Innovations in Education and Technology

Collaborative Learning in Pre–Clinical Dental Hygiene Education

Laura J. Mueller-Joseph, RDH, EdD; Luisa Nappo-Dattoma, RDH, RD, EdD

Abstract

Purpose: Dental hygiene education continues to move beyond mastery of content material and skill development to learning concepts that promote critical-thinking and problem-solving skills. The purpose of this research was to evaluate the effectiveness of collaborative learning and determine the growth in intellectual development of 54 first-year dental hygiene students.

Methods: The control group used traditional pre-clinical teaching and the experimental group used collaborative pedagogy for instrument introduction. All students were subjected to a post-test evaluating their ability to apply the principles of instrumentation. Intellectual development was determined using pre- and post-tests based on the Perry Scheme of Intellectual Development. Student attitudes were assessed using daily Classroom Assessment Activities and an end-of-semester departmental course evaluation.

Results: Findings indicated no significant difference between collaborative learning and traditional learning in achieving pre-clinical competence as evidenced by the students' ability to apply the principles of instrumentation. Advancement in intellectual development did not differ significantly between groups. Value added benefits of a collaborative learning environment as identified by the evaluation of student attitudes included decreased student reliance on authority, recognition of peers as legitimate sources of learning and increased self-confidence. A significant difference in student responses to daily classroom assessments was evident on the 5 days a collaborative learning environment was employed.

Conclusion: Dental hygiene students involved in a pre-clinical collaborative learning environment are more responsible for their own learning and tend to have a more positive attitude toward the subject matter. Future studies evaluating collaborative learning in clinical dental hygiene education need to investigate the cost/benefit ratio of the value added outcomes of collaborative learning.

Keywords: Classroom Assessment, Collaborative Learning, Dental Hygiene Education, Intellectual Development, Learning Environment Preference, Measure of Intellectual Development, Perry Scheme of Intellectual Development, Preclinical Course, Principles of Instrumentation

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Introduction

The concluding decades of the twentieth century were rich in producing a better appreciation of the learning process. Critical to the comprehension of the process is the fundamental tenet of modern cognitive theory - learners must be actively engaged in their learning.[1] The Boyer Commission, along with the National Research Council and the National Science Foundation, advocates instructional innovation in education to foster higher levels of learning, as well as the development of communication, teamwork and lifelong learning.[2] This education paradigm shift involves active learning methodologies that encourage discussion and exploration of concepts enabling students to become involved in higher order thinking tasks, such as analysis, synthesis and evaluation. There is growing evidence that learning is about making connections. Learners must do the work of learning by actively making connections and organizing learning into meaningful concepts.[1]

This paradigm shift from passive to active learning pedagogy has also affected dental education. A report from the Institute of Medicine on the future of dental education recommends that more curriculum hours be shifted from lectures to guided seminars and other active learning strategies that develop critical thinking and problem-solving skills.[3] This change in the approach of teaching stems from the fact that learning outcomes involving higher order thinking skills are difficult to achieve in health relat-

ed disciplines that have clinical components because knowledge obtained in the classroom is not easily transferred to the clinical setting.[4-6]

The notion of improved learning is enhanced through the use of new pedagogies involving collaborative learning. Collaborative learning is an active learning approach that improves learning through student interaction. Increased student performance, as well as advancement in intellectual development, has been associated with the collaborative process of education.[7-9] Students in this type of learning environment learn not only from course instructors but also from their peers.

Pre-clinical courses in health related disciplines typically use a traditional model of instruction where students work independently from their peers. Although traditional models have been successful in developing students' pre-clinical skills, collaborative pedagogies offer a more complete approach to learning. Active learning strategies have been successful in statistics courses, and are implemented in engineering, medical and nursing programs.[10,11] The use of a collaborative learning environment has positively influenced dental hygiene students regarding the traits of social interaction, task management and trust.[12] Active learning strategies incorporate tasks that increase opportunities for intellectual development through the utilization of interactive group work.[10]

Extensive research on intellectual development has been conducted by William Perry.[13] His research demonstrated that intellectual development occurs in stages, and that not all college students are at the same level of intellectual development. He recommended pedagogical interventions to enable students to develop cognitive ability in fostering critical thinking skills inherent within intellectual development.[13]

The Perry Scheme is a dialectical theory adapted from the cognitive development theory of Piaget. Perry suggested that intellectual development in adults occurs in a similar fashion to that which Piaget proposed occurs in children.[13] Perry's Scheme suggests that development occurs as a result of cognitive disequilibrium. When individuals are presented with information that cannot be disseminated into their existing structure, they alter this pre-existing structure to incorporate the advanced complexity. Perry and his colleagues observed a consistent change in development within college education and theorized that this change was secondary to cognitive disequilibrium. Perry's model has been used extensively in research studies conducted within higher education in assessing the intellectual development of students within various disciplines. It has been applied to many areas of academia including mathematics, psychology, science, engineering, medicine, dental and dental hygiene.[14-16]

Perry's developmental scheme includes 3 major stages: dualism, multiplicity and contextual relativism, which focuses on intellectual development. One final stage, commitment in relativism, focuses on the development of identity. Intellectual development, as used by Perry, is defined in terms of increasingly complex cognitive skills along a progressive continuum. There are 9 positions associated within this continuum. Positions 1 and 2 relate to dualism, 3 and 4 to multiplicity, and 5 relates to contextual relativism. Positions 6 through 9 relate to the development of identity in lifelong learning and commitment to self in the contextual relativism stage.[13]

An individual at the dualist stage is one who is a dichotomous thinker, where truth is absolute, and there is only one right answer to every question. The student is the passive receiver of knowledge and is dependent on authority to deliver the truth. At Perry's multiplicity stage there is a dissipation of dualistic thinking and a broadening of the student's viewpoint that there can be more than one approach to a problem. Truth is perceived as personal and students come to believe that authorities do not have all the right answers as they evolve beyond diversity of option.[13]

Early multiplicity leads to the realization that truth is unknown but that learning the process in arriving at a solution will eventually discover the truth. Students begin to evolve beyond dependency on authority and acknowledge that everyone has a right to their own opinion. In late multiplicity, the student perceives that very little is known for certain and diverse viewpoints are valid.[13]

At the contextual relativism stage students recognize knowledge as relative and that knowledge and values are disconnected from absolute truth. An analytical, evaluation approach to knowledge is cultivated where opinions are based on evidence and appropriate reasoning processes.[13]

In commitment in relativism, individuals evolve in their thinking and gradually make a personal commitment as one establishes one's own identity. Initially, there is a coming to terms with one's commitments to a set of values, a career and spousal choice. The second aspect of this stage involves issues requiring an endpoint in ultimate commitment. This stage, with its relative positioning along the continuum, takes place later in life. It is clearly the longest stage in the Perry Scheme and lasts one's lifetime. The

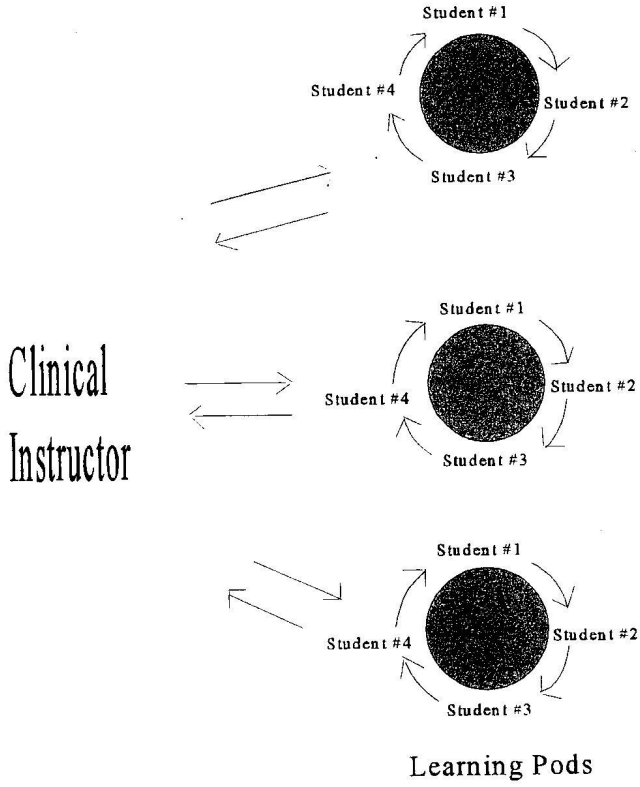
first 3 stages of the Perry Scheme are measurable throughout a student's college education. Therefore, for the purpose of this study, positioning along the first 3 stages was measured.

The purpose of this study was to design, implement and evaluate the effects of a collaborative pre-clinical model (CPCM) in dental hygiene education on learning outcomes and on the enhancement of intellectual development.

Description of a CPCM

The collaborative learning model used in this research focused on the application of instrumentation principles to various instruments used in dental hygiene treatment as taught in a pre-clinical course in the dental hygiene program at Farmingdale State College, State University of New York. The pre-clinical course is taught in conjunction with a preventive oral health concepts lecture. Students work together in the pre-clinical course for 8 hours per week. Throughout the semester time is allotted for demonstration and mini lectures. The collaborative learning model replaced the instrument demonstration component of the pre-clinical course. Collaborative groups of 4 were established and student roles within the groups were based on the 4 principles of instrumentation (grasp, fulcrum, adaptation, stroke). These collaborative groups were utilized throughout the semester as various instruments were introduced. During these collaborative activities faculty acted as facilitators rather than authority figures encouraging open lines of communication. Figure 1 depicts the general communication flow within the suggested pre-clinical collaborative model.

Figure 1: Communication Flow in Pre-Clinical Collaborative Learning Model



The clinical instructor assumes the role of facilitator and students work interdependently with their peers.

Methods and Materials

A randomized, 2 group research design was employed to test the effectiveness of collaborative learning in pre-clinical dental hygiene education and the advancement of intellectual development along Perry's Scheme.[13] The independent variables under investigation consisted of traditional clinical teaching (control group) and collaborative learning methodologies (experimental group). Students were randomly assigned to 1 of these 2 groups (n=26 control, n=28 experimental). The dependent variables were represented by the principles of instrumentation and the advancement of intellectual development along Perry's Scheme. Measurement of the dependent variables consisted of a pre-clinical post-test that evaluated the application of instrumentation principles and 2 pre- and post-tests to assess students' intellectual positioning on Perry's Scheme. These intellectual development pre- and post-tests were the Learning Environment Preference (LEP) and the Measure of Intellectual Development (MID) instruments.[17-19]

The traditional pedagogy, used as the control, followed a rote learning method of instrument introduction. In this approach, students gather around an instructor for a demonstration of instrument usage. These demonstrations took place throughout the semester as each new instrument was introduced. Following the demonstration students paired up and practiced on each other with direct 1-to-1 faculty supervision.

The application of collaborative learning focused on the principles of instrumentation. New instruments were introduced 5 times throughout the semester, and students worked in small groups on clinical manikins to problem solve the application of instrumentation principles. To promote group interdependence each member within the learning group was responsible for 1 of the principles of instrumentation. Roles within the group were rotated on a regular basis to ensure complete learning of the principles. The activities consisted of 4 to 6 open-ended, short answer questions designed to facilitate critical thinking. The initial exercise focused on instrument design, indication for use, grasp, fulcrum, adaption, stroke and patient/operator positioning. Subsequent exercises asked students to problem solve the principles

of instrumentation in comparison to each new instrument introduced. These activities acted as a problem solving guide while faculty were facilitators to redirect the student's thought process if they were unable to solve the problem.

The pre-clinical post-test was designed to evaluate the students' ability to apply the principles of instrumentation to 3 unfamiliar instruments. The instruments used in the post-test included the Gracey 13/14, Gracey 9/10 and the Langer 17/18. The purpose for using unfamiliar instruments was to eliminate the possibility of memorization. In pre-clinical instrumentation, students often memorize instrument usage based on the number engraved on the instrument handle. This evaluation was directed at higher order thinking skills and asked the students to critically think, analyze and apply their pre-clinical knowledge.

The practical instrumentation post-test was performed on a typodont during the last 2 weeks in the semester in a small classroom close by the clinic. Three unfamiliar instruments were presented to the students, who were then asked to determine how these instruments should be used according to the principles of instrumentation. Students were given approximately 15 minutes to complete the evaluation. The post-test evaluation was not part of the students' pre-clinical grade and had no bearing on student success in the course. Students were evaluated individually by an impartial examiner from New York University College of Dentistry who had no connection to the dental hygiene department at Farmingdale State College. The examiner was a dental hygienist who had experience in teaching and evaluating dental hygiene students in pre-clinical instrumentation. Scoring of the post-test involved direct observation and evaluation of instrumentation skill. Scores ranged from 0 to 4 for each stated criteria associated with the 4 principles of instrumentation. A score of 4 indicated that the student performed the stated criteria 90 to 100% of the time, a score of 3 indicated 80 to 90% achievement, a score of 2 indicated 70 to 80% achievement and a score of 1 indicated 60 to 70% achievement. Finally, a score of 0 indicated that the criteria were not met.

The instruments used in measuring intellectual development in this study included the objective LEP developed by Moore and the essay style MID developed by Knefelkamp and Widick.[17-19] The MID is considered the primary research instrument for the measurement of intellectual development in Perry's Scheme. The current version is a single essay, A or AP, which focuses on the student's "ideal learning environment," and essay Q as a post-class experience. The MID provides a single Perry score for the individual essay responses and is scored by 2 trained raters at the Center of Intellectual Development (CSID).[20] Ratings are represented by a 3 digit number indicating the dominant and sub-dominant positions or transitions in cognitive development and reflect a qualitative perspective. The MID ratings may be used as a dependent measure and treated as an interval scale for purposes of data analysis and are subsequently converted to numerical scores.[21] For example, 455 is converted to 4.67 and so forth. Traditional approaches to psychometric reliability, such as short-term repeated administration and split/half procedures of the MID, are difficult. Reliability measures include correlations with interviews, correlations with expert outside raters and inter-rater reliability data.[21] Inter-rater reliability can be determined by the absolute position agreement or within one-third of a position agreement. An absolute agreement of inter-rater reliability of 51.2% and an inter-rater figure of 93.6% within one-third of a position in evaluating 1,244 essays has been reported. The validity of the MID has been assessed in a variety of ways. A 0.45 and 0.13 correlation between the MID and Rest's Defining Issues Test, which measures moral judgment, has been determined. Also the LEP and MID averaged a correlation of 0.36.[21]

The LEP is a relatively new objective-style paper and pencil measure of intellectual development in Perry's Scheme. The LEP reflects a quantative perspective of the MID in that it focuses primarily on the intellectual portion of Perry's Scheme and consists of positions 1 through 5. The tests consist of 65 items across 5 domains: view of knowledge/learning, role of the instructor, role of the student/peer, classroom atmosphere/activities and role of evaluation/grading. The 5 domains focus on student preferences for specific aspects of a classroom environment in association with increasing complexity along the Perry Scheme. It also reflects the major cue categories used in rating the MID. The LEP assigns 1 cue per domain on direct quotes of the MID. The statement cues progress from least complex to most complex statements. The mixture in complexity helps to ascertain whether respondents are selecting responses due to complexity or their cognitive positioning. Scoring is also conducted by the CSID. Scores range from a 200 (stable position 2) to 500 (stable position 5).[22]

Reliability for the LEP has been determined in 2 traditional approaches. Internal consistency using Cronbach's coefficient alpha was computed for each domain and each position across the 5 domains.[23] The alpha reliability ranged from 0.63 on the "role of evaluation" to 0.84 for positions 4 and 5. Test/re-test reliability was performed on 30 subjects. The Cognitive Complexity Index demonstrated a test and re-test correlation of 0.89, indicative of a reasonable amount

Table I: Mann-Whitney Comparison of Instrumentation Post-Test Scores

Instrument / Principle of Instrumentation	Traditional Group		Collaborative Group		z=	p=
	Median	IQR*	Median	IQR*		
Langer 17/18						
• Grasp	16	12 to 16	16	13 to 16	-0.63	0.52
• Fulcrum	12	12 to 12	12	12 to 12	0.20	0.84
• Adaptation	8	4 to 10	8	4 to 9	-0.01	0.99
• Stroke	16	12 to 20	16	15 to 20	-1.19	0.23
• Total	52	45 to 56	53	48 to 57	-0.99	0.32
Gracey 13/14						
• Grasp	16	10 to 16	16	12 to 16	-0.06	0.94
• Fulcrum	12	12 to 12	12	12 to 12	-0.75	0.45
• Adaptation	4	4 to 8	5	4 to 8	-0.11	0.91
• Stroke	16	13 to 20	20	16 to 20	-1.87	0.06
• Total	48	44 to 56	53	49 to 56	-1.26	0.20
Gracey 9/10						
• Grasp	16	11 to 16	16	12 to 16	-0.67	0.50
• Fulcrum	12	10 to 12	12	12 to 12	-1.96	0.05
• Adaptation	8	4 to 11	8	4 to 11	-0.04	0.96
• Stroke	16	11 to 20	20	16 to 20	-1.06	0.10
• Total	48	40 to 59	55	44 to 59	-1.17	0.23

of stability for the measure in that time frame. Intercorrelations of the MID with the Cognitive Complexity Index are 0.36 and 0.25 for MID and GPA.[23]

Students were asked to complete the LEP pre-test on the first day of the fall semester. The instrument was a rating test that took 30 minutes to administer. Students were also given instruction on how to complete the MID essay as a take home assignment and to return the Essay AP the following class session. Both the LEP and MID were mailed to CSID for scoring. Scores are designed to measure patterns of longitudinal intellectual development across groups of students or as a pre-/post-evaluation of courses.

During the last class session students in both groups were asked to complete the LEP and MID Essay Q post-tests. The post-tests were also mailed to CSID for scoring and reconciliation.

Qualitative analysis was employed to analyze student perceptions of their pre-clinical experience using emerging themes. Written assessment of each class session was collected each day through daily classroom assessment activities adopted from Angelo and Cross[20] and an end-of-semester evaluation consisting of open-ended and likert scale questions assessed students' final perceptions of the preclinical course.

Results

The pre-clinical post-test evaluated student ability to apply the principles of instrumentation to 3 unfamiliar instruments: Langer 17/18, Gracey 13/14 and Gracey 9/10. The Mann-Whitney statistical test was used to compare distributions between the collaborative and traditional groups (Table I). Findings demonstrated no statistically significant differences between groups for all instruments with respect to the variables of grasp, adaptation and stroke. The variable of fulcrum did not demonstrate a significant difference between groups for the Langer 17/18 and Gracey 13/14, however, a statistically significant difference for fulcrum was noted for the Gracey 9/10 ($z=-1.96$; $p=0.05$), indicating that students in the collaborative group applied the principle of fulcrum better than the traditional group.

Both the MID and LEP were analyzed using an Analysis of Covariance (ANCOVA). The covariant was the pre-test scores for both instruments, and the outcome was the post-test scores, while the grouping factor was the different educational environment. For the MID scores the ANCOVA indicated that there was no relationship for the pre- and post-test scores ($F=31$; $df=1$; $p=0.58$), and no significant difference for the 2 groups ($F=0.68$; $df=1$; $p=0.41$). However, the ANCOVA demonstrated a significant relationship between pre- and post-test scores for the LEP ($F=4.01$; $df=1$; $p=0.05$) but no significant difference between the 2 groups ($F=0.99$; $df=1$; $p=0.32$). According to Knefelkamp early and late multiplicity stages are the lengthiest developmental periods within student development.[15]

Data collected from the Likert scale portion of dai-

Table II: Student Attitudes Toward the Preclinical Learning Environment* – Clarity of the Clinic Session

Responses	Session 1		Session 2		Session 3		Session 4		Session 5	
	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.
Totally Unclear	1 (4%)	0	0	0	0	0	0	0	0	0
Somewhat Clear	3 (12%)	1 (4%)	0	0	0	0	1 (4%)	0	0	0
Mostly Clear	7 (27%)	8 (30%)	4 (13%)	5 (18%)	5 (22%)	3 (11%)	4 (17%)	6 (21%)	3 (12%)	1 (4%)
Very Clear	7 (27%)	10 (37%)	10 (42%)	12 (43%)	8 (31%)	8 (30%)	12 (52%)	10 (36%)	12 (46%)	4 (15%)
Extremely Clear	8 (31%)	8 (30%)	10 (42%)	11 (40%)	10 (43%)	16 (59%)	6 (26%)	12 (43%)	11 (42%)	22 (81%)
Fisher's Exact Test	0.73		1.00		0.55		0.36		0.008**	

*Data represents the clinic days in which new instruments were introduced as reported by the daily classroom assessment activities.
**p<0.05

Table III: Student Attitudes Toward the Preclinical Learning Environment* – How Interesting was the Clinic Session?

Responses	Session 1		Session 2		Session 3		Session 4		Session 5	
	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.
Totally Boring	5 (19%)	0	0	0	0	0	1 (4%)	0	0	0
Mostly Boring	13 (50%)	0	2 (8%)	0	0	0	1 (4%)	0	0	0
Somewhat Interesting	5 (19%)	2 (7%)	4 (16%)	3 (11%)	7 (30%)	1 (4%)	6 (26%)	2 (7%)	5 (19%)	0
Very Interesting	13 (50%)	12 (44%)	11 (44%)	11 (39%)	8 (35%)	8 (29%)	9 (39%)	10 (32%)	13 (50%)	5 (19%)
Extremely Interesting	8 (31%)	8 (31%)	8 (32%)	14 (50%)	8 (35%)	19 (69%)	6 (26%)	16 (57%)	8 (31%)	22 (81%)
Fisher's Exact Test	0.28		0.35		0.01**		0.04**		0.003**	

*Data represents the clinic days in which new instruments were introduced as reported by the daily classroom assessment activities.
**p<0.05

ly classroom assessment activities revealed no individual differences within student responses over the course of the semester, but overall group differences did exist for the clinic days in which the pre-clinical pedagogy was significantly different (Tables II-IV). As time progressed the 2 groups diverged in the proportion of students who found the pre-clinical sessions extremely clear, interesting and useful. There was a large difference in comparison to the beginning of the semester when the response rate was equal between groups. It appeared that the collaborative group perceived the pre-clinical sessions had greater clarity, were more interesting and more useful as compared to the traditional group. The Fisher's Exact test revealed a significant difference between groups as evidenced on session 5 for clarity (Fisher's Exact=0.008), sessions 4 and 5 for how interesting (Fisher's Exact=0.04 and 0.003, respectively) and usefulness on session 5 (Fisher's Exact=0.03).

Coding themes generated from the open-ended portion of the classroom assessment activities revealed that 42% of students in the collaborative group, as compared to 0% of students in the traditional group, identified help from fellow students as an important part of the pre-clinical sessions. Also, 29% of students from the collaborative group and 62% of students in the traditional group identified help from the instructor as most helpful in clinic (Table V).

Table IV: Student Attitudes Toward the Preclinical Learning Environment* – Usefulness of the Clinic Session

Responses	Session 1		Session 2		Session 3		Session 4		Session 5	
	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.
Useless	0	0	0	0	0	0	0	0	0	0
Not Very Useful	0	0	0	0	0	0	1 (4%)	0	0	0
Somewhat Useful	0	2 (7%)	5 (20%)	4 (14%)	5 (22%)	1 (4%)	4 (17%)	3 (11%)	3 (12%)	1 (4%)
Very Useful	15 (58%)	13 (48%)	8 (32%)	11 (39%)	7 (30%)	7 (29%)	13 (57%)	11 (36%)	13 (50%)	6 (22%)
Extremely Useful	11 (42%)	12 (44%)	12 (48%)	13 (46%)	11 (48%)	16 (67%)	5 (22%)	14 (50%)	10 (38%)	20 (74%)
Fisher's Exact Test	0.57		0.82		0.11		0.12		0.03**	

*Data represents the clinic days in which new instruments were introduced as reported by the daily classroom assessment activities.
**$p<0.05$

Percentages of responses to each of the questions in the departmental end-of-semester course evaluation questionnaire indicated no significant difference between groups when the percentages were compared using the Fisher's Exact test. Although not statistically significant, meaningful results were obtained. Forty-six percent of students in the collaborative group, as compared to 22% in the traditional group, felt they learned the principles of instrumentation extremely well, while 57% of students in the collaborative group and 35% of students in the traditional group felt they strongly increased their commitment to the profession.

Table V: Student Attitudes Toward the Preclinical Learning Environment* – Emerging Themes

Found Most Helpful:		
Emerging Themes	Traditional n=26	Collaborative n=28
Help from Fellow Students	0	12 (42%)
Learning of Instrumentation Principles	4 (15%)	4 (15%)
Help from Instructor	16 (62%)	8 (29%)
Practice Time	6 (23%)	4 (15%)
How Class Could Be Improved:		
Emerging Themes	Traditional n=26	Collaborative n=28
More Help from Instructors	6 (38%)	13 (46%)
More Time to Practice	10 (62%)	11 (39%)
No Improvements Needed	0	4 (15%)

*Data represents the emerging themes associated with the open-ended questions in the daily classroom assessment

Discussion

Collaborative learning as an active learning approach did not promote intellectual development or improve learning outcome when compared to traditional pre-clinical teaching. However, it can be inferred from this investigation that the students' learning was not impeded by the use of collaborative learning. Although collaborative learning is a pedagogically sound alternative for traditional preclinical teaching in dental hygiene, critical thinking skills were not enhanced.

Critical thinking is the ability to evaluate, make judgments and apply knowledge to meet a challenge presented by a new experience or situation. As revealed in this investigation, students were not able to apply the principles of instrumentation when presented with unfamiliar instruments. The pre-clinical post-test evaluation demonstrated that there was no significant difference between the groups except for the variable of fulcrum on the Gracey 9/10. The fact that students were unaware that the instruments evaluated in the post-test were different than the instruments used in their pre-clinical experience represents a limitation in this post-test design. Future studies should emphasize to the students that unfamiliar instruments would be present in the post-test evaluation.

The advancement in intellectual development along Perry's Scheme did not differ significantly between a collaborative pre-clinical environment compared to a traditional environment. However, it is difficult to see change or advancement in intellectual development in dental hygiene education because

traditionally there is a teaching-learning environmental pressure of emphatic reliance on mastering the "correct technique" in the development of pre-clinical skills. The demand of developing correct dental hygiene instrumentation technique lends itself to maintaining the characteristics of early multiplicity in the students' perception of the instructor being the source of the "right way" regardless of learning environment.

Overall, students' perceptions and attitudes concerning pre-clinical dental hygiene education were the same for both groups, indicating that all students were satisfied with their pre-clinical experience. It was anticipated by the researchers that students in the collaborative group would feel more frustrated at the beginning of the semester because of the ambiguity of the collaborative learning process. However, results showed that students were receptive to the process. This may have been due to the fact that they knew they were participating in a research project, a limitation of the study.

Although all students found their pre-clinical experience satisfactory, significant differences were noted in the students' responses to individual pre-clinical sessions associated with the introduction of new instruments. It was evident from the research that students in the collaborative group found the individual pre-clinical sessions that introduced new instruments to be more clear, useful and interesting than did students in the traditional group. It can be inferred that the reason there was no significant difference between groups is that both groups were clearly in the dualistic phase of development. As time progressed the collaborative group may have better acclimated to the challenge and support of a collaborative environment. It is important to note that these pre-clinical sessions represented the different pre-clinical pedagogies used in the study. Therefore, it can be inferred from these findings that dental hygiene students in the pre-clinical setting found the collaborative pedagogy to be beneficial.

Lastly, students in both groups identified instructor assistance and practice time as important in the learning process. This is most likely related to the students' insecurity with learning a new skill in a new environment. However, students in the collaborative group also identified help from their peers as influential in their learning. As illustrated by a student responding to the daily classroom assessment activity, "listening and watching each other helped bring all the fundamentals together." This finding was not apparent in the traditional group, suggesting that collaborative learning assisted students in recognizing their peers as legitimate sources of learning.

Conclusion

Advancement in intellectual development was not significant in the collaborative group as compared to the traditional group. Perhaps the fact that collaborative pedagogy was employed only on the 5 days in which a new dental instrument was introduced may not have been enough collaborative intervention to foster intellectual growth. Although students were responsible for their own learning of the new scaling instrument they still perceived an emphasis on being perfect with their skill development. The pre-clinical environment might stifle intellectual development secondary to the nature of the discipline of clinical dental hygiene.

Another observation was that the MID essay question on post-test may have been misinterpreted by the students. Although the essay asked the students to define their experience in this pre-clinical course, the responses reflected harsh opinions of the entire first semester of classes within the dental hygiene curriculum and not just the course under investigation. This may have been problematic in scoring the essay in rating them for proper Perry positions.

The value added outcomes realized through the collaborative process are congruent with the work of Bruffee and Gamson who suggest that students involved in collaborative learning are more responsible for their own learning, tend to have a more positive attitude toward the subject matter, increase their tolerance for diversity of opinion, improve their interpersonal skills and enhance self-esteem.[7,8,24] Future studies evaluating collaborative learning in clinical education need to investigate the cost/benefit ratio of these value added outcomes. Collaborative pedagogy in didactic and clinical course across the dental hygiene curriculum would provide the foundation to foster a shared community of learners.

Laura J. Mueller-Joseph, RDH, EdD, is a professor and chairperson at the Department of Dental Hygiene and Acting Assistant Dean, The Theresa Patnode Santmann School of Health Sciences. Luisa Nappo-Dattoma, RDH, RD, EdD, is an associate professor at the Department of Dental Hygiene. Both are faculty at Farmingdale State College, State University of New York.

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