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In the Classroom

Student Perspectives of Small-Group Learning Activities

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Small-group learning is undergoing a renaissance in college science classrooms.

The purpose of this study was to understand what small-group learning activities meant to the students in an undergraduate thermodynamics course. Small-group learning activities (also known as cooperative- or collaborative-learning activities) were used throughout the course with one class session per week being entirely devoted to such activities. An analysis of field notes and a questionnaire completed by the students yielded three findings from the perspective of the students. First, these small-group learning activities created a learning community characterized by intellectual challenge, support, and encouragement producing a warmer classroom climate. Second, the interaction between students facilitated the development of interpersonal skills and communication skills which led to more meaningful learning. Third, these activities gave students the opportunity to focus on the material in order to draw connections between concepts. These findings allowed

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us to add breadth and depth to our understanding of positive small-group learning outcomes such as learning, achievement, and persistence and affirmed the importance of preparing students to work in groups.

Small-group learning is undergoing a renaissance in college science classrooms. One of the most heartening features of this renaissance is that the disparity between what research indicates about effective teaching and practices in college science classrooms may be decreasing. In chemistry, small-group learning activities have been implemented in general chemistry lecture and laboratory [1–4], organic chemistry [5, 6], analytical chemistry [7], and physical chemistry [8]. Small-group learning has also been implemented in other science disciplines such as physics [9], biology [10, 11], anatomy and physiology [12], and chemical engineering [13, 14].

Small-group learning has been touted as a method of ensuring that students actively engage in the course material and create their own knowledge as opposed to passively accepting knowledge from the instructor. Within the teaching and research literature there are discussions and comparisons of cooperative learning, collaborative learning, and small-group learning [15–24]. Although practitioners of each of these types of learning have the same goal, that is, to transform a passive classroom environment into an active student-centered environment, it is clear that many authors do not view these three types of learning as synonymous. Collaborative learning can be distinguished from cooperative learning, but both are consistent with the notion that students must engage in the material under study in order to learn information in a meaningful way [19, 20]. Both collaborative learning and cooperative learning can create an environment where students actively engage in the material by sharing ideas; by providing support, encouragement, and feedback; and by teaching each other.

We use the phrase “small-group learning” because it is more flexible and inclusive. It acknowledges that members of a group may or may not cooperate well or that the group members may simply collaborate. In many instances the interaction between group members depends on the type of task the group is asked to accomplish. In general, well-defined or algorithmic problems may not require much cooperation beyond sharing how the problem was set up and the actual numeric answer. Ill-defined or conceptual problems may require more cooperation or collaboration among group members to determine how to represent and solve the problem. Finally, small-group

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learning has become the current label given to the type of active-learning activity where students are put into groups and asked to accomplish tasks [24].

Research studies carried out in a wide range of settings—elementary, secondary, post-secondary, and training schools—and across content areas have shown that small-group learning leads to positive outcomes such as higher achievement, increased positive attitudes toward the subject area studied, higher self-esteem, greater acceptance of differences among peers, greater persistence and retention, and enhanced conceptual development [24, 26, 27]. These conclusions were derived primarily from quantitative means—looking for quantitative differences between students in cooperative classrooms (enough rewards and benefits for all) versus competitive (rewards only for a few students) and or individualistic (work alone to achieve a goal or a reward) classrooms. These studies, however, have not addressed the question of how and why small-group learning produces these positive outcomes. Few studies have listened to the voices of the students who are engaged in these activities, those who might shed light on how and why small-group learning promotes the positive outcomes cited above. Listening to student voices and analyzing what they say, write, or do requires a different research methodology—a qualitative methodology.

Patton writes that qualitative research methods are “ways of finding out what people do, know, think, and feel by observing, interviewing, and analyzing documents [28, p 94].” Thus, they are methods that can be used to reveal the student perspective of the classroom. Using qualitative methods to add the voices of the students to what is known about small-group learning activities would contextualize how and why small-group learning produces higher achievement, greater persistence and retention as well as other positive outcomes.

The goal of the present study was to learn what small-group learning activities meant to the students involved in them; thus, the following research question guided the study: *What did the small-group learning activities mean to the students involved?*

Methodology

Research Approach

To gather information about what the small-group learning activities meant to the

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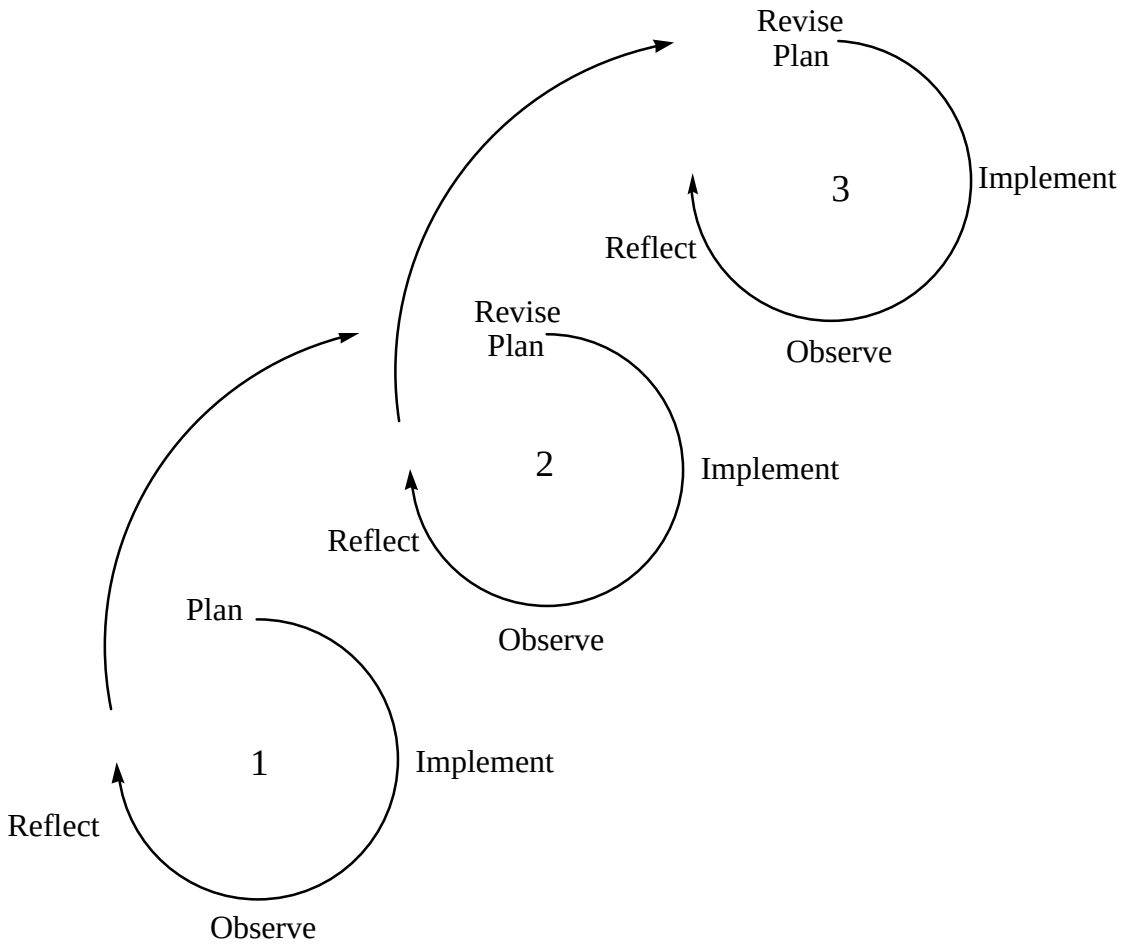

FIGURE 1. THE SPIRAL OF ACTION RESEARCH CYCLES ILLUSTRATING HOW THE PRECEDING CYCLE INFLUENCES REVISIONS FOR THE NEXT CYCLE [30].

students involved, we used a methodology known as action research [29, 30]. Action research, when applied to educational settings, emphasizes the link between practice and the analysis of practice. The process of action research helps to develop new perspectives about student learning and teaching and extends and transforms the teacher's viewpoints. Through a cycle of planning, implementation, observation, and reflection, action research can lead to changes in curriculum and/or classroom practices. As shown in Figure 1, the cycle can be repeated in a spiral fashion incorporating changes from the previous cycle into each subsequent cycle. It allows the teacher and researchers (they may be identical) to critique classroom practice which is an essential part of improving classroom practice and assessing the positive and negative impacts of innovations.

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In carrying out action research the researcher may employ quantitative and/or qualitative methods of collecting and analyzing data. The raw data may include responses to questionnaires, interviews, student journals, classroom observations, and field notes. The goal is to build an understanding that is associated with the classroom environment: to understand the issue under investigation with a naturalistic perspective. Finally, the written product of action research can enlighten not only the practices of the teacher, but other faculty by sharing how innovations were planned, implemented, observed, and evaluated within a specific classroom context.

The Students and the Course

The participants were undergraduate students at Ball State University. The class was composed of 19 students, four women and 15 men. Eighteen of the students were science majors and one was a preservice high school chemistry teacher. One female student was a minority and all of the students spoke English as a first language. None of the students dropped the course.

The course was the first semester of the classic physical chemistry sequence. It was tailored for chemistry majors and covered thermodynamics, chemical equilibrium, and solutions. Students attended three lectures, one 50-min "problem-solving session" (PSS), which was entirely devoted to small-group learning activities, and one three-hour laboratory per week. As the semester progressed, the class became oriented around 15–30 min lecture segments and 5–10 min small-group activities. The students were placed into one of four groups which remained the same throughout the semester. Sample PSS problems have been published elsewhere [8].

The course was graded on a straight percentage scale. A normative grading system was not used because it can quench cooperation among students [31–33].

Data Collection and Analysis

The data collected in this study consisted of field notes and student responses to a questionnaire. The instructor of the course (Towns) recorded classroom observations and informal student/professor conversations outside of class as field notes in order to describe events that took place during small-group learning activities. At the end of the semester an open-ended questionnaire (see Supporting Material 34mt1897.pdf) was administered to all students. By asking questions in an open-ended manner, the

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students' words could be used to construct an understanding of their experiences of small-group activities as they described them.

We analyzed the questionnaire by first grouping the responses by question, then reading the responses question by question to look for themes or patterns. By discussing the patterns we saw, we subsequently developed a coding scheme that included both of our observations, insights, and perspectives on the data [34, 35]. We developed categories that grouped these codes, and we associated properties that described the categories. Field notes were used to support, refute, and refine the emerging categories and properties. The product of our analysis were three categories which helped us formulate our findings.

Findings and Discussion

Three overall findings emerged from our analysis of the questionnaire and field notes. These findings are displayed in Figure 2, which serves as guide for our discussion. First, the findings are summarized, then the categories that support these findings are presented with representative quotes and descriptions taken from the questionnaire and field notes.

Findings

First, we found that small-group learning activities created an environment characterized by intellectual challenge, support, and encouragement, which produced a warmer classroom climate. Students developed friendships and built trust among groupmates, which allowed them to encourage, question, and support each other. Carl's voice spoke for many students in the course:

> I feel like the group work and just the friendships in the class in general made for a very conducive to learning atmosphere. When I transferred here…I didn't know anyone and I found myself not asking questions about topics I didn't understand or just needed a little clarification; once I began to know my peers, I was more comfortable asking questions and just being in the class in general, and being comfortable allows you to learn more from the class.

As the students sensed that they could rely on each other and trust each other, a feeling of community which promoted learning and achievement grew.

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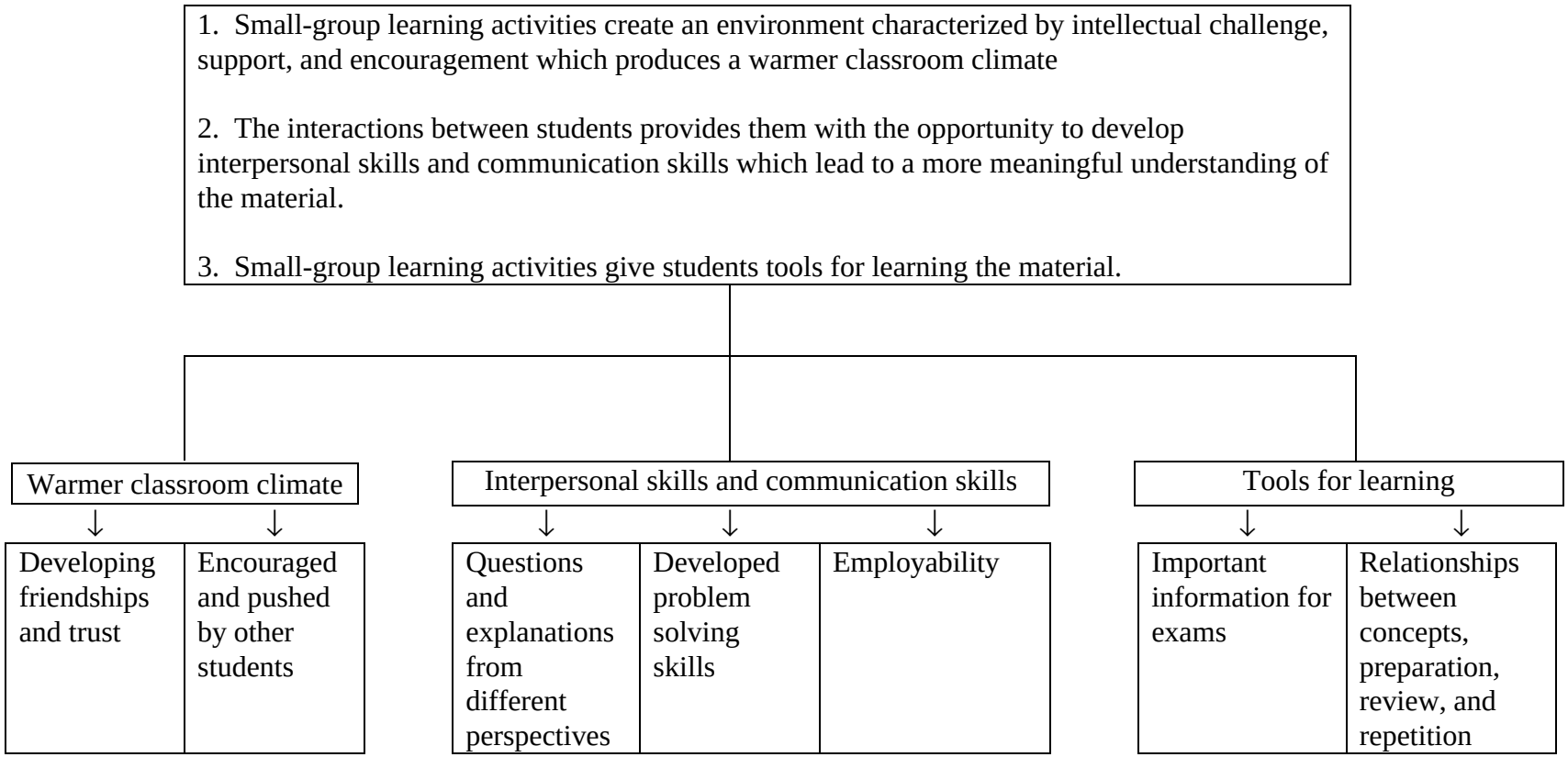

FIGURE 2. OVERALL FINDINGS WITH SUPPORTING CATEGORIES AND ASSOCIATED PROPERTIES.

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Second, the interactions between students provided the opportunity to develop the necessary interpersonal and communication skills. This led to a more meaningful understanding of the material. Students had the opportunity to share different perspectives on solving problems and to teach their peers. As Larry wrote: “The communication between the group members was invaluable when it came to different ways of solving a problem.” Through discourse generated during small-group learning activities, the students acquired different perspectives on solving problems and diversified their problem-solving skills. In addition, students built the “professional skills,” or interpersonal competence that they need to succeed and flourish in the workplace.

Third, small-group learning activities gave the students tools for learning the material. The problem-solving sessions, or PSS as the more formal small-group learning activities were known, provided an incentive to study the material in a timely fashion and helped students develop relationships between concepts. As Sally wrote: “The in-class work and the PSS were very helpful in keeping the material fresh in my mind and they also helped to see relationships among everything we’ve studied.” Students found that the PSSs helped them draw connections between concepts and applications, prepared them for examinations, and provided review and repetition over important information.

The remainder of the findings section is used to describe categories and associated properties derived from the questionnaire responses and field notes. By discussing the categories we generated, supported by quotations from the questionnaire and field notes, we show how small-group-learning activities led to a warmer classroom climate, improved interpersonal and communication skills, and provided students with tools for learning and integrating the material.

Category 1: Warmer Classroom Climate

Small-group learning activities provided the forum for students to develop friendships and to build trust among peers, which allowed them to encourage, question, and support each other. As Joshua wrote, one of the strengths of the PSSs was: “The chance to get to know one another as a person and develop friendship, which makes asking questions easier and learning easier.” In order to share information and to disclose their own reasoning students had to trust their groupmates to listen with respect and to critically evaluate their input. When students sensed that they could rely

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on each other, a feeling of community emerged that fostered a warmer classroom climate.

Developing Friendships and Trust

The PSSs gave students a chance to develop friendships and to build trust. Repeatedly, the students mentioned that developing friendships (and the trust that is inherent in friendship) made it easier to ask questions of each other and the professor. Students discussed how the small-group learning activities helped them form relationships with one another, and how these friendships changed their interaction with each other.

> I feel like the group work and just the friendships in the class in general made for a very conducive-to-learning-atmosphere…once I began to know my peers, I was more comfortable asking questions and just being in the class in general, and being comfortable allows you to learn more from the class. (Carl)

> I think that PSS also helps the students get to know each other and therefore makes it easier to ask each other questions other than the problems given. (Andy)

> It helped me associate with other members of the class more and made me feel more comfortable talking about PChem or anything else to them. (Judy)

These budding friendships or collegial relationships appeared to help the students become committed to each other. As this bonding proceeded, students sensed that they could rely on and trust each other. For students to disclose their own reasoning and to share information, they had to trust their groupmates to listen with respect and to critically evaluate their input; thus, trust became the key element in the development of a feeling of community which promoted learning and achievement among group members.

The importance of community was highlighted by Jim who made the following comment about PSS during an office visit (field notes December 1995). “This is the first time I’ve had friends in the chemistry department. Before, I never fit in. I wasn’t smart enough.” He was a student who stated early on in the fall semester that he “wasn’t good” at calculus and “never knew what it was good for” (field notes October 1995); however, over the course of the fall semester, Jim took on the leadership role in his group. He checked to make sure each group member understood how to obtain the answer to a given problem and would work through a calculation step-by-step to help

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his groupmates find an error (field notes October 1995). During the fall semester Jim began sitting in the chemistry conference room with other students to study, to write laboratory reports, and to eat lunch (field notes October 1995). Jim discovered that he did fit in, earned high grades in both semesters of physical chemistry, and is now pursuing a graduate degree in chemistry. The feeling of community that he experienced helped him achieve at a higher level than he anticipated and altered his career path.

Encouraged and "Pushed" By Other Students

The PSSs allowed students to challenge, encourage, and support each other, or to "push" each other, because they had to answer questions from other students about their own solutions (field notes October and November 1995). The challenging aspects of PSS were cited as strengths by Andy and Dean.

> …being taught by a peer and having to answer questions about the solutions you come up with. (Andy)

> Ironically, the PSS group pushed me to excel by my trying to keep up with the others. (Dean)

As the students became more comfortable with each other in their groups it became easier for them to converse, to question, and to construct meaning together. This type of discourse requires that the students clarify and refine their own understanding of the material—challenging them to conceptually understand the material and not simply memorize equations, derivations, and algorithms.

Category 2: Development of Interpersonal Skills and Communication Skills

Interactions between the students led to improved interpersonal skills and communication skills. These skills in turn led to a better understanding of the material through different perspectives on solving problems and the development of a repertoire of problem-solving skills. As Rick stated: "With the other people in the group helping, I could understand it better." In addition, some students realized that small-group learning activities help them develop the interpersonal skills and communication skills needed to succeed in the workplace.

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Questions and Explanations from Different Perspectives

The PSSs gave students the opportunity to share different perspectives or different representations on solving problems. Lou found that the strength of the PSSs was the "different perspectives that were made available through the people in the groups." Jim and Carl also found that PSS presented the opportunity to see the material from a different point of view.

> I like the group work because it gives me different ways of seeing the material. (Jim)
>
> [it] allows a different perspective of the topic. (Carl)

Other students saw their interactions with groupmates in terms of teaching or helping each other as John and Dean pointed out.

> It was a good opportunity to help other students. (John)
>
> The most obvious strength was the student interactions. Many times another student would remember a point that I didn't and their reminding me helped to cement that point." (Dean)

To understand a different perspective or representation of a problem, the student had to relate his or her translation of the problem to another student's translation. It was through these types of interactions that students clarified, refined, and extended their understanding of the material. Thus, small-group learning activities promoted the type of discourse that encourages sharing ideas, giving feedback, and teaching each other.

Developed Problem Solving Skills

Small-group learning activities afforded students the opportunity to develop their problem-solving skills by analyzing a problem via discussion with groupmates. During this interaction the problem was restructured, then appropriate mathematical relationships or concepts were applied to solve the problem (field notes September 1995, October 1995, November 1995, and December 1995). Different problem-solving methods could be explored. As Larry stated: "The communications between the group members was invaluable when it came to different ways of solving a problem." The interactions among groupmates allowed students to develop new approaches to solving problems by sharing different representations of the problem [36].

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Solving thermodynamics problems required students to apply their knowledge of calculus [37, 38]. Students had to recognize when to perform an integration, a differentiation, or a derivation in order to develop a solution. Thus, the discussion between group members led to an exchange of how to represent or translate the problem and diversified and strengthened the students' problem-solving abilities.

Employability

Students viewed the development of interpersonal skills and communication skills during PSS as important to their future in the workplace. For many students, small-group learning activities marked the first occasion in a science course that technical competence was balanced with interpersonal competence. As Pete aptly stated: "It's nice to finally realize that the world needs people with social skills as well as knowledge." During small-group learning activities students developed the interpersonal skills and communication skills that will impact their future employability and productivity [39]. Professional skills such as written and oral communications skills, the ability to understand the political landscape, the ability to make decisions, and the ability to work in a team are cited by scientists working in industry as some of their most valuable career skills [40]. Indeed, the ability to work in a team, strong oral and written communication skills, and undergraduate research were cited by participants in the American Chemical Society Committee on Professional Training Industrial Round Table as the skills that industry looks for in new hires in addition to technical competence [41].

Category 3: Tools for Learning

The PSSs gave students the opportunity to focus on the material in order to develop relationships between concepts. As Sally stated: "The in-class work and the PSS were very helpful in keeping the material fresh in my mind and they also help to see relationships among everything we've studied." Students specifically stated that the PSSs helped them to draw connections between concepts and applications, to prepare them for examinations, and to provide review and repetition over important information.

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Important Information for Examinations

The PSSs helped the students decipher and focus on important information. In that sense, students found the PSS helpful in preparing for examinations.

> I found PSS very helpful especially in focusing on what was important in the material we covered…[it] helps one focus on some of the important topics of the material and in this case the style in which questions will be asked. (Joshua)

> After PSS we have seen a lot that is going to be on the test and that helps. (Jim)

By working to solve problems during PSS, the groups wrestled to decode problems, build a helpful representation, and apply their knowledge of calculus to a given problem. Because students connected the problems covered during PSS to problems they would see on an examination, they found the PSSs to be valuable.

Relationships Between Concepts

Students specifically mentioned that the PSSs helped them to draw relationships between concepts and to integrate the material covered during the course. Sally's voice speaks for many students:

> The in-class work and the PSS were very helpful in keeping the material fresh in my mind and they also help to see relationships among everything we've studied…. The PSS develops relationships among topics and sometimes shows everyday applications of certain theories. For that reason, it doesn't seem like a bunch of "junk" we'll never use.

Thus, small-group learning fostered meaningful learning because it encouraged the integration of the material [25]. Through this integration, students can gain a "big picture" view of the material, rather than a patchwork understanding of isolated information [8].

Preparation, Review, and Repetition

The PSSs promoted weekly preparation because the students must review material in order to be prepared for class. As Andre stated: "I like working in groups, and I thought it forced me to stay up on the material covered in class." Other students such

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as Judy found that the PSSs provided a method for reviewing material and that in turn helped students prepare for quizzes and examinations.

> I felt it was good review to keep repeating the information; it prevented cramming before a quiz or test. (Judy)

Preparing for PSS helped the student to develop links between concepts throughout the semester. This action led to the students feeling like they were “on top of the material” as many stated, and it also helped many to prepare for examinations and quizzes with minimal amounts of “cramming”.

Conclusions

Our findings add to the current understanding of small-group activities by addressing the question of how and why small-group learning activities promote positive outcomes. This question was raised most recently by Springer et al. [24], but is also found in other reviews of cooperative learning [26, 27]. Our findings support previous research by Johnson and Johnson [42, 43], which indicates that cooperative learning activities result in more positive supportive peer relationships, the concept we referred to as *community*, rather than competitive and individualistic learning experiences [15]. Our findings also corroborate previous research that indicates that explaining one's understanding to other group members is related to achievement [43, 44]. This suggests that students become more aware of the limits of their own understanding through discussions with groupmates, a conclusion previously stated by other researchers [43, 44]. Finally, we find that persistence grows in an environment of peer academic support as Johnson and Johnson have described [15, 43, 45]. In addition to the particular studies cited above, our findings from the student perspective harmonize with Springer's [24] meta-analysis of small-group learning in college science, mathematics, engineering, and technology (SMET) classes, which revealed that the effect of small-group learning on achievement and persistence among undergraduates in SMET was positive and significant [24].

Our findings allow us to add breadth and depth to our understanding of positive learning outcomes associated with small-group learning activities. Drawing multidirectional relationships between our findings, as illustrated in Figures 3 and 4, allows us to add the dimension of context to *how* and *why* small-group learning promotes learning and achievement, and increases persistence.

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These findings contextualize our understanding of why small-group learning activities produce higher achievement gains compared to competitive or individualistic situations. Figure 3 illustrates the synergy between each of the findings and the promotion of learning and achievement. Small-group learning activities produce a feeling of community in the classroom and fosters a warmer classroom climate that promotes learning and achievement. This warmer climate expresses itself in the students forming collegial relationships and friendships and challenging and encouraging each other to truly understand the material. By asking questions, listening, and exploring each other's reasoning, students gain rapid feedback on what they know or do not know. This feedback hinges on the students using effective interpersonal skills and communication skills. They must listen to each other with respect and critically evaluate each other's contributions. They must strive to understand different ways of explaining concepts and different perspectives on solving problems. It has been observed that as students become more adept at articulating what they know, their level of engagement increases [44]. From these actions students develop a framework for understanding the material that integrates concepts, applications, and problem-solving skills. Each of these characteristics—the warmer classroom climate, the development of interpersonal competence, and the diversification of problem-solving abilities—promotes learning and achievement.

Our findings also add the dimension of context to the observed increased persistence within groups of individuals who become linked through a cooperative component [43, 44]. Figure 4 depicts the interaction between the warmer classroom climate and the development of interpersonal competence which promotes persistence. We find that in our classroom, where small-group activities are an integral part of the curriculum, a feeling of community and a warmer classroom climate evolves as the students build friendships and collegial relationships and develop trust. If the students believe that they can rely on one another, then they can encourage, question, and support each other. Their tenacity and willingness to endure frustration increases because they believe that they will eventually succeed. Because they are committed to each other, they want every group member to be a part of this success. There are enough rewards for every student to achieve at a high level and to be recognized for that success (recall, a normative grading system was not used). Thus, persistence hinges upon the students building a feeling of community.

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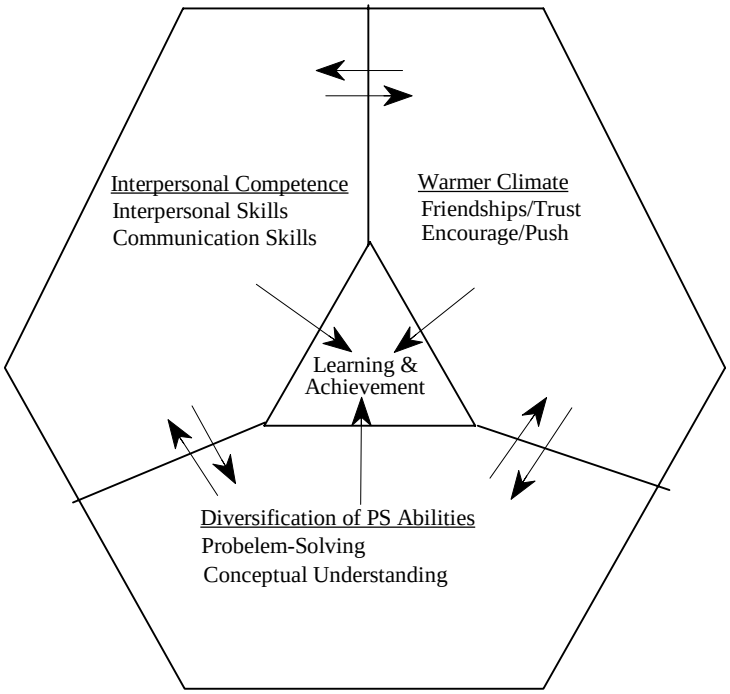

FIGURE 3. SYNERGY OF WARMER CLASSROOM CLIMATE, INTERPERSONAL COMPETENCE, AND DIVERSIFIED PROBLEM-SOLVING ABILITIES, WHICH PROMOTES LEARNING AND ACHIEVEMENT.

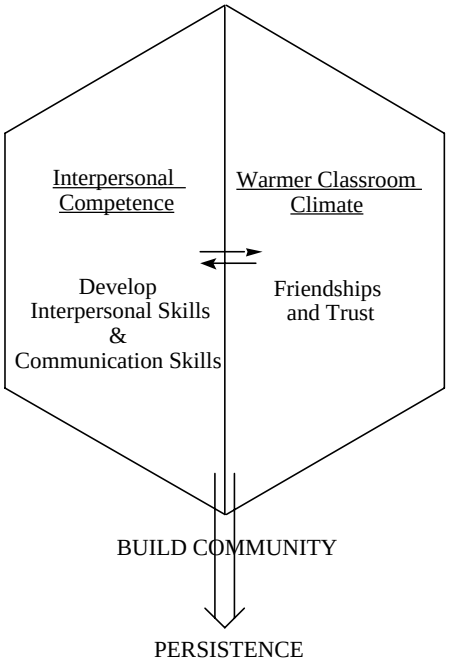

FIGURE 4. INTERACTION BETWEEN THE DEVELOPMENT OF INTERPERSONAL COMPETENCE AND THE WARMER CLASSROOM CLIMATE, WHICH HELPS TO BUILD COMMUNITY IN THE CLASSROOM AND PROMOTES PERSISTENCE.

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Reflections on Student Learning and Teaching in Chemistry

As we reflected upon our study, we tried to develop an understanding of the relationship between our findings, student learning, and classroom teaching. In essence, we asked how can we alter, extend, or transform our view of student learning and teaching in chemistry. In addition to the contextualization of positive outcomes of small-group learning activities described above, we developed connections to conceptual learning and to the teacher's role in forming community.

Our findings point towards small-group learning activities as a method of helping students learn concepts, thus narrowing the gap between algorithmic and conceptual understanding of chemical phenomena [4, 46–49]. Small-group learning activities encourage interaction among students and active engagement in the material [2, 20, 22, 32]. When conceptual problems are the focus of group discourse, then the students may generate an understanding from more than one perspective and develop more than one approach to the correct response [8]. Thus, our findings support Nakhleh's [4] conclusion that small-group learning activities can cultivate connections between concepts and lead to a more integrated and accurate understanding of the material under study.

Our findings also affirm the importance of preparing students to work in groups [8, 31, 50, 51]. Within small-group learning the teacher is viewed as a facilitator of student learning. The process of facilitating student learning begins by helping the students learn how to work with each other. Framed in the results of this study, we believe that it is impossible for the students to build a feeling of community if they don't even know each other's names [52]. Simply placing students into groups and telling them to work together does not mean that they will do so, even if they know how. Teachers must help groups proceed through the four stages in the life of a group—forming, storming, norming, and performing [53, 54].

Team-building exercises can help groups through the *forming* stage by helping members to build relationships, to define the responsibilities of each group member to the group, and to define the responsibilities of the group to each member [31, 51]. The group can discuss how to operationalize these responsibilities and begin trying to solve problems and execute tasks under these operating rules. As the group attempts to solve problems together, there will be discussion and conflict centering on how the group members interact with each other, and how problems will be solved or tasks will be

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accomplished. The teacher can help groups move through this *storming* stage by reminding them to adhere to group operating rules and by leading the group through a group processing discussion [31, 32]. During group processing group members can discuss what behaviors or actions to start doing, to stop doing, and to continue doing [54]. This activity focuses on maintaining favorable working conditions for the group. The group can develop strategies to overcome obstacles, clarify operating rules or group norms, and refocus on accomplishing tasks.

As the group proceeds into the *norming* stage the group members believe that they can rely on each other, they trust each other, and they solve problems and accomplish tasks by sharing insights and different perspectives. Finally, the group reaches the *performing* stage where they use effective interpersonal and communication skills to nurture and maintain the group, and focus on solving problems and completing difficult tasks. During the norming and performing stage, teachers can facilitate student learning by attending to two broad needs. First, the teacher can help the students use effective interpersonal and communication skills so that their group forms a community which fosters learning and achievement. Second, the teacher can help groups solve problems and accomplish tasks by asking questions, clarifying concepts, and redirecting group efforts while affirming the ability of the group to eventually solve the problem or accomplish the task without the teacher's direct guidance.

Summary

The findings from this study on the student perspective of small-group learning activities have allowed us to build an understanding of how and why small-group learning activities promote learning and achievement, and increase persistence. The interaction of three characteristics—the warmer classroom climate, the development of effective interpersonal skills and communication skills, and the diversification of problem-solving abilities—promote learning and achievement. As students build a feeling of community through collegial relationships and the use of effective interpersonal skills and communication skills, their willingness to persist or to endure frustration increases because they believe that they will eventually succeed and be rewarded.

Our findings support the work of quantitative researchers who found that small-group learning activities promote positive learning outcomes such as achievement and

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persistence [24, 26, 27]. This combined body of research supports the inclusion of more interactive forms of instruction, such as small-group learning, in college chemistry classrooms. When implementing such activities our findings emphasize the importance of fostering a warm classroom climate, encouraging the development of interpersonal competence, and promoting problem-solving abilities and conceptual understanding. Finally, the results of our study affirm the importance of the teacher's role in helping the students build community.

Lastly, at the suggestion of a reviewer we would like to comment upon the schedule for the PSSs within the course. When a station approach was adopted in the physical chemistry laboratory section of the course we replaced a one-hour pre-lab with PSS. We did not replace one hour of lecture with PSS. As the reviewer pointed out, it is important that adequate class time, such as a PSS, be available for students to struggle with the complex issues involved in negotiating meaning from a small-group learning activity. The question which subsequently arises is how to block out a course in which small group learning activities are used. We have no firm answers, but having one hour specifically set aside in the course for such activities was a benefit to the instructor in terms of planning and to the students in terms of supplying adequate time for exploring these activities.

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