2 Can Students Learn by Teaching Their Peers during Cooperative Learning?

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IS COOPERATIVE LEARNING BENEFICIAL ONLY FOR STUDENTS WHO RECEIVE HELP FROM THEIR PEERS?

Cooperative learning (CL) has a large volume of evidence that supports its practice. Johnson and Johnson (2010) refer to it as a one of the success stories in education. In reviewing the history of CL, it is possible to distinguish three different generations of research: The first generation compared CL to other ways of learning; the second one focused on the effectiveness of different CL methods; and the last generation is trying to identify the factors that mediate its success (Duran, 2018).

Despite the widely acknowledged value of cooperation and the evidence-based knowledge of its principles—in the form of methods or techniques—CL encounters considerable resistance for its systematic use. As Sharan (2010) states, it is a valued pedagogy with a problematic practice, due to the different types of barriers that teachers and schools face when using it. She points out some of these barriers that explain the gap between the promise of CL and its implementation include: The perception of CL as something with magical properties, the confusion generated by the rich variety of methods, and the lack of teacher preparation or the understanding of teaching as transmission. Many authors have been studying these barriers (e.g., Page, 2017) or difficulties in practice (e.g., Grisham & Molinelli, 2001).

From our experience, working for the last decade helping teachers and schools to use CL through different peer tutoring programmes (e.g., Duran, Flores, Oller, Thomson-Garay, & Vera, 2016), one of these barriers lies in the mind of many teachers, students, and families. It is based on the belief that CL practices benefit the learning of students who receive this pedagogical help from their peers—usually identified as students with difficulties—but have no benefits—in terms of learning—for students who offer this help, that is, those who teach others. This belief is supported by the main available explanations for learning. There is common agreement that if a student receives personalised pedagogical help from their peers, in the close and comfortable space of the team—with one, two, or three more classmates—he or she will

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certainly have opportunities to learn. But what happens when students teach others? Recognising that in CL, students learn from each other also involves acknowledging that they teach each other as well.

In fact, there is a lack of scientific explanations of the learning that occurs when individuals teach others. If we can understand and support the possibilities of learning by teaching, we will be able to overcome—or at least reduce—this barrier to the use of CL. In so doing, we will then see it as a rich learning opportunity for all the students who take part in these practices, either by receiving or giving pedagogical help.

EVIDENCE AND LIMITS OF LEARNING BY TEACHING: TOWARDS AN EXPLANATORY FRAMEWORK

We all remember situations in our lives in which we have learned by teaching others. Informal learning, powered by the Internet, is based on collaboration, and often allows participants to receive help—learn—but also to offer help—teach. When we search for how-to explanations or video tutorials—the most common request on search engines, we easily find someone who has learned something and can teach it to others.

We teachers also have experiences of having learned something to teach our students, or of having deepened our knowledge through helping them learn the content. In addition to personal experiences, there are testimonies through the ages and cultures. There are quotations attributed to famous teachers—such as *Teaching is learning twice*, by Joubert—or even the famous learning pyramid, reproduced in many articles, which claims that teaching is the best way of learning, although it is not based on any scientific evidence.

Undoubtedly, teaching others—an exclusively human activity (Calero, Goldin, & Sigman, 2018)—involves an active position on the part of the teacher. However, defending the idea that teaching is an effective way of learning needs to be supported by the available scientific knowledge.

The first empirical studies that collected data on the effects of learning in the person who teaches emerged from the evaluation of peer tutoring practices, in the 1960s in the United States. These studies documented—with surprise—that tutor students who taught their tutees made more progress than matched peers who were not tutors (Topping, Duran & Van Keer, 2016). These findings—which are maintained in current studies (Leung, 2018; Roscoe & Chi, 2007)—raised interest in explaining the phenomenon of learning by teaching. What explains the learning potential of teaching?

Following Duran (2017), we present a synthesis of the revision of studies organised into four stages: (1) Expecting to teach; (2) Presenting information; (3) Explaining the knowledge; and (4) Questioning the understanding (See Figure 2.1). This organisation gives shape to an explanatory framework of how our students themselves can learn by teaching their peers and helps to define the kind of tasks that teachers should promote, as well as those that

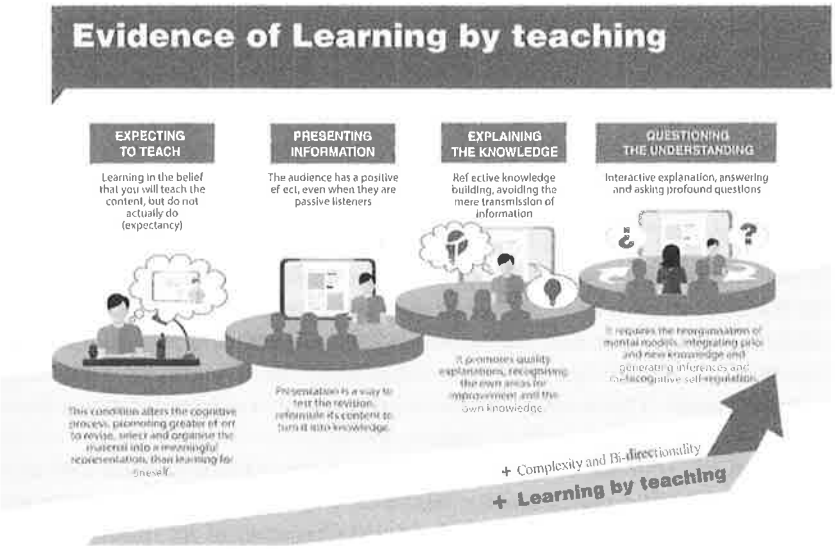

Figure 2.1 Explanatory framework of learning by teaching.

should be avoided. Not all ways of teaching offer opportunities for learning by teaching.

Expecting to Teach

Learning something for oneself and learning expecting to teach others involve different mental processes. Gartner, Kohler, and Riessmann (1971) synthesised the cognitive benefits that seem to arise when learning for later teaching: revising the material, organising the material for presentation, and identifying the basic structure. These general ideas were contrasted in an experiment by Bargh and Schul (1980), who compared students who learned for themselves—to pass a test—with students who learned in the belief that they would need to teach the content to others, even though they did not actually do so—expectancy. The results were better for students who learned in expectancy and the authors confirmed that this condition altered the learning process, promoting greater effort to select the relevant elements and organise them into a meaningful representation. However, this initial experiment had significant limitations, but it encouraged further work, such as Benware and Deci's (1984) replica, in an educational context, with identical results.

Recent studies (Fiorella & Mayer, 2013; Guerrero & Wiley, 2021; Nestojko, Bui, Kornell, & Bjork, 2014) argued that teaching expectancy promotes deeper, more selective, and more organisational processing of information to-be-taught than expecting to take a test. However, a meta-analysis by Kobayashi (2019) shows that these benefits are conditional and limited in different ways. For example, the type of audience students are expecting

to teach or the type of product (i.e., textual or audio-visual explanations) can affect this first stage of learning by teaching (Ribosa & Duran, 2022). Preparing the explanation in a collaborative way, as students do in CL, seems to be more beneficial than learning by teaching through individual preparation (Kobayashi, 2021).

Presenting Information

Subsequent studies added the possibility that participants present what they had learned, often to an examiner or to a video camera. Presenting things to others is a way to test how our mind reviews and reformulates information to turn it into knowledge, just as we consolidate our thoughts by explaining them to friends. This is also true for situations with a passive listener, which is known as the audience effect (Zajonc, 1966).

The most significant study in this area by Annis (1983) divided 130 students into five different situations, where they all learned the same content. One group was taught the material; another group read it; another group read the material and was also taught; another group learned to teach the content but did not actually do so—expectancy—and, finally, the last group learned and explained the content. When students were assessed in terms of cognitive benefits, students who were asked to prepare to teach performed better, especially those who actually had the opportunity to do so. Annis agreed with previous works that teaching others favoured verbal learning and required more attention to what you teach—and learn—as it involved personally coding and associating the content with prior knowledge.

Following Annis' (1983) research, further research provided similar results (Ehly, Keith, & Bratton, 1987), even when the content variable is controlled (Lambiotte et al., 1987). The comparison between these two situations of learning by teaching (*expectancy* and *presenting)* still attracts interest nowadays. Fiorella and Mayer (2013) argue that both situations promote learning, but preparing and producing explanations for others increases the results in long-term assessments.

Explaining the Knowledge

Explaining—not only presenting information—involves considering the target audience; adjusting the information to their needs, interests, or characteristics; and checking their comprehension. A meta-analysis on tutor learning in peer tutoring conducted by Roscoe and Chi (2007) concludes that, like self-explaining, explaining to others offers ample opportunities for the tutors to become involved in *reflective knowledge building* that leads to learning: producing quality explanations, recognising their own areas for improvement, reorganising their own knowledge, and inferring to repair the errors. In addition, using examples or representations may allow the explainers to deepen their own knowledge. To do so, the tutors must perform an important

metacognitive activity: assessing their own knowledge and checking whether their explanations make sense and are logical.

However, their review of the research indicates that tutors do not always take advantage of the opportunity to learn by explaining. It seems that rather than *building* knowledge, many tutors limit themselves to *knowledge telling*. They tend to offer explanations as built-in responses to questions, summarise information or describe procedures with little preparation. As emphasised in the prior learning-by-teaching stage, *telling* knowledge can have a positive impact on tutors' own learning—reinforcing memorisation—and forms the basis of the knowledge construction process. Sadly, tutors often do not take advantage of their role and learn more and better through building knowledge. Consequently, not all the ways of explaining have the same effect on learning by teaching. But the good news is that teachers can promote this process by helping tutors to recognise their own Zone of Tutor Development—which is the difference between what they can already teach and what they have not had the opportunity to teach yet (Roscoe, 2014)—and offer them some training (Topping et al., 2016).

There is another body of research that goes beyond the reasons why we can learn by teaching and uses this potential to develop instructional software. Biswas, Schwartz, Leelawong, and Vye (2005) have designed *teachable agents*—computer programmes that simulate a learner to be taught—so that the student can learn by teaching. This approach may raise doubts about whether it is worth making such an effort to place a student in front of an artificial intelligence software, which can hardly offer the richness and complexity of the mind of real classmates. However, these studies are providing clear evidence of how learning by explaining can foster knowledge building.

Questioning the Understanding

When the student who teaches considers the audience—his or her tutee or groupmates—the other common activity along with explaining is questioning, which includes both asking and answering questions. As Roscoe and Chi (2007) note, tutors ask questions to introduce topics and to guide the tutees' line of thinking, and answer questions arising from the tutees' confusion. Asking implies putting a problem into words and articulating the question to generate an answer, organising, and integrating concepts and high-level reasoning. Questioning becomes more beneficial when questions are profound and require the integration of prior and new knowledge, reorganisation of mental models, generation of inferences, and metacognitive self-regulation (King, 1998).

Tutors can benefit from formulating questions that help the tutee to think deeply: They may ask the tutees to contrast concepts, apply them, or find causal relationships. Therefore, tutors must think how to generate questions, but they also must think about ideas, relationships, and principles required to elaborate a correct answer. They thus reorganise their own understanding

and can detect gaps. So, questioning and answering can increase the tutors' involvement in the reflective construction of knowledge and their own learning, overcoming the phase of *telling* knowledge.

Nonetheless, as Roscoe and Chi (2007) indicate, when tutors teach their tutees, they spontaneously tend to *tell* the knowledge, except when they are instructed to go further. In measurements of comprehension and recall, tutors that were trained to ask and answer questions outperformed those that were less trained in terms of their own learning. The quality of the questions is a key factor to explain reflective knowledge construction.

Obviously, it is difficult to promote such dialogues based on deep questioning through the interactions between a teacher and a large group of students. However, it is not that difficult in contexts with few participants, such as cooperative teams or peer tutoring settings. The classic structure of the IRF educational discourse (Sinclair & Coulthard, 1975)—teacher Initiates; student Responds, and teacher offers Feedback—is enriched in the reduced contexts of teamwork, using a dialogue in which participants together improve the quality of the response (Graesser, D'Mello, & Cade, 2009). In this collaborative phase, participants jointly construct knowledge, rather than simply telling knowledge, offering adjusted aids through dialogic behaviours (Duran & Monereo, 2005). These open development zones allow the most expert participants to learn by teaching.

As we have indicated, there is enough evidence to know that some teaching actions can promote student learning by teaching: creating expectation, offering them an audience, promoting that they explain what they have studied, and having them ask and answer deep questions. Each of these actions incorporates the previous one, so that the more we progress towards forms of teaching that move away from transmission and promote bidirectionality, the more opportunities our students have to learn by teaching.

EDUCATIONAL PRACTICES CONTAINING LEARNING BY TEACHING: COOPERATIVE LEARNING

The components and actions we have reviewed make it possible to identify and help develop educational practices that implicitly or explicitly contain the learning-by-teaching principle. Of course, there are no practices *of* learning by teaching, as if it was a pedagogical method. Rather, there are enriching and complementary practices—along with others that teachers use—that include this principle. Following Duran and Topping (2017), we present some of these practices below, paying special attention to CL.

Learning by Developing Educational Materials

Along the lines of expectancy, students learn by creating a teaching material that will allow others to learn at a later stage, known as Indirect or non-interactive

teaching (Kobayashi, 2019; Lachner, Hoogerheide, van Gog, & Renkl, 2021). For example, making video tutorials (Ribosa & Duran, 2021).

Learning by Replacing the Teacher in Front of the Class

Whilst there are many practices across all levels of the education system where students replace teachers for some functions, it is at university where such practices have been documented for some time. In a review of *peer teaching* experiences, Goldschmid and Goldschmid (1976) identified discussion groups led by students who, having already studied the subject, helped other students in groups. Although the focus was originally on the learners, seen as the assistant students who acted as substitutes for the teacher, many of these practices have progressively been incorporated into curricular activities, assessing the assistant student's own learning. One example is the model called LdL (*Lernen durch Lehnren* or Learning-by-teaching), in which students prepare lessons (Grzega & Schöner, 2008).

Peer Tutoring, Students Learning by Teaching Peers

As seen in the previous section, the first evidence of learning by teaching came from peer tutoring. In a formal context, we can understand peer tutoring as a peer learning method based on the creation of pairs, with an asymmetrical relationship, derived from their respective roles: Tutor and tutee (Topping et al., 2016). Moving away from simple pair work, peer tutoring involves a more able student helping another student, and this requires previous planning of the interaction between both members, so that the student tutor can learn by teaching and the tutee can also learn by receiving personalised help.

Peer Assessment, Learning by Correcting, and Providing Feedback

Having the opportunity to assess their peers—and to be assessed by peers—can also be a good way for students to learn, reflecting on how others have dealt with the same activity, learning from their mistakes, and providing feedback. Therefore, peer assessment has been considered a form of peer learning (Falchikov, 2001). As not all forms of feedback are effective (Topping, 2018), it is worth training the assessors. Choosing the right level of support will enable students—as assessors—to become involved in the construction of reflective knowledge, and therefore, to learn by teaching.

Students as Co-Teachers

The existence of established practices of co-teaching—between two teachers—and the growing use of peer learning in North American schools have given rise to a new form of co-teaching: students acting as co-teachers (Villa, Thousand, & Nevin, 2010). From interesting practices reported in secondary

schools, but easy to transfer to other educational stages, the authors propose different ways of sharing teaching with students.

Learning-by-Teaching through Cooperative Learning Techniques and Methods

All cooperative structures, understood as pedagogical designs that promote positive interdependence and individual accountability (Johnson & Johnson, 2010), include episodes of learning by teaching, to a greater or lesser extent. As stated at the beginning of this chapter, students who work in teams learn from each other, which means that they teach each other.

To illustrate this point, let us take one of the most well-known and researched CL methods: Jigsaw (Aronson & Patnoe, 2011). Surely, similar analyses can be done with other CL methods (Davidson, 2021). However, Jigsaw is adequate because its consecutive steps allow us to identify different components of learning by teaching, and in some cases stress them to guarantee the learning of the students when helping their teammates.

In Jigsaw, students take part in small teams—generally four or five members. Each member is assigned to learn a part of the material or content necessary to reach the learning objective. For example, if the lesson goal is to learn about four different kinds of renewable energy sources, each member of the team will be responsible for one of them. This is using the principle of expectancy: Knowing that they will be able to teach their part, students will make a better effort than when they simply study for themselves. Thus, it is important to raise the awareness that they are learning to teach their teammates—and we should provide the necessary help for effectively doing so. At the same time, the stress that can emerge from having to teach their peers has to be managed to encourage students' responsibility towards the learning of their classmates.

Considering that every student will teach their teammates, the teacher has to offer resources and help not only to master the content (i.e., their assigned renewable energy source, in this example) but also to know how to present it to others. In the expert groups, which in Jigsaw are temporary groups with one student from each team assigned to the same content (i.e., energy source), it is important to take time to review the material, organising it for the presentation, identifying its structure—main and secondary ideas— and preparing the explanation through different formats—supported by teaching materials, examples, activities, or questions to check comprehension. Since students are learning to teach, it is important that they discuss strategies of how to best present the material and to rehearse the presentation in their expert groups (Aronson, 2021). In short, expert groups are not only the place where students learn the content but also the context where they collaboratively prepare what they will teach (Kobayashi, 2021).

On returning to their teams, students experience the audience effect. To increase this effect, it is important to reinforce the positive independence: All the team members need to listen carefully to understand the presentations,

because every part is equally important for obtaining the group's goal. Moreover, the situation of tutoring three or four teammates allows for adjusting the presentation, using different formats, as well as contextualising the explanation, activities, and examples. Promoting these adjustments, instead of just *telling* knowledge, allows students to have opportunities for *reflective* knowledge building (Roscoe & Chi, 2007).

The possibilities of dialogue allow students not only to ask the planned questions to check the understanding of their teammates, but also to answer to deep questions from them. Knowing that questioning is an important part of learning by teaching (Roscoe & Chi, 2007), it is important to foster it. When teammates ask questions that the presenter is unable to answer so that he or she requires the teacher's help, it will be a great opportunity to gain a deeper understanding of the topic at hand.

CONCLUSION

A better understanding of how students can learn by teaching their peers may help to introduce CL into classrooms and schools. In CL settings, students learn and teach each other. Classrooms can become communities where not only do students learn from their teachers but also from their peers. For this reason, CL poses an important challenge to teachers: sharing teaching—the last monopoly they have—with their students. If we introduce practices based on learning by teaching, just as we introduced learning by doing in the past, we will be promoting opportunities for our students to learn to teach. Moreover, learning to teach others is a necessary competence if we want to build a democratic knowledge society, in which people must learn—and teach—throughout their lives.

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