of pairing is more likely to result in cognitive growth (Tudge & Winterhoff, 1993b).

According to Vygotskian scholars, interaction with a more competent peer should lead to better learning, provided that the superior understanding of the more competent peer is accepted and understood through a process of shared meaning-making (e.g., Azmitia, 1988; Garton & Pratt, 2001; Tudge & Winterhoff, 1993a). Neo-Piagetian scholars, on the other hand, have focused on the interactions between two partners with *different* initial cognitions, which are incorrect (W_x–W_y pairs). Several studies have shown that students benefit more from W_x–W_y pairing than from interaction with an R partner (Ames & Murray, 1982; Doise & Mugny, 1979; Doise et al., 1975; Glachan & Light, 1982; Schwarz et al., 2000). Ames and Murray (1982), furthermore, have demonstrated that growth from exposure to a different perspective in W_x–W_y pairs only occurs when children are given opportunities to interact and talk. Most of these studies were conducted with small children on typical Piagetian conservation tasks (but see Schwarz et al., 2000, for an exception).

Results from past investigations on optimal dyadic composition remain, then, inconclusive. Recognizing that what may be responsible for learning in either type of pairing is the extent to which students engage in productive dialogue and collaboratively attempt to establish a shared meaning (Rogoff, 1998), collaborative