WileyPLUS Learning Space

What Happens When We Learn Together

A Research-Based Whitepaper on the Power of Collaborative Learning

November, 2014

Dr. Bruce McLaren, Carnegie Mellon University

WILEY

At Wiley, we are dedicated to helping institutions and educators improve student outcomes, supported by the latest and best learning research. Our recently released teaching and learning environment, *WileyPLUS Learning Space*, embraces and leverages concepts of collaborative learning. In this white paper, we review some general concepts of collaborative learning, especially collaborative learning with technology, the empirical research that supports it, and how Wiley's new educational technology is informed by the latest research and trends.

100% of surveyed universities and colleges are now using social media for some educational purpose...

The NMC Horizon Report 2014 (Johnson 2014) recently featured collaborative learning as one of its "fast trends," those developments that are quickly shaping the educational landscape in higher education for both students and educators. A variety of technologies are helping to facilitate the trend toward collaborative learning. For instance, the NMC report cites a University of Massachusetts Dartmouth study that found that 100% of surveyed universities and colleges are now using social media for some educational purpose, with the incorporation of video and blogs the most common features (Johnson 2014). The integration of in-class social networks, blogs, wikis, and eportfolios is becoming commonplace, and the variety of tools available to educators has grown dramatically over the last five years. Wikispaces claims that almost 8 million students are currently using their platform, and in 2014, $125 billion was invested in new education technology companies, with an additional $559 million in the first quarter of 2014 (CB Insights, 2014). While not all of these tools are focused on collaborative learning, many are and all are aimed at improving student/educator communication and student engagement, connecting students to their instructors and peers in new ways. Wiley is using its expertise not just to take advantage of the new connectivity available to students and educators, but to create a learning experience that achieves the goal of improving learning outcomes for all learners.

What Is Collaborative Learning?

According to Gerlach (1994), collaborative learning is "based on the idea that learning is a naturally social act in which the participants talk among themselves." This idea is central to *constructivism*, a theory of learning that states that learning first occurs in a social context, such as the talk Gerlach mentions, before it transfers to individuals. Collaboration and collaborative learning have been a part of our culture from the beginning of our evolution; we are inherently social beings and social learners. When collaborative learning techniques are used to support instruction, students tend to be more engaged, retain information better, and have better learning outcomes than those of individual learners.

...we are inherently social beings and social learners.

Collaborative learning is gaining prominence as an instructional approach in our educational institutions, perhaps even taking center stage, due to three key factors.

Collaborative learning is gaining prominence as an instructional approach in our educational institutions...

First, there is robust, and still accumulating, evidence of the benefits of collaborative learning. Educational psychologists have been studying collaborative learning for many years (e.g., Johnson et al, 1981; Sharan & Sharan, 1992; Slavin, 1983), and there is a strong understanding of what makes it successful and what inhibits it (Webb, 2013). A relatively new multidisciplinary research field—the Learning Sciences—has emerged over the past two decades to continue the exploration of and experimentation with collaborative learning, with technological support of collaboration a central research theme within this research community.

Second, many state and national educational standards now include recommendations in support of collaborative learning, in particular to help students develop both language and mathematics skills (Common Core, 2014). It is also now common for the "Four C's" to be cited as critical to 21st century education, with collaboration as one of the Cs, along with critical thinking, communication, and creativity (NEA, 2012). Educators have recognized that students enjoy and benefit from interacting and collaborating with one another, and teachers like to use students as an additional educational resource by having them help one another in collaborative groups.

Finally, computer technology—and in particular the Internet and social networking software—supports and enables collaboration in ways that were previously not possible. Kids are growing up with Facebook, Twitter, Instagram, Pinterest, as well as many other web-based collaborative tools, such as wikis and blogs, that make instant communication and collaboration part of everyday life, work, and education. In addition, educational technology researchers are developing Artificial Intelligence-based techniques and tools that support and guide collaboration (Adamson et al, 2014; Kumar et al, 2007; McLaren, Scheuer, & Miksatko, 2010). Tools such as these allow people to communicate and collaborate effectively in ways that were not possible, or even imaginable, ten years ago.

The Structure of Collaborative Learning

Collaborative learning typically involves students working together who have relatively equal standing (i.e., the same age or grade and close to the same level of understanding of the topic). Collaborating students also typically share the same goal or expected outcome in working together (Johnson & Johnson, 1994). Thus, a knowledgeable tutor or teacher instructing a student would not be "collaborative learning," whereas a group of students of roughly equal age and ability who are given a shared assignment (i.e., a common goal) would be an example of a collaborative learning scenario. Ideally, a collaborative learning group will also have interdependence (Johnson & Johnson, 1991), meaning that there is a mutual need among members of the group for one another's contributions, so that all members are equally invested in the group goal.

Collaborative learning groups can range from a pair of students (called a dyad), to small groups (3-5 students), to classroom learning (25-35 students), on to large-scale online learning (hundreds or even thousands of students). Most collaborative learning research until now has focused on dyads and small groups, since this is the group size where students are most likely to have an opportunity to contribute and where creating interdependence is most easily arranged. This is also the typical size of groups formed within classrooms, where the majority of collaborative learning research has traditionally focused. However, while the opportunities for students to collaborate used to be limited by the physical and practical limitations of the classroom, as technology has advanced and improved, the prospects for learners to connect remotely and collaborate on a larger scale have increased dramatically. Collaborative scenarios that have emerged from these technological advances include synchronous classrooms, collaborative learning spaces (such as wikis, real-time learning communities facilitated by social networking sites and software), and peer-to-peer learning support sites. All of these scenarios can be supported by a range of devices (i.e., computers, tablets, smartphones), connecting learners wherever they are.

..the prospects for learners to connect remotely and collaborate on a larger scale have increased dramatically.

How is Collaborative Learning Promoted or Suppressed?

Educational psychologists who have studied collaboration—not necessarily or even typically computer-mediated collaboration—have identified a variety of behavioral and interaction mechanisms that both promote and suppress learning in groups (Webb, 2013). As we consider how technology might support fruitful collaboration, it is important to first review and reflect upon these mechanisms.

Promotion Mechanisms

Promotion Mechanism 1:
PREPARATION FOR COLLABORATION

Rummel and Spada (2005), found evidence that time spent individually preparing for collaboration—in their case, students studied video examples of good collaboration before actually collaborating with another student—leads to better collaboration and learning results. When students spend time rehearsing and preparing what they know in order to present it to fellow students, they are often led to a deeper understanding of the material themselves (Bargh & Schul, 1980). This result is unsurprising; anyone who has ever taught or tutored students can certainly attest to the value of preparation and how it helps the instructor learn (or reinforce) what they will teach.

Promotion Mechanism 2:
LEARNING THROUGH EXPLANATION

When students present their ideas to help fellow students understand material—when they take on the role of teacher or tutor, in other words—they often end up understanding the material better themselves (Webb & Palinscar, 1996; Howe et al, 2007). Particular types of explanations given by students have also been shown to be critical to learning. For instance, it has been shown that *giving complex explanations*, those supported by a variety of evidence and/or well elaborated (Chinn, O'Donnell, & Jinks, 2000), or *giving conceptual explanations*, those supported by underlying concepts, such as how an answer makes sense (Fuchs et al, 1997), leads to better learning outcomes. Of course, many students do not explain material in complex or conceptual ways; these students generally do not benefit as much from collaboration as those who do. On the other side of the "explanation coin"—*receiving explanations and acting upon them*—Vygotsky (1978) theorized that a student's learning can be enhanced by actively listening to a more knowledgeable student and then applying what is learned to the task at hand. Vedder (1985) and others have empirically demonstrated how receiving explanations can benefit students.

Promotion Mechanism 3:
BUILDING UPON ONE ANOTHER'S IDEAS

A final critical collaboration-based behavior to promote learning is that of students building upon one another's ideas, sometimes referred to as "knowledge building" (Scardamalia & Bereiter, 2006) or "knowledge co-construction" (Vygotsky, 1978). The idea of knowledge building, with an emphasis on developing knowledge as a group rather than as individuals, playing off of one another's ideas and developing those ideas further, can spark students' interest and enthusiasm in collaborating with one another.

Suppression Mechanisms

Suppression Mechanism 1:
FAILURE TO PROVIDE ELABORATED EXPLANATIONS

The flip side of students giving complex or conceptual explanations is the *failure to provide elaborated explanations* (Galton et al, 1999). When students simply restate or rephrase information with little elaboration, it has been shown that these students will have limited and weak collaboration and learning (Roscoe & Chi, 2008).

Suppression Mechanism 2:
FAILING TO SEEK AND OBTAIN HELP

Another behavior that can hurt collaboration is *failing to seek and obtain help* (Nelson-Le Gall, 1992). Students are often unaware of their need for help or, when they are aware of their need, they may seek help that is irrelevant or ineffective. Also, students may not seek help for other reasons, such as not wanting to appear "dumb" or dependent on other students (Ryan, Pintrich, & Midgley, 2001).

Suppression Mechanism 3:
SUPPRESSED STUDENT PARTICIPATION

Another mechanism that hurts collaboration is *suppressed student participation*. For instance, students may feel inadequate and thus not fully participate when working with higher status or higher achieving peers (Cohen & Lotan, 1995). Issues of race and gender may also play a role, (i.e., white, male students being more active and vocally dominant than students of color or female students). There is also the relatively common and well-known case of students choosing not to participate, getting a "free ride." In such cases, more active members of a group may start to contribute less when they detect that some members are not giving their full effort (Salomon & Globerson, 1989).

Suppression Mechanism 4:
COGNITIVE CONFLICT

There is also a problem in groups when students have *too little or too much cognitive conflict* (Bearison, Magzamen, & Filardo, 1986). Cognitive conflict refers to how much students agree or disagree about the topic they are discussing or problem they are solving. If there is too much agreement, relevant and important new ideas may not be introduced and incorrect ideas may go unchallenged. One reason why students sometimes avoid disagreement is to maintain positive social relationships (Chiu & Khoo, 2003). On the other hand, if there is too much disagreement, students may spend all of their time fruitlessly arguing, with no new ideas being introduced or accepted by group members.

Suppression Mechanism 5:
LACK OF COORDINATION

Sometimes *lack of coordination* causes problems in collaboration. For instance, students may not take turns listening to one another, may reject one another's proposals without careful consideration, or may advocate only for their own ideas and contributions to a discussion (Barron, 2000). In well coordinated groups, students listen intently to one another's ideas and build upon them.

Suppression Mechanism 6:
NEGATIVE SOCIAL BEHAVIOR

A final detriment to effective collaboration is *negative social behavior*. When students are rude or unresponsive to one another, such as berating a fellow student or consciously ignoring fellow students, the quality of the group's work suffers (Chiu & Khoo, 2003).

Approaches to Support Effective Collaborative Learning

So what can be done to help promote these positive behaviors and, at the same time, suppress the negative behaviors in support of effective collaborative learning? Leaving students to their own devices is not the solution; researchers have found that effective collaboration and discussion typically do not occur spontaneously and without support (Barron, 2000; Dillenbourg, Baker, Blaye, & O'Malley, 1995; Slavin, 1992). In unstructured collaborative groups, the promotive behaviors discussed above are typically not present (or erratically present), while the suppressive behaviors are very common. Thus, it appears that collaboration needs to be structured or scaffolded to be truly effective, which is what we have strived for in *WileyPLUS Learning Space*'s design.

...effective collaboration and discussion typically do not occur spontaneously and without support.

Approaches that have been developed to support effective collaboration, and to address some of the above issues, are *collaboration scripts, structured controversy, explanation/ sentence opener prompts, discussion diagramming,* and *support for teacher interventions.* We discuss each in turn.

- ***Collaboration scripts*** (Fischer et al, 2013) are like movie scripts in which the phases of work or roles are predefined so that students have a blueprint to follow as they work together. Rummel and Spada (2005), mentioned previously, addressed the issue of preparing students for collaboration by guiding students with *activity scripts*, in which they first worked individually (i.e., studied good collaboration examples) and then collaborated on a task. Activity scripts can be quite elaborate, for instance with multiple alternating phases of prescribed activity, or relatively straightforward such as the Rummel and Spada approach. *Role scripts* can be helpful in making sure students find a way to contribute to group work by assigning specific roles to individuals, such as Leader, Summarizer, Reviewer, Facilitator, or Tutor/Tutee (O'Donnell & Dansereau, 1992; King, 1999). Roles can rotate to allow all students to take on different responsibilities and to give every student a chance to, for instance, give explanations (e.g., as a Tutor) and receive and act on explanations (e.g., as a Tutee), which are two of the collaboration promoting behaviors mentioned earlier. A specific type of role script, the jigsaw design (Aronson & Patnoe, 2011), has been extensively used to promote effective student collaboration. The jigsaw classroom, originally designed by Elliot Aronson in the 1960s as a way to minimize racial conflict, putting students on a more equal footing with one another, works by giving students separate problems to work on that depend on one another, thus leading to a reciprocal need and equality when they join together to work in a group. More recently, researchers have recognized the importance of collaboration scripts that adapt to the behavior and progress of students (Gweon et al, 2006). External scripts, imposed from outside the student, eventually must give way to "internal scripts" as students learn to become good collaborators on their own (Stegmann, Mu, Gehlen-Baum, & Fischer, 2011).
- ***Structured controversy*** involves having students read and review different, conflicting sides of an issue and then joining together in discussion and debate (Johnson & Johnson,

1995; Scheuer, McLaren, Weinberger, & Niebuhr, 2013). This approach helps students see different sides of an issue, pushes conflict front and center and thus avoids the suppression mechanism of "too little cognitive conflict."

- In order to promote effective **explanations**—in particular, elaborated and conceptual explanations—***sentence opener prompts*** are another structuring technique that has been developed and studied extensively by researchers (Coleman, 1998; McAlister, Ravenscroft, & Scanlon, 2004; Scheuer et al, 2013). Explanation prompts, such as "Explain why you believe that your answer is correct or wrong" are intended to help students think more deeply about their answers and to justify and/or relate responses to underlying concepts. Sentence-opener prompts, such as "I believe this answer is correct because _____", are intended to help students identify ways to effectively discuss and justify their conclusions. The goal is that once the prompts are not provided, the student will have incorporated their use well enough to use them without prompting.

- If student collaboration is focused on discussion and argumentation—learning good debate skills through reasoned argumentation—the approach of ***discussion diagramming*** (Nussbaum & Schraw, 2007), creating diagrams that outline and represent different arguments and perspectives on an issue, has proven to be successful. In this approach students collaboratively make contributions to an argument in a shared and evolving workspace (Scheuer et al, 2010). The shared discussion diagram can help guide the discussion and, later, in reflecting on and reviewing group work.

- Finally, ***support for teacher interventions*** with small groups is an important way to structure collaboration—and also empowers teachers (Johnson & Johnson, 2008). Some of the conditions teachers look for include one or more students dominating a discussion, one or more students retreating from a discussion, and students making unsupported claims (Ding, Li, Piccolo, & Kulm, 2007). Recently, techniques have been developed to automatically evaluate collaborative arguments and provide feedback and "alerts", to help teachers find some of these conditions so they can intervene and guide student groups within a classroom (McLaren, Scheuer, & Mikšátko, 2010). This is one of the ways that new and advanced technology can make a big impact on collaborative learning.

Most of the fundamental research on collaboration-promoting approaches originally came from investigating group work and learning in face-to-face collaboration without computer mediation. Yet, computers and the Internet provide an opportunity to follow and guide collaborative work and learning in ways that were much more difficult for earlier, non-computer-based research. Into this void, the field of computer-supported collaborative learning (CSCL) has emerged over the past 25 years. CSCL draws heavily from learning theories that emphasize that knowledge is the result of learners interacting with one another, sharing knowledge, and building knowledge as a group. In CSCL research computers are used for communication, as a common resource, or to intelligently guide collaboration. A big emphasis in CSCL is on interaction processes; that is, how students communicate and interact with one another, instead of strictly focusing on outcomes (e.g. posttest results, learning gains). *WileyPLUS Learning Space* is reflective of best practices in CSCL design, and is focused heavily on interaction, sharing and building knowledge, ensuring that learners are as engaged in their learning as they can be. It will provide instructors with rubrics for collaborative activities, which instructors can use, adapt, or replace with their own. Additionally, it offers both asynchronous and synchronous communication, which will allow for student/instructor and student/student interaction no matter when or where a student is studying.

What Do the Learning Sciences Have to Offer to Achieving Effective Collaborative Learning?

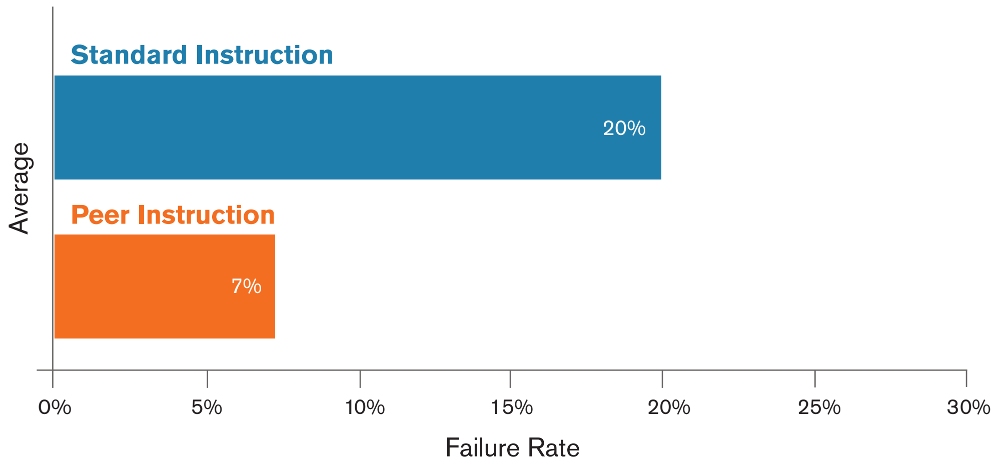
Given the promise that educational software, and in particular Internet-based technologies such as social networks, blogs, wikis, and eportfolios, brings to collaborative learning, what role will the Learning Sciences play? The Learning Sciences explore how people learn, the techniques and approaches that are best for learning, and how technology can best support that learning. Computer Supported Collaborative Learning (CSCL) is a subfield of the Learning Sciences.

The interdisciplinary mix of contributors to the Learning Sciences—educational psychology, cognitive science, artificial intelligence, computer science—is vital to addressing the challenges and possibilities of collaborative educational software. All of these academic fields—some more focused on human learning and psychology, some more on advanced technology—play a key role in the Learning Sciences. We have so far reviewed findings that come primarily from educational psychology and cognitive science, but these results have been absorbed and leveraged by researchers and developers in computer science and artificial intelligence to help in building the collaborative learning systems of today and tomorrow. In the following section we discuss how some of these findings about collaborative learning have been turned into educational software to support collaboration and learning.

Research Into Collaborative Learning Assisted by Technology

The use and benefits of collaboration, supported by technology, have been shown in a variety of research studies. For instance, Beth Simon and colleagues (Porter, Bailey-Lee, & Simon, 2013) compared standard instruction to technology-supported peer instruction (Crouch & Mazur, 2001) in a large, multi-year study of computer science classes. In the Standard Instruction version of the course, it was business as usual (i.e., lectures, quizzes, etc). In the Peer Instruction version of the course, students used clickers to answer instructor-posed questions, followed by peer conversation and re-clicking during class. Simon, et al conducted a study of classes from 2001 through 2012, involving almost 11,000 students (Total = 10,680 students; Standard Instruction = 8,612; Peer Instruction = 2,068). As can be seen from the graph below, the students in the Peer Instruction version of the course had a significantly lower failure rate over the 12-year duration of study (Only 7% of the Peer Instruction students failed, while 20% of the Standard Instruction students failed).

The benefits of collaboration, supported by technology, have been shown in a variety of research studies.



Only 7% of the Peer Instruction students failed, while 20% of the Standard Instruction students failed.

A collaborative learning system that has shown benefits to students is WISE (Linn, Clark, & Slotta, 2003, http://wise.berkeley.edu/), a software platform designed to support science inquiry activities. This educational technology system is intended to support students as they collaboratively observe, analyze, and experiment with scientific concepts and is based on an approach, called scaffolded knowledge integration, developed by Marcia Linn (Linn, 1995). The WISE system scaffolds learning using some of the collaboration-promoting approaches earlier mentioned, such as role scripting, activity scripting and discussion diagramming. It provides cognitive hints, a means for students to write reflection notes, a tool to do concept mapping, and a tool for discussion. WISE is typically used by pairs of students working together on science challenges.

VMT-Basilica (Kumar et al, 2007) is a collaborative learning system that uses so-called “conversational agents” or “virtual partners” to help spur and adapt conversation in solving joint design problems. The virtual partners, developed using AI natural language techniques, make contributions to keep the conversation moving, raising and answering questions and using conversational techniques to engage the small group of students in discussion. Kumar developed a system called VMT-Basilica, which is used by students to collaboratively design a power plant. The conversational agent discusses thermodynamics with students and suggests design alternatives. This is a form of “adaptive scripting” because the conversational agent adapts to what the collaborating students are saying, as they try to engage them.

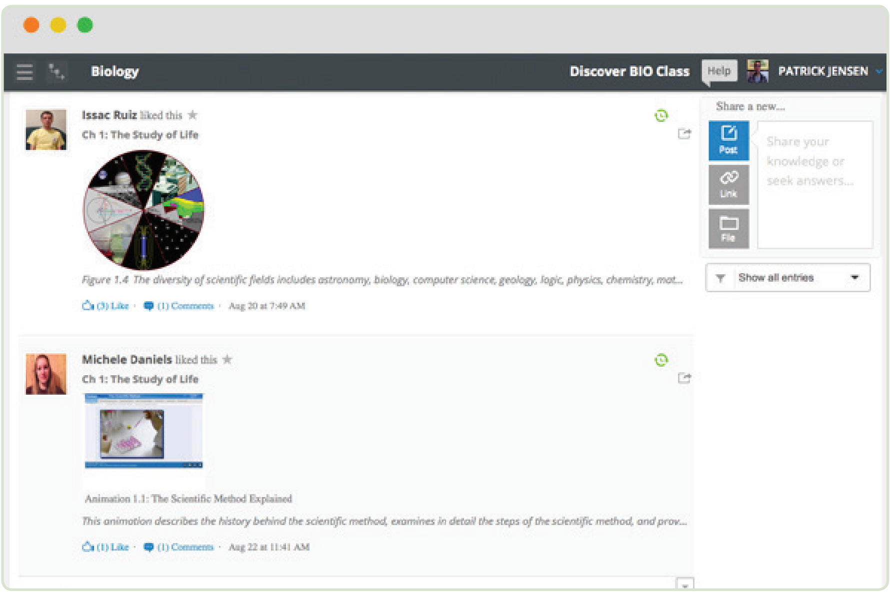
Another example of a collaborative learning system is LASAD, a web-based argumentation environment, in which students collaboratively debate issues (Loll, Pinkwart, Scheuer, & McLaren, 2012). The purpose of LASAD is to help students in collaboratively engaging in and learning argumentation and critical thinking skills. Students work on separate computers but share a workspace, offering contributions to the shared workspace that are connected to one another in an evolving argument. LASAD employs collaborative scripting methods to guide students in their learning and debating, such as providing sentence openers to scaffold their interaction, and also uses automated techniques to analyze student interaction. In one of the studies conducted with LASAD (Scheuer et al, 2013), individual students of collaborating pairs were each given a different controversial text to read (an example of the structured controversy approach to collaboration, discussed above) and then were asked to diagram the argument they had just read. Next, some students were guided in conversation about their diagrams by sentence openers (another approach previously discussed) as they discussed and debated their conflicting texts. This approach improved students’ argumentation and learning, versus an approach that did not use sentence openers.

These are just a few examples of collaborative learning systems that have emerged from research. For the most part, these are "systems of the future" in the sense that they are still being designed, developed, and researched; they are not yet widely and routinely used in schools or educational institutions.

How *WileyPLUS Learning Space* Supports Collaborative Learning

Support for collaborative learning is inherent in the design of *WileyPLUS Learning Space* preparation, learning through explanation, and building upon one another's ideas—the key behaviors identified earlier in this document as essential in promoting collaborative learning—are at the core of the pedagogical framework of the system. Through individual study tools, the "Course Stream" (a running list of all shared posts, links, files, and discussions), and more formal groups, students have multiple and varied opportunities for collaborative learning.

Through individual study tools, the "Course Stream" (a running list of all shared posts, links, files, and discussions) and more formal groups, students have multiple and varied opportunities for collaborative learning.



Students are able to prepare for collaborative tasks and group assignments by individual study (supported in *WileyPLUS Learning Space* by tools such as note taking, highlighting, bookmarking) as well as by interacting with one another on a less formal level and in non-graded social interactions via the Course Stream. In this environment, students can create ad hoc groups to help each other, while being able to choose how much and with whom they want to share.

One type of social interaction supported by *WileyPLUS Learning Space* is the opportunity for students to insert questions or comments anywhere in the course content and share these with others. If a student doesn't understand something in the course, be it in the text, an assignment, etc., he or she can post a question in the Course Stream. Another student may answer the question, or find an online resource that helps clarify the concept, and post it for the benefit of the entire class. Some students may post helpful resources before others have even asked for them. Students thus build on each other's ideas and at the same time help curate and supplement the course content with their own contributions. This form of peer learning supports the concept of “learning through explanation” and has been shown to be particularly beneficial for improving higher order cognitive tasks that require application, analysis, and synthesis (Linton, Farmer, & Peterson, 2014).

Students have immediate access to the instructor and/or their peers if needed, so that they can ask for help from their preferred source at the point of need. Also, the system reinforces the expectation that when participation is required it is easily monitored to ensure that no one gets lost in the process.

This feature also addresses some of the suppression mechanisms discussed earlier, particularly “failure to seek and obtain help.” Because students have the ability to control with whom they share their questions and comments, they can seek help from peers or instructors, either publicly or privately, based on their preferences and level of comfort. This can minimize at least some of the reasons behind students’ reluctance to seek help identified by Webb, such as fear of being judged or appear incompetent (Webb, 2013). These students may also feel that they are the only ones who do not understand the material; seeing questions from other students helps them to understand that they are not alone and may encourage them to seek help.

Because student participation and engagement can be monitored by the instructor, he or she can intervene if imbalance in student participation and contributions is evident. In addition, students are able to monitor their own engagement metrics on the dashboard (see Figure below: Dashboard) and compare them to those of others, which can increase their motivation to participate and contribute. Explicit grading criteria for formal group assignments in the form of evaluation rubrics is another tool by which a balanced student participation can be encouraged.

The instructor can address cognitive conflicts, if they arise, by monitoring students' interactions and contributions and guiding and scaffolding their work or by introducing new resources that can stimulate further discussion and collaboration. *WileyPLUS Learning Space* also allows for changing and re-forming groups so that instructors can intervene and create new, more or less heterogeneous groups as necessary.

WileyPLUS Learning Space also provides mechanisms to minimize negative or inappropriate student behavior and posts. Students are able to "report abuse" and alert the instructor to any comment or resource posted by another student, even in interactions otherwise not monitored by the instructor. Multiple "abuse" reports on a single posting will result in automatic removal from the Course Stream.

The Benefits of Collaborative Learning in *WileyPLUS Learning Space*

Let's look at how the capabilities that support collaborative learning in *WileyPLUS Learning Space* provide benefits for students, teachers, and institutions.

Benefits to Students

Students are able to benefit from the *WileyPLUS Learning Space* in a variety of ways:

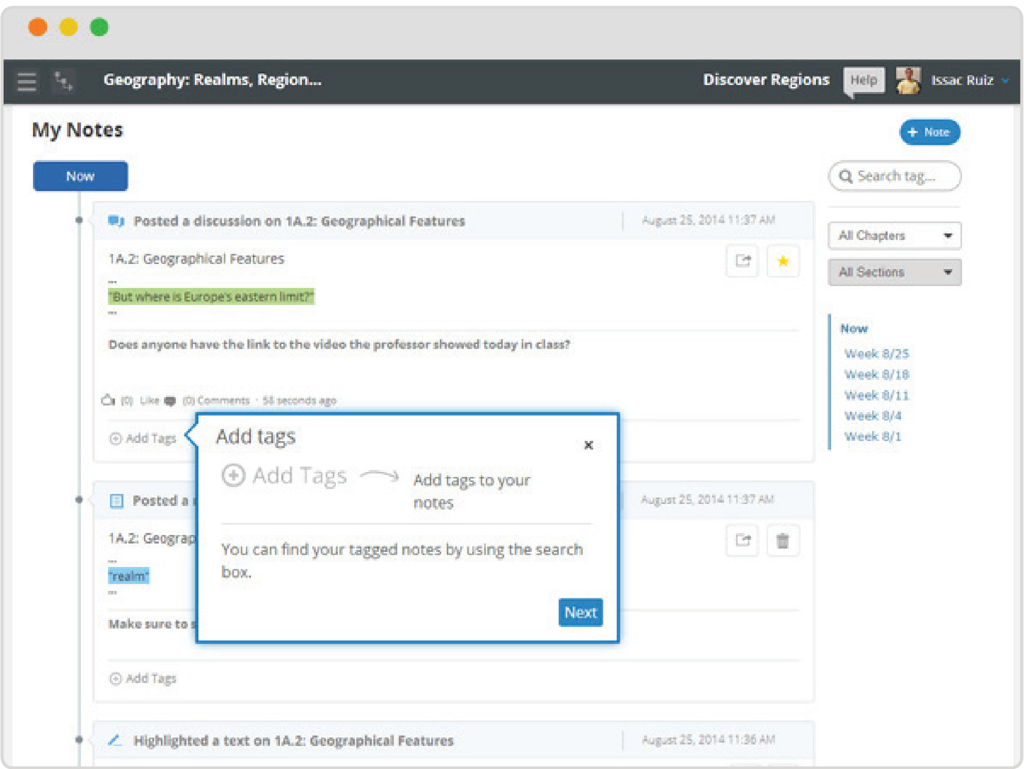
- Collaborative activities help students direct their own learning and increase engagement in course material (Nada, 2012).
- Collaborative knowledge construction supports additional learning, and by helping each other, students build a supportive community that can raise the performance of each student.
- Collaborative projects are authentic learning tasks that are transferable to the work environment.
- *WileyPLUS Learning Space* provides tools for multiple types of formal and informal collaborative learning, such as peer instruction, small group discussions, group projects, peer reviews, etc.
- In the *WileyPLUS Learning Space* environment, students have the ability to curate their own course content at the individual level (refer to Figure below: My Notes) as well as in cooperation with smaller groups or the entire class.

Benefits to Educators

Instructors are also able to benefit from *WileyPLUS Learning Space* in a different way from students, but perhaps even more critical:

- Computer-supported collaboration poses challenges for the instructors regarding how to design, facilitate/moderate, and evaluate student learning. To help with these challenges, *WileyPLUS Learning Space* courses contain suggested discussion questions and group assignments to serve as models. Standard rubrics are also available for instructors as samples, but they can easily modify them or create their own.

- Instructors are able to monitor and participate in all discussions but can select not to be included in the informal Course Stream exchanges and only participate in and/or monitor assigned and graded discussions or projects.
- Miscellaneous reports that are available to instructors allow them to monitor student participation and engagement and intervene if and when necessary.
- Instructors can easily create and recreate groups throughout the semester, if desired.
- The collaborative learning tools that are at the core of the *WileyPLUS Learning Space* design help promote student-instructor interaction, which has shown to be a significant contributor to student satisfaction, as well as learning in a technology-mediated course (Sher, 2009).
- By allowing students to contribute to the course content, instructors themselves can learn about new resources and perspectives and build on and improve their course and teaching methods over time.



Benefits to Institutions

Institutions benefit directly from the improvements to learning that the *WileyPLUS Learning Space* experience provides to students and instructors:

The benefit to institutions is straightforward: students who are more engaged in their learning will hopefully demonstrate more engagement and better learning outcomes. But over time, this benefit increases further. Once enough students have moved through the Learning Space system, the data generated will be able to help inform everything from the curriculum design all the way through course completion. Analyzing the granular learning data will give each institution the opportunity to better understand its students, its instructors, and, ultimately how learning best happens. As students move through different courses, their learning profiles will become clearer, allowing a better understanding of each learner's needs. Success predictors may be able to identify what will benefit new students coming into the university and, over time, could potentially be used as predictors of future career success, pointing students in those directions for which they are best suited.

- In their synthesis of research and literature on improving student engagement, Zepke and Leach suggest as one of their ten proposals for action for institutions to create learning "that is active, collaborative and fosters learning relationships" in order to increase student engagement (Zepke & Leach, 2010).
- Increased sense of community, fostered by *WileyPLUS Learning Space*-supported collaborative learning, has been shown to correlate with student satisfaction and retention (Brindley, Blaschke, & Walti, 2009).

Conclusion

In summary, there is ample evidence that collaborative learning works and is valuable to students, educators, and institutions. While there is still much room for technology development and scientific study of collaboration and educational technology, there has been significant forward movement, propelled in part, by the Internet and social networking revolution. A transformation in online learning is underway, with collaborative learning a key part of that. The Learning Sciences are uncovering and testing theories of collaborative learning and guiding the development of collaborative educational software that follows from the theories.

References

Adamson, D., Dyke, G., Jang, H. J., Rosé, C. P. (2014). Towards an agile approach to adapting dynamic collaboration support to student needs, *International Journal of Artificial Intelligence in Education 24*(1).

Aronson, E., & Patnoe, S. (2011). Cooperation in the classroom: The jigsaw method (3rd ed.). London: Pinter & Martin, Ltd.

Bargh, J.A. & Schul, Y. (1980). On the cognitive benefits of teaching. *Journal of Educational Psychology, 72,* 593–604.

Barron, B. (2000). Achieving coordination in collaborative problem-solving groups. *Journal of the Learning Sciences 9* (4), 403–436.

Bearison, D.J., Magzamen, S., & Filardo, E.K. (1986). Socio-conflict and cognitive growth in young children. *Merrill-Palmer Quarterly,* 32, 51–72.

Brindley, J., Blaschke, L., & Walti, C. (2009). Creating Effective Collaborative Learning Groups in an Online Environment. *The International Review of Research in Open and Distance Learning,* 10 (3).

CB Insights (2014). https://www.cbinsights.com/blog/ed-tech-venture-capital-record/

Chinn, C.A., O'Donnell, A.M., & Jinks, T.S. (2000). The structure of discourse in collaborative learning. *The Journal of Experimental Education*, 69, 77–97.

Chiu, M. M., & Khoo, L. (2003). Rudeness and status effects during group problem solving: Do they bias evaluations and reduce the likelihood of correct solutions? *Journal of Educational Psychology, 95,* 506–523.

Cohen, E.G., & Lotan, R.A. (1995). Producing equal-status interaction in the heterogeneous classroom. *American Educational Research Journal,* 32, 99–120.

Coleman, E.B. (1998). Using explanatory knowledge during collaborative problem solving in science. *Journal of the Learning Sciences*, 7, 387–427.

Common Core (2014). Frequently Asked Questions. http://www.corestandards.org/about-the-standards/frequently-asked-questions/#faq-2323

Crouch, C. H., and Mazur, E. (2001). Peer instruction: Ten years of experience and results*. American Journal of Physics 69*.

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1995). The evolution of research on collaborative learning. In P. Reimann & H. Spada (Eds.), *Learning in humans and machines: Towards an interdisciplinary learning science* (pp. 189–211). Oxford: Elsevier/Pergamon.

Ding, M., Li, X., Piccolo, D. & Kulm, G. (2007). Teacher interventions in cooperative-learning mathematics classes. *Journal of Educational Research, 100*, 162–175.

Fischer, F., Kollar, I., Stegmann, K., Wecker, C., Zottmann, J., & Weinberger, A. (2013). “Collaboration Scripts in Computer-Supported Collaborative Learning.” In Hmelo-Silver, C.E., Chinn, C.A., Chan, C.K.K., and O’Donnell. A. (Eds.), *The International Handbook of Collaborative Learning.* Routledge: New York and London.

Fuchs, L.S., Fuchs, D., Hamlett, C. L., Phillips, N.B., Karns, K. & Dutka, S. (1997). Effects of peer-assisted learning strategies in reading with and without training in elaborated help giving. *Elementary School Journal, 99,* 201–219.

Galton, M., Hargreaves, L., Comber, C., Wall, D., & Pell, T. (1999). Changes in patterns of teacher interaction in primary classrooms: 1976-96. *British Educational Research Journal, 25,* 23–37.

Gerlach, J. M. (1994). “Is this collaboration?” In Bosworth, K. and Hamilton, S. J. (Eds.), *Collaborative learning: Underlying processes and effective techniques, New directions for teaching and learning, No. 59.*

Gweon, G. Rosé, C.P., Zaiss, Z., & Carey, R. (2006). Providing support for adaptive scripting in an on-line collaborative learning environment. *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 251–260). New York: ACM Press.

Howe, C., Tolmie, A., Thurston, A., Topping, K., Christie, D., Livingston, K., … Donaldson, C. (2007). Group work in elementary science: Towards organizational principles for supporting pupil learning. *Learning and Instruction, 17,* 549–563.

Johnson, D., Maruyama, G., Johnson, R., Nelson, D., & Skon, L. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. *Psychological Bulletin, 89,* 47–62.

Johnson, D.W. & Johnson, R.T. (1991). *Learning together and alone: Cooperative, competitive, and individualistic learning*. Englewood Cliffs, NJ: Prentice Hall.

Johnson, L., Adams Becker, S., Estrada, V., Freeman, A. (2014). NMC Horizon Report: 2014 Higher Education Edition.

Johnson, R.T. & Johnson, D.W. (1994). “An overview of cooperative learning.” In Thousand, J., Villa, A., & Nevin, A. (Eds), *Creativity and Collaborative Learning.* Baltimore, MD: Brookes Press.

Johnson, D.W. & Johnson, R.T. (1995). *Creative Controversy: Intellectual Challenge in the Classroom.* Edina, MN: Interaction.

Johnson, D.W., & Johnson, R.T. (2008). Social interdependence theory and cooperative learning: The teacher’s role. In R.M. Gillies, A., Ashman, & J. Terwel (Eds.), *The Teachers Role in Implementing Cooperative Learning in the Classroom* (pp. 9–36). New York: Springer.

King, A. (1999). Discourse patterns for mediating peer learning. In A.M. O’Donnell & A. King (Eds.), *Cognitive Perspectives on Peer Learning* (pp. 87-116). Mahwah, NJ: Erlbaum.

Kumar, R., Rosé, C. P., Wang, Y. C., Joshi, M., Robinson, A. (2007). Tutorial dialogue as adaptive collaborative learning support. In R. Luckin, K.R. Koedinger, & J. Greer (Eds.), *Proceedings of the 13th International Conference on Artificial Intelligence in Education* (AIED-07), Artificial Intelligence in Education: Building Technology Rich Learning Contexts That Work. Amsterdam: IOS Press.

Linn, M.C., Clark, D. B. & Slotta, J. D. (2003). WISE Design for Knowledge Integration. S. Barab (Ed.). Building Sustainable Science Curriculum: Acknowledge and Accommodation Local Adaptation. *Science Education.* 87: 517–538.

Linn, M.C. (1995). Designing computer learning environments for engineering and computer science: The scaffolded knowledge integration framework. *Journal of Science Education and Technology, 4*(2), 103-–126.

Linton, D. L., Farmer, J. K., & Peterson, E. (2014). Is Peer Interaction Necessary for Optimal Active Learning? *Life Sciences Education, 13,* 243–252.

Loll, F., Pinkwart, N., Scheuer, O., & McLaren, B.M. (2012). “How Tough Should It Be? Simplifying the Development of Argumentation Systems using a Configurable Platform.” In N. Pinkwart, & B. M. McLaren (Eds.), *Educational Technologies for Teaching Argumentation Skills,* Bentham Science Publishers.

McAlister, S., Ravenscroft, A., & Scanlon, E. (2004). Combining Interaction and Context Design to Support Collaborative Argumentation Using a Tool for Synchronous CMC. *Journal of Computer Assisted Learning, 20*(3), 194–204.

McLaren, B.M., Scheuer, O., & Mikšátko, J. (2010). Supporting collaborative learning and e-Discussions using artificial intelligence techniques. *International Journal of Artificial Intelligence in Education (IJAIED) 20(*1), 1–46.

Nada Dabbagh, A. K. (2012, January). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education, Volume 15* (Issue 1).

NEA (2012). Preparing 21st Century Students for a Global Society: An Educator’s Guide to the “Four Cs”. http://www.nea.org/assets/docs/A-Guide-to-Four-Cs.pdf

Nelson-Le Gall, S. (1992). Children’s instrumental help-seeking: Its role in the social acquisition and construction of knowledge. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in Cooperative Groups: The Theoretical Anatomy of Group Learning* (pp. 49–68). New York: Cambridge University Press.

Nussbaum, E. M., & Schraw, G. (2007). Promoting argument-counterargument integration in students’ writing. *Journal of Experimental Education, 76,* 59–92.

O’Donnell, A. M., & Dansereau, D. F. (1992). Scripted cooperation in student dyads: A method for analyzing and enhancing academic learning and performance. *Interaction in cooperative groups: The theoretical anatomy of group learning,* 120–41.

Porter, L., Bailey-Lee, C. & Simon, B. (2013). Halving fail rates using peer instruction: A study of four computer science courses. *Proceedings of ACM Special Interest Group on Computer Science Education (SIGCSE) 2013.*

Roscoe, R.D. & Chi, M.T.H. (2008). Tutor learning: The role of explaining and responding to questions. Instructional Science, 36, 321–350.

Ryan, A.M., Pintrich, P.R., & Midgley, C. (2001). Avoiding seeking help in the classroom: Who and why? *Educational Psychology Review, 13,* 93–114.

Rummel, N. & Spada, H. (2005). Learning to collaborate. An instructional approach to promoting collaborative problem solving in computer-mediated settings. *Journal of the Learning Sciences, 14*(2), 201–241.

Salomon, G., & Globerson, T. (1989). When teams do not function the way they ought to. *International Journal of Educational Research, 13,* 89–99.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp. 97–118). New York: Cambridge University Press.

Scheuer, O., McLaren, B. M., Weinberger, A., & Niebuhr, S. (2013). Promoting critical, elaborative discussions through a collaboration script and argument maps. *Instructional Science.*

Scheuer, O., Loll, F., Pinkwart, N. & McLaren, B.M. (2010). Computer-supported argumentation: A review of the state of the art. *International Journal of Computer-Supported Collaborative Learning, 5*(1), 43–102.

Sharan, Y. & Sharan, S. (1992). *Expanding cooperative learning through group investigation.* New York: Teacher's College Press.

Sher, A. (2009). Assessing the relationship of student-instructor and student-student interaction to student learning and satisfaction in Web-based Online Learning Environment. *Journal of Interactive Online Learning,* 102–120.

Slavin, R. (1983). *Cooperative learning.* New York: Longman.

Slavin, R. E. (1992). When and why does cooperative learning increase achievement? Theoretical and empirical perspectives. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in Cooperative Groups: The Theoretical Anatomy of Group Learning* (pp. 145–173). New York: Cambridge University Press.

Stegmann, K., Mu, J., Gehlen-Baum, V., & Fischer, F. (2011). The myth of over-scripting: Can novices be supported too much? In H. Spada, G. Stahl, N. Miyake, & N. Law (Eds.), *Connecting computer- supported learning to policy and practice: CSCL2011: CSCL2011 Conference Proceedings* (Vol. 1, pp. 406–413). Hong Kong, China: ISLS.

Vedder, P. (1985). *Cooperative learning: A study on processes and effects of cooperation between primary school children.* Westerhaven, Groningen, Netherlands: Rijkuniversiteit Groningen.

Vygotsky, L.S. (1978). Mind in society: The development of higher psychological processes (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds. & Trans.). Cambridge, MA: Harvard University Press.

Webb, N.M. (2013). "Information processing approaches to collaborative learning." In Hmelo-Silver, C.E., Chinn, C.A., Chan, C.K.K., and O'Donnell. A. (Eds.), *The International Handbook of Collaborative Learning.* Routledge: New York and London.

Webb, N.M. & Palincsar, A.S. (1996). Group processes in the classroom. In D. Berliner & R. Calfee (Eds.) *Handbook of Educational Psychology* (pp. 841–873). New York: Macmillan.

Zepke, N., & Leach, L. (2010). Improving student engagement: Ten proposals for action. *Active Learning in Higher Education,* 167–177.

Dr. Bruce M. McLaren is a Senior Systems Scientist at Carnegie Mellon University who is passionate about how technology can support education and has dedicated his work and research to projects that explore how students can learn with educational software, in particular, software that runs on the world-wide web.
He is particularly interested in intelligent tutoring systems, e-learning principles, and collaborative learning. Dr. McLaren has over 100 publications spanning peer-reviewed journals, conferences, workshops, symposiums and book chapters.

Other contributors to this whitepaper include Tara Hein-Phillips of Vestar Consulting and Barbara Heaney.

WILEY