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Emergence of Different Perspectives of Success in Collaborative Learning

Sarina Falcione

Mount Royal University, sfalc348@mtroyal.ca

Eleanor Campbell

Mount Royal University, ecamp161@mtroyal.ca

Brett McCollum

Mount Royal University, bmccollum@mtroyal.ca

Julia Chamberlain

University of California, Davis, jchamberlain@ucdavis.edu

Miguel Macias

University of California, Davis, migmacias@ucdavis.edu

Layne Morsch

University of Illinois - Springfield, morsc1@uis.edu

Chantz Pinder

University of Illinois - Springfield, cpinder2@uis.edu

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Emergence of Different Perspectives of Success in Collaborative Learning

Abstract

Collaborative learning involves an interdependence between success of the individual and success of the group, requiring both personal preparation and teamwork. Asynchronous work, in combination with group interaction and problem solving, differentiates collaborative learning from other interactive teaching methods. In this study, three professors and five student participants individually reflected on a past collaborative learning experience that they considered successful. Reflections were coded using thematic analysis. Themes that emerged from participant's descriptions of successful collaborative learning were: (a) familiarity with collaborative learning, (b) relationships, (c) benefits, (d) motivations, and (e) design and process. Furthermore, a phenomenographic theoretical framework revealed that a participant's prior experiences generated significant variation in what characteristics they described as promoting success in collaborative learning. Past experiences that can generate this variation include training in educational theory, participation in and familiarity with related research, the individual's role, prior experience with collaborative learning as a student, and advocacy by one's professor before participation in collaborative learning. Our findings can inform educational practice, improving the implementation of collaborative learning pedagogies.

L'apprentissage collaboratif implique une interdépendance entre la réussite d'une personne et la réussite d'un groupe, ce qui exige à la fois une préparation personnelle et un travail d'équipe. Le travail asynchrone, en conjonction avec l'interaction entre les membres du groupe et la résolution de problèmes, différencie l'apprentissage collaboratif des autres méthodes interactives d'enseignement. Dans cette étude, trois professeurs et cinq étudiants participants reflètent individuellement sur une expérience d'apprentissage collaboratif passée qui, selon eux, a été réussie. Les réflexions ont été codées en effectuant une analyse thématique. Les thèmes qui ont émergé des descriptions des participants à cette expérience d'apprentissage collaboratif réussi étaient : (a) la familiarité avec l'apprentissage collaboratif, (b) les relations entre participants, (c) les avantages, (d) les motivations et (e) le design et le processus. De plus, un cadre théorique phénoménographique a révélé que les expériences préalables d'un des participants avaient généré une variation significative dans les caractéristiques que cette personne avait décrites comme ayant favorisé la réussite en apprentissage collaboratif. Les expériences préalables qui peuvent générer cette variation comprennent la formation en théorie de l'éducation, la participation à des recherches connexes et la familiarité avec ces recherches, le rôle de la personne, l'expérience préalable avec l'apprentissage collaboratif en tant qu'étudiant et la sensibilisation de la part du professeur avant la participation à une expérience d'apprentissage collaboratif. Nos résultats peuvent contribuer à la pratique éducationnelle et améliorer la mise en pratique des pédagogies d'apprentissage collaboratif.

Keywords

active learning, chemistry, collaborative learning, higher education, phenomenography, SoTL, success; apprentissage actif, chimie, apprentissage collaboratif, enseignement supérieur, phénoménographie, ACEA, réussiteada

Cover Page Footnote

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Collaborative learning requires students to interact with peers to develop conceptual connections and alternative methods of understanding (Laal & Laal, 2012). Although it requires a group component, collaborative learning is unique from other group-based learning styles. In comparison to cooperative learning, collaborative learning incorporates individual work, generated in preparation for small group interactions that weave together individual contributions in order to solve a larger problem. Learners may create their individual contributions at different times or places, or it may be done separate from other team members at the same time or place. For ease of discussion, and based on the styles of collaborative learning described within this paper, we will refer to these individual contributions as the asynchronous component of collaborative learning. It is the asynchronous component that distinguishes collaborative learning from related approaches to learning (Smith & MacGregor, 1992). Five elements common to problem-based learning, cooperative, and collaborative learning are listed below (Davidson & Major, 2014, pp. 29). The 6th element in the list is specific only to collaborative learning (Smith & MacGregor, 1992).

1. A common task or learning activity suitable for group work;
2. Small-group interactions focused on the learning activity;
3. Cooperative, mutually helpful behavior among students as they strive together to accomplish a learning task;
4. Individual accountability and responsibility;
5. Interdependence in working together; and
6. Students work with each other, but not necessarily interdependently, towards a shared goal. Thus, they may work independently at times and then later collaboratively bring their portions of the work together.

Our definition of collaborative learning includes the expectation that learners go beyond simply compiling their contributions. Thus, this final element in the list could be restated as follows:

Students work with each other towards a shared goal, weaving together their independently prepared work. This results in a product or a learning experience that is more than the summation of individual contributions.

Collaborative learning is not a means of transferring information from professor to student, but instead is the exposure of students to unfamiliar concepts that are within their realm of understanding (Barkley, Cross & Major, 2014). In collaborative learning, the metacognitive ability of participants is improved due to the absence of a professor's help throughout the process; learners must turn to each other, or outside sources, to overcome barriers, encouraging recognition of their own misunderstandings (Davidson & Major, 2014). The rich conversation that occurs between learners is grounded in their individual preparation (Schusler, Decker & Pfeffer, 2010). Drawing upon social constructivism, the theory that knowledge can be developed and established through social interactions (Palincsar, 1998), collaborative learning uses social interactions to enhance each student's knowledge and professional skills for long-term benefits (Barkley et al., 2014). Furthermore, students are forced to examine, evaluate, manufacture, and apply information throughout the experience which also increases their higher order thinking skills as well as critical thinking skills (Laal & Laal, 2012). As a result, individual success requires active participation and engagement (Laal & Laal, 2012).

The group component of collaborative learning consists of communication and the sharing of information within the partnership, in addition to group cohesion and commitment. Communication sets a foundation for students to use critical argumentation in order to build group and individual success (Kolikant & Pallack, 2015). Students must believe that their outcomes are linked in order to succeed (Laal & Laal, 2012) therefore, the success of one will increase the success of the others (Laal & Ghodsi, 2012). As communication within groups increases in a meaningful and constructive way, the knowledge of the students begins to converge, and a shared understanding is developed (Balasooriya, Hawkins, & Corpo, 2010).

Due to the benefits that collaborative learning can provide in terms of mastery of course content and development of long-term interpersonal skills, collaborative learning has been increasingly incorporated into higher education through a variety of different approaches (Gould, Gilbert, Pike & Menzies, 2018; Lee, Morrone, & Siering, 2017; McCollum, in press; Skagen, McCollum, Morsch & Shokoples, 2018; So & Brush, 2008; Vuopala, Hyvönen, & Järvelä, 2015). To facilitate improved implementation of collaborative learning strategies within higher education, our research team engaged in individual guided reflections on collaborative learning experiences that we had previously participated in either as a learner or an instructor. Our objective was to identify and classify what characteristics of collaborative learning were instrumental to a successful experience, and how those characteristics vary among a group of eight faculty and student research partners across three universities.

Research Question

Our research questions for this study were:

1. What are the characteristics that people identify when describing a collaborative learning experience that they consider successful?
2. What factors result in variation of reported characteristics for successful collaborative learning?

Methodology

Reflection and Autoethnography

The methodology of this study draws upon the traditions of autoethnography (Ellis & Bochner, 2011), a qualitative research method in which researchers seek to understand community or cultural experience through self-reflection and writing. Autoethnographers recognize the ways that personal experience influences the research process, such as selection of the research question and methods for data collection and analysis. Subjectivity, emotionality, and researcher influence is typically unavoidable when analyzing your own writings. Rather than hiding these influences, in autoethnography researchers aim to identify their bias and explore how their experience impacts their writing (Bochner, 2002). This work was deemed exempt from ethics approval by the Human Research Ethics Board / Internal Review Board of each of the authors' home institutions.

Data Sources

Seeking to better understand the characteristics of successful collaborative learning, each author individually engaged in reflective writing about a collaborative learning experience that they considered successful. Student and faculty members at the same site wrote about the same collaborative learning experience, each from their own perspective. Our experiences, as professors or as undergraduate research students, inevitably influenced how we described our successful collaborative learning experience.

Purposefully, the collaborative learning experiences we used in our reflections were not uniform throughout the research team. Rather, we are interested in how our diverse backgrounds, varied settings, and different collaborative learning designs influence our expectations and how we define “success” in the broad context of collaborative learning.

Two sets of prompts were generated by the team to guide our reflections: a learner (student) version and a facilitator (faculty) version. Although not identical, the two sets of questions were isomorphic, ensuring that all team members were similarly prompted through their reflection on collaborative learning. Both sets of reflection prompts are provided in Appendix A. Each author individually prepared written responses to the questions during a period of time lasting from thirty minutes to two-hours. Reflections were submitted to a shared drive without individuals reading other team members responses. No further revisions were permitted after submission. Thus, the reflections captured the individual responses of each author at the time of reflection, uninfluenced by the reflections of other members of the research team. These questions captured the experience and perceived objectives of the learning experience that each author identified as collaborative learning and as successful.

Universities Involved

Participants involved in this study came from three universities: Site 1, Mount Royal University (MRU) in Alberta, Canada; Site 2, University of Illinois – Springfield (UIS) in Illinois, USA; and Site 3, University of California – Davis (UCD) in California, USA. Chemistry students and faculty from these universities engaged in a collaborative learning experience that each person considered successful. Organic chemistry students at Sites 1 and 2 participated in a series of online collaborative assignments in an international partnership with a peer from the other university. While the collaborative experience for these two universities was designed to operate in the same way, the cultural backgrounds of the two populations was previously known to impact the international interactions (McCollum, Morsch, Shokoples & Skagen, 2019). Additionally, the disparate learning activities of their local classrooms shaped how team members experienced the collaborative learning, and hence influenced their reflections. Details on collaborative methods used in the Site 1 and Site 2 classrooms are reported elsewhere (McCollum, 2016; McCollum, Fleming, Plotnikoff & Skagen, 2017; Morsch, 2016; Skagen et al., 2018). In the collaborative learning experiences at Site 1 and Site 2, student partners were required to arrange a weekly time to video chat online in order to complete a collaborative assignment. Each student was given specific information about a chemistry problem to solve on their own (the asynchronous component). They then had to communicate their portion of the assignment to their partner in a manner that would guide their partner through answering the complementary portion of the question (the synchronous component). For example, a Site 1 student would be given a chemical

structure and would have to describe it to their partner, with the intent that their partner would be able to draw this structure based on the given description.

Site 3 students participated in a collaborative learning experience that incorporated an in-class synchronous component. The instructor assigned readings and homework questions, which were expected to be completed prior to coming to class (the asynchronous component). During lecture, the instructor would spend a few minutes at the beginning of the class answering questions from the previous day's material. The class would then participate in an academic reading circle (McCollum, Sepulveda & Moreno, 2016; Seburn, 2016) with support from the professor, in which they were to discuss the material that they understood from the reading, as well as any topics that they had found challenging. An intent of this was to encourage the students to resolve any misconceptions pertaining to the material, prior to the collaborative problem solving session. Students spent the remaining portion of class time answering challenging "critical thinking" questions created by the instructor to develop conceptual connections to the reading and further reinforce the course material (the synchronous component).

In comparison to a cooperative learning approach in which students are introduced to and discover concepts in groups, such as Process Oriented Guided Inquiry Learning (POGIL) (Hu & Shepherd, 2013), students from each site were required to complete asynchronous preparation before exploring concepts with partners.

Demographics

Julia (Site 3) is an early career tenure-track Lecturer and has completed postdoctoral work in chemistry education research. Layne (Site 2) has industry experience and spent a portion of his early faculty career doing laboratory chemical research before moving into chemistry education as an Associate Professor. Brett (Site 1) is a Professor focused on chemistry education research and has comparable years of teaching experience with Layne.

The undergraduate participants enrolled in a BSc biology major are Ellie (Site 1) and Sarina (Site 1), and Kiana (Site 2). Chantz (Site 2) and Miguel (Site 3) are biochemistry majors in BSc programs. Table 1 shows the demographics of participants from all three institutions.

Table 1
Participant Demographics

	Site 1 (MRU)	Site 2 (UIS)	Site 3 (UCD)	Total
Participants	3	3	2	8
Females	2; Ellie, Sarina	1; Kiana	1; Julia	4
Males	1; Brett	2; Chantz, Layne	1; Miguel	4
Visible Minorities	0	1	1	2
Professors	Brett	Layne	Julia	3
Students	Ellie, Sarina	Chantz, Kiana	Miguel	5

Theoretical Framework and Analysis Methods: Phenomenography and Thematic Analysis

After all reflections had been submitted, each reflection was coded by other team members using thematic analysis (Clarke & Braun, 2017). Thematic analysis is used to analyze qualitative data in which themes are identified, examined, and interpreted. Using an iterative open-coding approach, two reflections (one faculty and one student) were analyzed by all team members and codes were then organized into a small collection of themes. After the emergent codes and themes were agreed upon, the remaining reflections were coded using a similar approach, each reflection being analyzed by two or more team members. Members who coded the same reflection met online or in person to resolve coding differences. This alignment of codes improved our application of the coding scheme and reduced individual bias. Appendix B lists the themes and codes that emerged from participant reflections.

While these emergent codes organized the general essence of participants' comments, we observed that within a distinct code there was variation in the specific topics or ideas that participants identified. These variations within each code were explored by creating a list of specific ideas expressed by participants, and then populating that list into a matrix (ideas vs. participant). All team members participated in this deeper analysis of the reflections.

Although our data collection methods have similarities to the autoethnographic tradition, our second research question focused on determining variations in participant experiences, influenced by different backgrounds and collaborative designs. Phenomenography, a research framework that explores the outcome space of possible ways that a phenomenon can be experienced by participants, is appropriate for this type of study (Marton, 1981). Prior examples of our use of phenomenographic analysis in chemistry education can be found elsewhere (McCollum et al., 2016; McCollum et al., 2017; Skagen et al., 2018).

A follow-up survey on prior experiences with collaborative learning, and educational training was conducted. This survey is provided in Appendix C.

Results and Discussion

Discussion of collaborative learning often focuses on active participation in the synchronous components (Laal & Laal, 2012; Davidson & Major, 2014). However, the group work alone does not distinguish the practice from cooperative learning. Barkley et al. (2014) argue that an individual preparatory component is integral to the experience. Therefore, we see the minimum criteria for an individual learner to experience success in collaborative learning as asynchronous preparation and active participation in the group.

Our findings reveal that the ways that individuals describe a successful collaborative learning experience is more nuanced. While the themes identified can be situated around the two components of collaborative learning (synchronous and asynchronous), the authors reflected deeply about the structure of these components, such as the relationships and motivations involved.

Even though all authors discussed each of the five themes in their reflection, there was significant variation in what characteristics of the experience each author focused on as paramount to success. In this paper, we describe the patterns of variation between the authors, revealing the impact that former experiences have on how an individual describes success in a more recent collaborative learning experience. A summary of these patterns is provided in Appendix D.

Role in the Collaborative Experience

The role of the participant in the learning experience was found to influence the ways that participants described their experience of success in collaborative learning. The two roles were faculty (Case A) and students (Case B). This influence emerged in much of theme 5 (design and process), including subcodes 5a (purpose and intended outcomes), 5b (faculty preparation), 5d (non-competitive), and 5f (assessment). Faculty emphasized an intentional design linked to the desired outcomes of the collaborative experiences that they had created and implemented. This is demonstrated by the following excerpt from Layne's reflection.

Plan the collaboration carefully before assigning it. Decide on what outcomes you want before deciding what the assignment will be like, so that the assignment can achieve the desired actions and outcomes. Make sure that the points for the assignment are related to the outcomes. Write the activities so that what the students are each supposed to do is clear and in a way that they cannot complete it without the other person. (Layne)

Layne describes his order in the design process for collaborative learning assignments, starting by determining the intended learning of the collaboration, which then informs his design of the assignment. In his reflection, Layne continues to describe how he collects observations on the efficacy of the assignment for helping students to attain the intended learning and his approach to revisions for future implementation. Brett and Julia also discussed similar design objectives to promote collaboration between partners. In contrast, students, reflected minimally - if at all - on any aspects of design of the collaborative assignments or collaborative experience. The student reflections included descriptions of their personal processes for completing the asynchronous and synchronous aspects of the assignments, and what they determined was the intended learning of the assignments. However, careful analysis revealed that there was almost no discussion of intentionality to the design or how their professor may have designed specific elements within the assignment to stimulate particular student behaviour. During the data analysis stage, the student authors reported that although they recognized that their professors created and facilitated the experience, they did not identify the design aspects of the experience because they were not involved in the development. A similar observation was reported by Boudreaux et al. (2008) with students in science laboratory courses acknowledging the presence of controlled variables without analyzing the reasons for why they were employed. Interestingly, this pattern relating to participant role, that clearly distinguished between faculty and students, only emerged in codes connected to the theme of Design and Process.

First Experience with Collaborative Learning

A second pattern, related to previous experience with collaborative learning, emerged within the theme of Relationships (theme 2) through subcodes 2e (Student personal preparation, asynchronous) and 2f (Cooperative work, synchronous). These codes reorganized how the participants were partitioned. Case A included Brett, Chantz, Ellie, Kiana, Miguel, Sarina. Case A participants focused on factors such as timeliness, preparation, scheduling, and reliability. They described how personal preparation influences the effectiveness of the synchronous work and impacts the relationships between peers in a collaborative learning experience, as demonstrated by the following excerpt from Sarina's reflection: "With partners that I knew I could trust to be

prepared and just as dedicated as me to succeeding in the class, I looked forward to our weekly video chats and was stress-free about the whole experience.” Having only experienced collaborative learning as a student, Sarina’s reflection drew upon her personal observation of the factors that determined her partnership’s ability to complete the assignments.

Case B only included Julia and Layne. They primarily described the process of interaction between peers, but not the responsibility that students had toward one another or the relationships that develop between peers. They did not specifically identify the needs of a partner as justification for a student’s preparation. Rather, they focused on how personal preparation impacts personal learning.

The follow up survey (Appendix C) revealed that all participants in Case A had experienced collaborative learning as a student, while Case B participants had their first experience with collaborative learning as an instructor. Brett, as the only instructor who had their first experience with collaborative learning as a student, described the importance of asynchronous and synchronous work on relationships more in-line with the student authors. Beghetto (2007) has observed similar carry-over effects, wherein an instructor’s prior experiences as a student influence their current academic experiences and inform their approach to instruction. In contrast, Layne and Julia identified other experiences, such as independent study or faculty development during their career, to be their first experience with collaborative learning. Thus, we observe that experience as a student in a collaborative learning experience, or lack thereof, influences how one describes their experience in collaborative learning.

Training in Educational Theory

The outcome space for code 2a (support from faculty) resulted in a new pattern. Case A (Brett, Ellie, Julia, and Miguel) consisted of those who identified support from faculty as instrumental to student success in collaborative learning. Case B (Chantz, Kiana, Layne, Sarina) were participants who wrote little-to-nothing matching this code. Initially, it was unclear why the participants were found in their respective categories. One might have expected that the division of authors would be along the line of faculty versus student, however, this was not the case. Both cases in the outcome space included at least one professor and one student. Discussion of this result among the research team revealed that the two cases aligned with participants’ level of formal training in educational theory. Case A included 4 participants, each of whom have received some amount of formal education training, such as an undergraduate education course or a graduate teacher-training course. However, none of the authors had completed, or were enrolled in, an education degree or science/education combined degree. Consider how Ellie, a student, describes a professor’s role in supporting collaborative learning:

As with many collaborative learning experiences, the experience is in the hands of the learners, and the professor is more so in the background providing the framework. Therefore, knowledge of content may not always [lead to] success. Regardless, the interactions and social skills that I developed whilst working with my partner- even if neither of us understood the content at times- are important skills that I will be able to use in the future in a professional scientific environment. (Ellie)

Ellie noted that simply developing the disciplinary content knowledge is not the sole objective of collaborative work; thus, she felt that a collaboration is not successful if students do not develop

social and professional skills as an outcome of the interaction. She also described the role of the professor as support rather than primary source in student-centered collaborative learning, as an important condition for the development of these skills. Similarly, the following quote reveals how Brett, a professor in Case A, described a professor's role in implementing collaborative learning experiences in the classroom:

If you have done your preparatory work designing the collaborative learning activities, then allow your students to struggle and grow. Don't be a "helicopter professor." When they discover that you won't rescue them from their first barrier, they turn toward their teammates for support and work to find a collaborative solution. As much as is reasonable, be consistent with your expectations across groups, yet maintain flexibility to resolve for unanticipated situations. Keep your goals for the collaborative learning in mind as you facilitate the experience. (Brett)

Brett sees his role in the collaborative experience as a facilitator of learning, allowing students to struggle, and thereby he indirectly stimulates conversations between students when partners are forced to rely on each other for success. Not only does he describe in his reflection how he views his role, but also that his reasoning and intended effect is to enhance student growth. All other participants that have formal education training also discussed the hands-off approach that they or their professor provided and why it was beneficial to student growth. Collaborative learning is known to help students gain metacognitive skills because of the lack of professor involvement (Davidson & Major, 2014). Balasooriya et al., (2010) also recognize that since students are required to do individual work along with group work and do not have a teacher for support, they are thereby encouraged to increase their participation. As a result, student learning autonomy is increased.

In contrast, participants in Case B of the pattern (describing faculty support) did not have any course-based professional education training and did not describe the supportive role of faculty during collaborative learning. It is interesting to notice that the difference between Case A and Case B was not in relation to the number of years of teaching experience that a participant has, but solely on formal educational training.

This pattern based on training in educational theory was also observed for subcodes of theme 1 (familiarity with collaborative learning), 1a (definitions of collaborative learning) and 1b (expectations and norms). As part of the reflection, participants were asked to describe what they considered to be the expectations and norms of a collaborative learning experience. Case A participants, having education training, provided descriptions that aligned closely with a formal definition of collaborative expectations removed from any particular setting, while Case B participants drew more upon their personal experiences with collaborative learning when describing expectations and norms. This is seen in the following quote from Brett (Case A).

For collaborative learning to be successful, team members must (1) understand the shared goal, (2) complete their individual contributions in a timely manner, (3) attend the team meetings when the individual contributions are assembled, evaluated, and potentially improved upon, and (4) the learners acquire or develop new knowledge. (Brett)

This shows Brett's orderly thought process when describing his main criteria for successful collaborative learning. Furthermore, Brett went into great detail about every aspect of the

experience, from group cooperation to individual responsibility. This aligns with the major characteristics, individual accountability and group interactions, which are requirements for collaborative learning (Laal & Laal, 2012). In contrast, another quote is provided from Layne, who is of similar status and teaching experience and has engaged in significant professional development as a teacher, but has not taken a course on educational theory.

[In collaborative learning, students are] working together with others for a common purpose. There should be some sense of equal partnership. More should be learned through working together than would be by doing the same exercises independently. There should be tasks that require the participants to engage with one another. (Layne)

This excerpt from Layne's reflection reveals a thoughtful and informed perspective. His description focused solely on the group aspect, likely informed by his prior experiences facilitating team-based learning and collaborative learning in his classroom. We do not mean to say that he did not, or does not, carefully think about the asynchronous aspect of collaborative learning, rather that this aspect did not emerge during his reflection as part of his definition of success in collaborative learning. Many educators, including Brett, Julia, and Layne, intentionally, or intuitively, engage in action research to improve their craft. However, Abell and Bryan (1997) note the importance of educational training on an instructor's ability to inquire and reflect upon their own role and practice. Beyond codes 1a and 1b, this pattern based on educational training is also apparent in code 3a (self-awareness). Furthermore, participant responses for code 5e (flexible design) and code 5g (reflection) mirrored this pattern. However, the two students (Ellie and Miguel) who previously were situated in Case A, instead aligned more closely with Case B. While these students have some educational theory training, their experience applying educational theory was less developed, and thus their written reflections did not include these codes. This is consistent with standard Bachelor of Education programs in Canada and the United States, where students are introduced to educational theory prior to engaging in a practicum where theory is applied.

Local Effects

Our analysis of code 2b (peer-interdependence) reveals a pattern in which reflections among all participants of the same university present similar ideas showing a "local effect". This provides us with three unique cases: (A) Site 1, (B) Site 2, (C) Site 3. It is important to recognize the divergence between Site 1 and Site 2 in this pattern. Although faculty and students were involved in a collaborative experience with partners from the other university, their reflections do not express the same ideas. This pattern was therefore not due to the type of collaborative experience, but instead how each professor had described the intended objectives, process, and benefits of the collaborative experience to their students. Thus, we see that how faculty advocate for collaborative learning influences how their students describe success in collaborative learning. This observation was further supported in codes 3b (disciplinary skill development) and 5h (barriers to collaboration). Reflections of students not only mirrored their professors in both quantity and specificity of the ideas discussed, but they also aligned with the other student(s) of the same university when applicable. This relationship is demonstrated in the following two quotes, the first from Julia:

Individuals with deeper understanding or greater knowledge may assist others with their learning, yet in a collaborative learning environment there are mutual gains: novices will learn new things while experts may solidify their own knowledge by revisiting and revising their ideas for better accuracy and consistency. (Julia)

and the second from her student, Miguel:

This type of atmosphere promotes a better understanding of course material not only for struggling students but also excelling students. This is because the excelling students are able to reinforce their knowledge when trying to problem solve and clarify course material to their struggling peers. (Miguel)

Both Miguel and Julia describe successful collaborative learning as including peer tutoring alongside the development of course concepts. Julia’s explanation of the intended benefits of peer interdependence, particularly when students are matched with dissimilar strengths, is echoed in Miguel’s reflection.

As shown in Table 2, each professor emphasized specific elements of collaborative learning as fundamental to success in the experience. However, each professor discussed the value of peer interdependence in collaborative learning with different focuses. At each site, alignment between professor and students’ reflections emerged. It is important to note that these reflections were written approximately eight months after the collaborative learning experiences were completed. Thus, the influence of the professor’s opinions and vision of collaborative learning persisted among the student participants even after the experience ended.

Table 2
Concepts from Code 2b “Peer Interdependence” Emphasized by All Researchers at the Same University

Site	Common Concepts
Site 1	<ul style="list-style-type: none"> • Scheduling • Time management • Commitment • Asymmetric co-construction of knowledge • Communication skills
Site 2	<ul style="list-style-type: none"> • Equal effort • Communication skills
Site 3	<ul style="list-style-type: none"> • Equal effort • Differing levels of understanding • Asymmetric co-construction of knowledge • Greater understanding from collaboration

Umbach and Wawrzynski (2005) reported that interactions between faculty and students bring about improvements in classroom experiences, such as greater engagement within these experiences, along with an increase in student’s personal and social development. In their study of

student and instructor descriptions of learning, Trigwell, Prosser, and Waterhouse (1999) reported a correlation between the approach used by an instructor and student perception of experiences. Our observations further exemplify this relationship in the context of collaborative learning, demonstrating the value of professor advocacy prior to, and during, the collaborative experience.

Clearly, the manner in which the student authors assessed success in collaborative learning was shaped by the description and advocacy of their professor. Of particular note is the set of themes through which this pattern emerged. Each of the professors dedicated time in class to describe the barriers students may encounter in their collaborations (code 5h), how students can get more out of the experience by helping each other (code 2b), and the intended skills they would develop (code 3b). In contrast, other themes did not align with this pattern of “local effect,” likely because the professors did not sufficiently discuss the associated concepts during their advocacy (e.g., code 5c: Design and Process - Discussion and negotiation). Furthermore, this suggests that faculty should carefully consider how they present a collaborative learning experience to their class. This initial description influences how students will evaluate the success of the collaborative learning.

Existing Familiarity with Related Research

Code 2d (development of existing relationships) yielded an unusual pattern. One author, Brett, generated a distinct description of the development of existing relationships. Unlike the rest of the project team, he identified the impact of reliability, accountability, supportiveness, interpersonal bonding, negotiating, looking forward to meeting, interacting with a stranger, nervousness or self-consciousness, and local or international relationships. Previous to this project, Brett was published in *Scholarship of Teaching and Learning (SoTL)* on relationships in collaborative learning and flipped classrooms (McCollum et al., 2017). It is evident that Brett’s previous research and experience in this domain impacted his perspective, as his ideas are distinct from all other participants. Consider the following quotes that exemplify Brett’s perspective in code 2d (existing or developing relationships): “It seemed that the relationships that the students developed with their international partner were something they looked forward to renewing with each assignment.”; “While there was apparent nervousness, I noticed that the students were excited to work with a peer from another country.”; and “[The students] were also responsible for negotiating through difficulties with their partner, whether that be scheduling issues, personalities, or understanding course content.” Brett reflects upon the student attitudes that are important for their collaborative learning relationships to continue to be successful beyond the initial interactions. Brett’s prior experience conducting research on relationships in collaborative learning is evident in the way in which Brett reflects on the relationships that should exist and develop during collaborative learning. The idea that research and publishing correlate with enhanced teaching practice has previously been identified by Stanton, Taylor, & Stanaland (2009).

Although it is clear that Brett thought about and reflected a great deal upon the relationships that should develop and exist in collaborative experiences, he did not stress this point to his students when implementing the collaborative learning experience in his classroom. Therefore, although we have previously discussed the transfer of ideas from professor to student in the local effect portion of this paper, when describing relationships in code 2d, Brett’s students Ellie and Sarina did not discuss these ideas in their reflections. We can thereby conclude that Brett’s prior knowledge and familiarity with collaborative education research was significant in his own perceptions of the relationships in collaborative learning.

Notably, code 2d was the only code where a pattern of a single researcher was partitioned from the rest of the team. This shows how past research conducted by an individual can impact how they describe success in collaborative learning. Though the reflection prompts did not include questions pertaining to prior collaborative learning familiarity, Brett's research experience in this field nevertheless affected the way in which he gauged the success of this experience. It is clear that prior research experience is not a requirement to be successful in a collaborative learning experience, either through facilitation or participation; however, it did add a layer of depth onto Brett's experience. We draw upon an analogy between scholarly teaching and other forms of scholarly work (Glassick, Huber, & Maeroff, 1997; Shulman, 1999), wherein scholars must situate themselves within the field, learning the language and nuances before adding to the conversation. Our results demonstrate that instructors will have a more complete understanding of collaborative learning, and potentially deliver a richer learning experience, if they engage with the literature on collaborative learning before designing and facilitating a collaborative learning experience.

Further discussion among the authors led to the unanimous opinion that a new round of reflections would likely result in all authors discussing the importance of existing relationships in collaborative learning, thus eliminating this pattern. Consider the following quote, provided by Layne after participating in this research:

The process of discussing what defines success in collaborative learning has been highly valuable for my own teaching and has helped me think more critically on the methods used to incorporate collaborative learning in my classes. One example is the student reflection aspect. While re-designing a collaborative learning assignment this year, the lack of student reflection was apparent. Therefore, a reflection piece was added to the end of each collaborative work period to encourage students to understand the value of the experience in broader terms. (Layne)

This quote illustrates that the reflections and research that Layne participated in had an impact on his understanding of collaborative learning and, in turn, on how he will implement it in his future classrooms. This again reflects the observations of Stanton et al. (2009) that faculty research impacts the practice of teaching. We propose that our results demonstrate that when faculty and students engage in research on teaching and learning, both groups are impacted in terms of teaching and learning practice.

Limitations

A limitation of this study was that all student authors were highly-engaged learners so there are no perspectives from students that are marginally reflective. They were invited to participate in the project based on their demonstrated ability to express themselves. This was important for the project because data collection was in the form of personal written reflections. Poorly crafted or minimalistic reflections would have been difficult to analyze. Also, reflections were focused on a single collaborative experience in chemistry from each participant. Reflections on additional collaborative experiences in chemistry, or in other disciplines, may yield other variations in experience. Furthermore, all student authors are interested in innovative teaching methods, and this likely impacted the quality of their reflections and the bias introduced in their analysis. Inclusion of students from varied academic performances and backgrounds may yield different results.

As noted in Table 1, two student authors identify as visible minorities. We did not observe any influence of race on how authors describe collaborative learning. Given the small sample size, we cannot say if this observation can be extended more broadly.

Conclusion

Three different collaborative experiences were implemented in chemistry classes at three different universities. Reflection revealed five unique themes: familiarity with collaborative learning, relationships, benefits, motivations, and design and process. Upon analysis of these themes, five discrete patterns emerged: (a) role in the collaborative experience, (b) participating in collaborative learning as a student, (c) differences in experience based on participant educational training, (d) differences in student experience based on professor's definition and advocacy, and (e) differences in experience based on participant previous familiarity with related research.

Our results reveal that a universal definition of successful collaborative learning based on individual and group success is overly simplistic. Rather, the ways that individuals describe success in collaborative learning experiences varies based on their past experiences, knowledge, and role in the experience. Faculty are more aware than students of the importance of purposeful design of collaborative learning experiences, and how that work must be done before the deployment of a collaborative assignment. In contrast, students are keenly focused on the responsibility for personal preparation and cooperative behaviours during the assignment. We found that the students are generally unaware of the efforts of faculty in facilitating a collaborative learning experience.

We propose that faculty should endeavour to visualize the student experience during the assignment/collaborative learning design stage, predicting potential challenges and conflicts, and planning accordingly. This is an opportunity for faculty to engage with students as partners (Healey, Flint, & Harrington, 2014) to increase the potential impact of the experience. For faculty new to student-as-partner initiatives, there is an emerging collection of research on the topic (Acai et al., 2017; Cliffe et al., 2017; Cook-Sather, Bovill, & Felten, 2014; McCollum, Morsch, Wentzel, Ripley, Pinder, & Skagen, 2019).

How faculty describe the potential experience to their class will have a great impact on student perceptions of the experience. Furthermore, these perceptions are lasting and can influence future collaborative learning experiences. This leads us to suggest that it is crucial for faculty to dedicate time in class to clearly outline (a) the individual and group responsibilities in a collaborative learning experience, (b) the potential benefits of the experience, and (c) their motivations and design plan for the experience. Providing this information to students at the outset of the experience has the potential to resolve and reshape existing negative attitudes toward collaborative learning, as well as provide a new framework for understanding collaborative learning. We also encourage students to hold their instructors to account, asking for the intended goals, motivations, design plans, and responsibilities in the collaborative experience. We argue that an intentional and informed approach to collaborative learning will increase the likelihood of success from both student and faculty perspectives.

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Appendix A

Reflection Prompts

Faculty Questions:

1. How do you define collaborative learning?
2. How do you define success in relation to collaborative learning?
3. What are the key characteristics of a successful collaborative learning experience?
4. What are your motivations for using collaborative learning in your classroom?
5. Describe a collaborative learning experience that you've implemented. What did you design and what did you want students to get out of it?
6. What worked well with it (and why)?
7. What would you change if you did it again (and why)?
8. What was your role?
9. What was the students' role?
10. What characteristics made this specific collaborative learning experience successful (or not successful)? (could be different from what characteristics make it collaborative)
11. For this specific example, did you measure success in terms of the process or as a product? Explain how you determined/defined the level of success.
12. For this example, how did you assign and structure groups? How did this impact the success of the collaborative learning experience?
13. Thinking more generally, do you use collaborative learning for content knowledge or to promote soft skill development? Does one of these motivate you more than the other?
14. If you had another faculty member approach you and ask you for tips on collaborative learning, what would you suggest?
15. After completing this reflection on collaborative learning, has your definition of a successful collaborative learning experience changed?

Student Set of Questions:

1. How do you define collaborative learning?
2. How do you define success in relation to collaborative learning?
3. What are the key characteristics of a successful collaborative learning experience?
4. What do you think your instructor's motivations were for using collaborative learning in your classroom?
5. Describe a collaborative learning experience that you were involved in. How was it designed and what do you think was the intended benefits of it?
6. What worked well with it (and why)?
7. What would you change if it were up to you (and why)?
8. What was your role?
9. What was the professor's role?
10. What characteristics made this specific collaborative learning experience successful (or not successful)? (could be different from what characteristics make it collaborative)
11. For this specific example, discuss the success in terms of process and in terms of a product? Which do you think was more important? Explain how you determined/defined the level of success.
12. For this example, how did your professor assign and structure groups? How did this impact the success of the collaborative learning experience?
13. Thinking more generally, do you see the benefits of collaborative learning in terms of content knowledge or of transferable skill development? Does one of these motivate you more than the other?
14. If you had another student approach you and ask you for tips on collaborative learning, what would you suggest?
15. After completing this reflection on collaborative learning, has your definition of a successful collaborative learning experience changed?

Appendix B

Themes and Codes

Theme	Code	Description
1-Familiarity with collaborative learning	(a) Definitions of collaborative learning	Personal definition of collaborative learning after completion of experience
	(b) Expectations and norms	Conceptions of what collaborative experiences should include and characteristics
2-Relationships	(a) Support from faculty	Involvement, or lack of, from professors
	(b) Peer interdependence	Trust and reliability of partners on each other
	(c) Respectful interactions	The types of interactions students had with their partners
	(d) Existing or developing	The new and old relationships that were affected by the collaborative experiences
	(e) Student personal preparation, asynchronous	Individual work students had to do before they could actively participate in the group interactions of the collaborative experience
	(f) Cooperative work, synchronous	The work that took place within small groups of students
3-Benefits	(a) Self-awareness	Enhanced metacognitive abilities
	(b) Disciplinary skill development	Chemistry language skills and content knowledge developed throughout the experience
	(c) Professional- and 'soft'- skills development	Long term benefits that were obtained which can be applied to areas beyond chemistry
	(d) Broadening perspectives	Views obtained by working with remote or unfamiliar peers
	(e) Enhance learning from group	Increased learning facilitated through partner interactions and problem solving
4-Motivation	(a) Faculty motivations	What participants felt persuaded faculty to implement this learning experience
	(b) Student motivations	What participants felt motivated students to engage in the experience

5-Design and Process	(a) Purpose and intended outcomes	What the goals of the experience were when designing the experience
	(b) Faculty preparation	Instructor preparatory work (making worksheets and lesson plans)
	(c) Discussion and negotiation	Incorporation of peer feedback and interactions as a purposeful part of the design
	(d) Non-competitive	Fostering safe environment within partnerships and group work
	(e) Flexible design	Ability of instructors to adapt the experiences when necessary
	(f) Assessment	How experiences were graded by instructors
	(g) Reflection	Incorporation of reflection into the design and manufacturing of the experience
	(h) Barriers to collaboration	Situations and circumstances that impeded the learning experience

Appendix C

Prior Experience and Training

1. What is the major/area of study of your education?
2. What is your research area of study?
3. Select the choices that best describe your prior experience regarding collaborative learning (experience prior to the one discussed in our research paper):
 - a. Some undergraduate experience with collaborative learning (1-3 classes)
 - b. Facilitated some collaborative learning experience (1-3 quarters/semesters)
 - c. Some high school experience with collaborative learning (1-3 classes)
 - d. Formal training in collaborative learning (educational development training)
 - e. Facilitated many collaborative learning experiences (>3 quarters/semesters)
 - f. Published on a collaborative learning experience
 - g. No prior experience with collaborative learning
4. How did you learn about collaborative learning?
5. What is your current level of education?

Appendix D

Phenomenographic Patterns and Codes

Phenomenographic Patterns	Corresponding Codes
Role in the collaborative experience	5a- Purpose and Intended Outcomes 5b- Faculty Preparation 5d- Non-competitive 5f- Assessment
First experience with collaborative learning	2e- Student Personal Preparation (asynchronous) 2f- Cooperative Work (synchronous)
Training in educational theory	1a- Definition of Collaborative Learning 1b- Expectations and Norms 2a- Support from Faculty 3a- Self-Awareness 5g- Reflection 5e- Flexible Design
Local effects	2b-Peer-interdependence 3b-Disciplinary Skill Development 5h-Barriers to Collaboration
Existing familiarity with related research	2d- Existing or Developing [Relationships]