Actual Versus Preferred Laboratory Classroom Practices: An Evaluation of the Effectiveness of Laboratory Classroom Teaching at the Post-Secondary Level[1]

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Abstract

Students' perceptions of the actual and preferred classroom environment were evaluated using the Science Laboratory Environment Index (SLEI). The SLEI evaluates the classroom environment based on five scales: Student Cohesiveness, Open-Endedness, Integration, Rule Clarity and Material Environment. In addition to evaluating the total classroom environment, the level of integration was evaluated between students in a face-to-face lecture course and students in an online lecture course. A sample of 109 post-secondary students enrolled in Introduction to Entomology Laboratory at the University of Florida responded to the SLEI. Results revealed statistically significant differences between the actual and preferred classroom environment. The results suggest that students enrolled in this laboratory course would like to see an increase in activities that fall within all scales of the SLEI. Additionally, there should be a greater level of integration between information presented in lecture and experiments carried out in the laboratory portion of the course.

Introduction

The actual classroom environment has been studied extensively over several decades; however there has been little research on the preferred classroom environment. Due to this lack of research, there has been great interest in understanding a student's preferred classroom environment. Research has shown that students' perception of the classroom environment can affect how the student perceives the quality of the classroom (Dorman, 2008). The quality of the classroom environment has been suggested to have an effect on student learning as indicated by the level of student achievement (Byrne et al., 1986; Dorman, 2008). When using student learning and achievement as a basis for measuring classroom environment preference, Fraser et al. (1995) found that students achieve better when there is great congruence between the actual and preferred classroom environment. Attempts to close this gap have resulted in greater student outcomes (Dorman, 2008).

In addition to using student outcome and achievement as a basis of evaluating the preferred classroom environment, student perceptions have also been used to determine preferences in classroom environment. Bryne et al. (1986) measured students' preferred classroom environment through the use of three instruments each administered to 1,675 students in grades 7, 9 and 11. The researchers reported that classroom preference was found to be dependent on the age and gender of the learner. Younger students (ages 5-11) preferred structure and class cohesiveness, while middle age students (ages 11-16) preferred competition and older students (ages 16-18) preferred self-initiated activities but also desired cohesiveness. Male students preferred more competition, whereas female students preferred social harmony (Bryne et al., 1986). Based upon this information, age and gender of the learner have been cited as significant factors when assessing the preferred classroom environment.

Age and gender of the learner have influenced classroom perceptions just as overall classroom morale, as perceived by students, has affected the classroom environment. Students have preferred the classroom morale to be more positive than what they have been

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experiencing (Dorman, 2008). Positivity has been characterized as a social and affective characteristic of the classroom. Social and affective characteristics deal with the behaviors of students and teachers and the feeling of the environment generated from those interactions (Ripple, 1965). These characteristics, or feelings developed through interactions have had just as much influence on learning as instructional characteristics (Doll et al., 2010). Social and affective characteristics have helped promote student engagement and active participation in the learning process (Doll et al., 2010). Thus, students will be more committed to learning when they perceive a more positive environment and feel valued and respected by their teacher (Doll et al., 2010).

Review of Literature

Fraser et al. (1993) developed the Science Laboratory Environment Index (SLEI) based upon Moos (1987) general categories of dimensions for conceptualizing all human environments. Moos identifies three dimensions which impact all social climates—Relationship Dimensions, Personal Growth or Goal Orientation Dimensions and System Maintenance and Change Dimensions.

Relationship Dimensions assess "personal relationships in a setting" (Moos, 1987, p. 8). Items such as involvement, cohesion and support are measured within the Relationship Dimensions. Personal Growth or Goal Orientation Dimensions evaluate the "ways in which an environment encourages or stifles personal growth" (Moos, 1987, p. 8). In general, this dimension measures independence and intellectuality, which in classroom settings, is evaluated by assessing a student's performance and competitiveness.

The System Maintenance and Change Dimensions measure *"how orderly and organized the setting is, how clear it is in its expectations, how much control it maintains and how responsive it is to change"* (Moos, 1987, p. 9). In classrooms, this dimension measures how aware students are of rules and the consequences associated with not following the rules. When utilizing these dimensions to evaluate a social climate, Moos believed a complete picture of the environment could be obtained.

Fraser et al. (1993) based the development of the SLEI on Moos (1987) dimensions and a comprehensive review of the literature to determine environments that are unique to the science laboratory classroom. The researchers also evaluated past classroom environment questionnaires and interviewed numerous science teachers and students in the development of the SLEI. The SLEI was constructed specifically to evaluate the science classroom to examine what makes a science laboratory classroom unique. Learning in a science laboratory is distinct because laboratory experiments help students meet learning goals through the use of hands on activities.

In order to facilitate hands on activities, adequate science laboratory facilities have been necessary. When adequate facilities have been available, laboratory activities have allowed students to have concrete experiences that were connected with the learning objectives (Freedman, 1997). Facilities have had a great impact on student success in meeting the goals of the teaching and learning of science (Ainley, 1990). Student success in science has been improved through laboratory work that is exciting and encouraging which can positively influence students' attitude toward science (Freedman, 1997). However, not all students have viewed laboratory work as exciting. Research has shown that students have felt laboratory work is boring and just an act of going through the motions without any clear purpose (Fraser et al., 1993). Therefore, research on students' perceptions of the science laboratory and their performance within the laboratory is still needed to help improve the teaching and learning of science.

One such study by Freedman (1997) evaluated the effects of hands-on laboratory experience on achievement in science knowledge. Students were assigned to 20 physical science classes. Classes in the treatment group participated in laboratory experiences once a week for 36 weeks, while the control group had no laboratory experience. The effects of the laboratory or non-laboratory setting were evaluated based on mid-term and final examination scores. A significant difference was found between students who participated in laboratory experiences and those that did not, illustrating that students who had laboratory experience achieved higher scores (Freedman, 1997). Research has suggested that science laboratories have been an effective means of teaching students science concepts.

Science laboratories have provided students with the opportunity to have hands on experiences, however students have also needed to understand the concepts being taught in a laboratory setting. McKee et al. (2007) sought to evaluate students' understanding of the concepts being taught in the science laboratory. Researchers evaluated the conceptual understanding of students in two different laboratory groups: those students that participated in the laboratory exercise and those students who only veiwed the lab exercise as a demonstration by the teacher. Results showed no significant difference between the two groups after the experiement, indicating that both hands on learning and demonstration laboratories provided students with the same opportunity to learn. There was no difference in conceptual understanding based upon the students' interaction with the laboratory experience.

In addition to ensuring students develop a conceptual understanding of the information being taught, the information taught in the laboratory should be integrated with the concepts that have been taught in the classroom. Integration has occured through the use of the laboratory setting as a tool for students to confirm the information learned and to gain a visual representation of processes discussed in the lecture course (Hofstein and Lunetta, 1982). Integration of lecture and laboratory material has been cited as one of the most imperative dimensions of instruction because the student learning experience should be integrated with the rest of the course, or instruction can be meaningless for the student (Byrne et al., 1986). When the courses are not integrated, students have perceived concepts or exercises as unrelated to learning outcomes (Bluic et al., 2009).

One challenge of effective integration has been the delivery method of the lecture course. Recently, alternative delivery methods have been developed for course instruction rather than traditional face-to-face instruction, one such alternative being the Internet. The Internet has become a useful vehicle for delivering courses at the post-secondary level (Perez-Prado and Thirunarayanan, 2002). At the post-secondary level, students have the option of taking courses face-to-face or online. Online instruction has provided the opportunity for the facilitation of information with regard to the type of learner and their location (Johnson et al., 2000). Conversely, researchers (Johnson et al., 2000) have found that face-to-face courses are criticized for encouraging passive learning and not meeting the needs of the individual learners. However, face-to-face instruction has continued to evolve in order to meet the needs of learners (Johnson et al., 2000). There have been benefits and criticisms of both online and face-to-face instruction, but researchers (Johnson et al., 2000) suggested that one method of delivery is not better than the other.

In order to evaluate the two different methods of course delivery, a study conducted by Johnson et al. (2000), placed graduate students in two different versions of the same course, taught by the same instructor, with one version of the course being taught face-to-face while the other was online. Results showed that student satisfaction was slightly more positive for students in a traditional face-to-face environment. Students in the face-to-face course provided a slightly more positive rating of the instructor and of the learning environment characteristics than those enrolled in the online section. Although there was a difference in course ratings between the two groups, there was no difference in the quality of work submitted from each group or the distribution of grades between the two groups. Although the online students were not completely satisfied with the course and the instructor, they performed at a level equivalent to that of the students in the face-to-face section. If level of performance has been a primary concern, results illustrated that either method of delivery will yield the same outcome however, student perceptions may be important to consider when developing a course.

Based on the aformentioned findings, the fundamental problem this study investigated was the congruence between the actual and preferred science classroom laboratory environment in a post-secondary institution. A lack of congruence could result in lower student achievement. In addition, the level of integration between the lecture and laboratory courses was evaluated, as well as the differences in the face-to-face and online lectures.

Methods

Most of the studies involving the use of the SLEI have been used in secondary education settings. Just as in secondary education, laboratory components are still a vital part of student learning at the post-secondary level. When evaluating science laboratories the previous research using the SLEI has shown that greater congruence between actual and preferred classroom environments has resulted in greater students learning. Research has also shown differences in learners opinions based on course delivery. The objectives of this study were to:

1. Determine if science classroom laboratory instruction at the post-secondary level is operated in a manner that meets the needs of learners by evaluating students' actual and preferred classroom environment.
2. Determine whether material presented in the lecture portion of the class is pertinent to the material presented in the laboratory portion.
3. Determine if there is a difference of opinion concerning lecture/laboratory integration level between face-to-face and online versions of the lecture class.

Each objective was tested at a significance level of .05.

The Science Laboratory Environment Inventory (SLEI) (Fraser et al., 1993) was used to evaluate the actual and preferred classroom environment of post-secondary education students in science laboratory classes. The SLEI contains two forms, a personal form and a classroom form. The personal form evaluates students' perceptions of their role within the classroom and the classroom form evaluates the students' perceptions of the class as a whole. Only the personal form was used to evaluate students' opinions of the actual and preferred classroom environment. The preferred form of the SLEI consists of 35 items with responses on a 5 point scale with the alternatives of 1 = Almost Never, 2 = Seldom, 3 = Sometimes, 4 = Often and 5 = Very Often. The SLEI contains five scales: Student Cohesiveness (SC), the extent to which students are encouraging and supportive of each other; Open-Endedness (OE), the extent to which activities and experiments are open-ended; Integration (I), the extent to which the laboratory activities are integrated with the theories taught in the lecture portion of the course; Rule Clarity (RC), the extent to which the laboratory is guided by formal rules; and Material Environment (ME), the extent to which the materials and equipment are adequate for the course. Each of these scales were evaluated using seven questions (Table 1) (Fraser et al., 1993). The SLEI was adjusted to meet the needs of the study. Wording within the instrument items was edited to read correctly in American English. The University of Florida Institutional Review Board approved the study and all participants provided written informed consent.

Fraser et al. (1993) validated and tested the SLEI in its original form (72 items and eight scales) in six difference countries (Australia, United States, Canada, England, Israel and Nigeria). After the instrument was tested in each of these countries, an item analysis was conducted on each item to identify the questions which would enhance the consistency and discriminant validity of the instrument. Item analysis procedures were applied separately for the actual and preferred versions so as to develop an instrument that could accurately assess the actual and preferred environment. In addition to the ensuring accurate assessment of the actual and preferred forms, the researchers desired to establish cross-national validity, thus, the item analyses were performed separately for each of the six countries. This item analysis led to the deletion of 20 items and one scale from the original 72 items in the SLEI. The resulting 52 items of seven scales formed the starting point for the factor analyses (Fraser et al., 1993).

A series of factor analyses was run on the remaining 52 items, where the actual and preferred version analyses were run separately. This factor analysis resulted in the deletion of two more scales and two items from each of the remaining scales, resulting in a 34-item, five scale instrument—all scales had seven questions except the Open-Endedness scale which had six. Factor loadings were obtained from the total sample of 3,727 students in 198 classes. A factor loading value of 0.30 was utilized. The actual form had a factor loading greater than 0.30 for each of the 34 items. The pattern for the preferred form was similar. Overall, these results indicate the factorial validity of the 34-item, five scale SLEI (Fraser et al., 1993).

Table 1. Item and Item Scale for the Science Laboratory Environment Index (SLEI) administered to Students Enrolled in Introduction to Entomology at the University of Florida in 2010

SLEI Item	SLEI Scale[z]
I get along well with students in this laboratory class.	SC
There is opportunity for me to pursue my own science interests in this laboratory class	OE
What I do in our lecture class is unrelated to my laboratory work.	I
My laboratory class has clear rules to guide my activities.	RC
I find that the laboratory is crowded when I am doing experiments.	ME
I have little chance to get to know other students in this laboratory class.	SC
In this laboratory class, I am required to design my own experiments to solve a given problem.	OE
The laboratory work is unrelated to the topics that I am studying in the lecture class.	I
My laboratory class is rather informal and few rules are imposed on me.	RC
The equipment and materials that I need for laboratory activities are readily available.	ME
Members of this laboratory class help me.	SC
In my laboratory sessions, other students collect different data than I do for the same problem.	OE
My work in the lecture class is integrated with laboratory activities.	I
I am required to follow certain rules in the laboratory.	RC
I am ashamed of the appearance of this laboratory.	ME
I get to know students in this laboratory well.	SC
I am allowed to go beyond the regular laboratory exercise and do some experimenting of my own.	OE
I use theory from my lecture class sessions during laboratory activities.	I
There is a recognized way for me to do things safely in this laboratory.	RC
The laboratory equipment which I use is in poor working order.	ME
I am able to depend on the other students for help during laboratory classes.	SC
In my laboratory sessions, I do different experiments than some of the other students.	OE
The topics covered in lecture are quite different from topics in aboratory sessions.	I
There are few fixed rules for me to follow in laboratory sessions.	RC
I find that the laboratory is hot and stuffy.	ME
It takes me a long time to get to know everybody by his/her first name in this laboratory class.	SC
In my laboratory session, the teacher decides the best way for me to carry out the laboratory experiments.	OE
What I do in laboratory sessions helps me to understand the theory covered in lecture.	I
The teacher outlines safety precautions to me before my laboratory sessions commence.	RC
The laboratory is an attractive place for me to work in.	ME
I work cooperatively in laboratory sessions.	SC
I decide the best way to proceed during laboratory experiments.	OE
My laboratory work and lecture class work are unrelated.	I
My laboratory class is run under clearer rules than my other classes.	RC
My laboratory has enough room for individual or group work.	ME

[z] SC= Student Cohesiveness, OE= Open-Endedness, I= Integration, RC= Rule Clarity, and ME= Material Environment

The instrument developers also wanted the SLEI to be capable of differentiating between perceptions of students in different classrooms. Thus, a one-way analysis of variance (ANOVA) was performed for each scale. Results indicated that each scale differentiated significantly between classrooms (Fraser et al., 1993).

After all item analysis procedures and validity was established, the refined version of the SLEI, with 34-items and five scales, was administered to senior high school students. After administering the instrument a decision was made to add an additional item to the

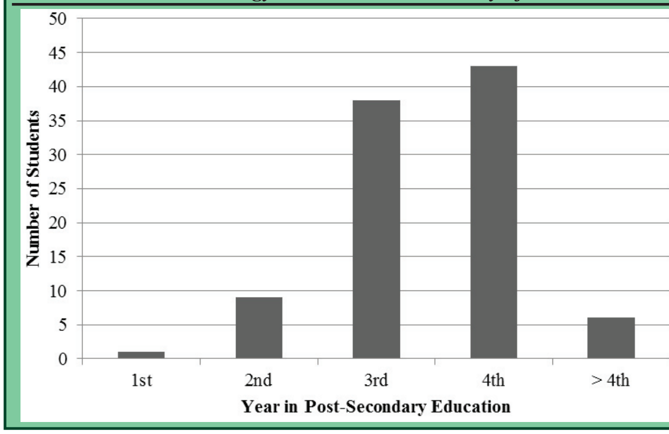
Open-Endedness scale so that each scale would have seven items. This made the instrument easier to score and the 35-item version was cross-validated with 1,594 students (Fraser et al., 1993).

The target population for this study was post-secondary students enrolled in an upper division course of Introduction to Entomology at the University of Florida. The survey was administered three-quarters of the way through the semester so that students were able to evaluate all relevant aspects of their laboratory experience. The total sample that responded to the SLEI consisted of 109 post-secondary education students enrolled in five different sections of the course. Each laboratory section had a different instructor, but all students had the same instructor for the lecture portion of the course, regardless of the method in which it was delivered (i.e., face-to-face or online). Students enrolled in the online version of the lecture course, were required to attend laboratory sessions on campus. Statistics were calculated using SPSS® version 17.0 for WindowsTM. Post-hoc reliability analysis of the instrument yielded the following Cronbach's alpha coefficients for the five scales, for both actual and preferred scores: SC actual= 0.79; SC preferred=0.64; OE actual=0.53; OE preferred= 0.59; I actual= 0.84; I preferred= 0.69; RC actual= 0.57; RC preferred= 0.53; ME actual= 0.66; ME preferred= 0.57.

Results

Demographic information was collected for the variables of gender, major, college, year in post-secondary education, if the course was required and if the student was admitted as a freshman or a transfer student from a community college. Out of 109 respondents, 48% (n=52) were male and 52% (n =56) were female. In total, there were 20 different majors reported from all five sections of the course. The most prevalent major reported was biology at 39% (n =42). Of those 20 majors, 10 majors were housed in the College of Agricultural and Life Sciences, two majors (biology and microbiology and cell sciences) are shared with the College of Agricultural and Life Sciences and the College of Liberal Arts and Sciences, the other eight majors were distributed among three other colleges at the University of Florida. In total, 61% (n =60) students are enrolled in the College of Agricultural and Life Sciences. As reported in Figure 1, the majority of students were undergraduate students with 45% (n =43) being seniors, while the next most prevalent were juniors at 39% (n =37), then sophomores at 9% (n =9) and freshman at 1% (n =1). The remaining students (6%; n=6) were post-bachelor, master's or PhD students. This course was required by 65% (n =70) students, while the other 35% of students took this course as an elective. The majority of undergraduate students enrolled in this course were admitted to the University of Florida as a freshman, while 34% (n =33) of the students were admitted as a transfer student.

Figure 1. Year in Post-Secondary Education of students enrolled in an Introduction to Entomology course at the University of Florida in 2010.



The first objective of this study was to determine if this science classroom was meeting the needs of its learners, through the occurrence of greater congruence between the actual and preferred classroom environment.

To determine if there was a significant difference between the actual and preferred scores of each scale on the SLEI an analysis of variance (ANOVA) was performed (Table 2). Differences between the actual and classroom environment were found to be significant in each of the five scales.

Table 2. Analysis of Variance (ANOVA) of Mean Scores for the Five Scales on the Science Laboratory Environment Index (SLEI) for Students Enrolled in Introduction to Entomology at the University of Florida in 2010 (n=109)

Scale	SS	*df*	MS	F
Student Cohesiveness	15.29	16	.96	3.64**
Open-Endedness	10.25	24	.44	2.51**
Integration	29.26	16	1.83	4.94**
Rule Clarity	19.92	22	.91	9.13**
Material Environment	7.94	14	.57	4.57**

**P=0.01

Table 3 depicts the mean scores for each of the scales of the SLEI, as well as the minimum, maximum and standard deviation for each scale. In every SLEI scale (e.g., SC, OE, I, RC, and ME), students preferred the items listed in that scale to occur more often.

The second objective in this study was to determine if the information provided in the lecture portion of the class was relevant to the information presented in the laboratory portion of the class. Evaluation of this objective was based on the analyses conducted for the integration scale. The seven questions associated with the integration scale measured the extent to which the laboratory activities are integrated with non-laboratory and theory classes. Based on the analyses conducted there was a statistical significance, with a P-value<.01.

Table 3. Minimum, maximum, mean and standard deviation for all scales of the Science Laboratory Environment Index (SLEI) on Actual and Preferred Scales for Students Enrolled in Introduction to Entomology at the University of Florida in 2010

	Actual[y]				Preferred[y]			
Scale[z]	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
Student Cohesiveness	2.14	5.00	3.63	0.60	3.00	5.00	4.23	0.50
Open-Endedness	1.29	3.71	2.50	0.48	1.43	4.57	2.87	0.59
Integration	1.14	5.00	3.61	0.77	2.71	5.00	4.19	0.61
Rule Clarity	2.57	4.68	3.69	0.51	2.43	5.00	3.78	0.51
Material Environment	3.29	5.00	4.35	0.43	2.71	5.00	4.66	0.35

[z] Scores were based on a 5 point scale, with "1"= Almost Never and "5"=Very Often.
[y] Actual indicates how the practices were actually occuring the laboratory and preferred indicates how the student would prefer for those practices to occur in the laboratory.

Table 4. Analysis of Variance (ANOVA) of Mean Scores for the Integration Scale between Face-to-Face and Online Students Enrolled in Introduction to Entomology at the University of Florida in 2010 (n=109)

Scale	SS	*df*	MS	F	*p*
Integration[y]-Actual[z]	.23	1	.04	.38	.57
Integration[y]-Preferred[z]	.14	1	.14	.37	.55

[z] Actual indicates how the practices were actually occuring the laboratory and preferred indicates how the student would prefer for those practices to occur in the laboratory.
[y] Integration is the extent to which the laboratory activites coincide with the information presented in the lecture portion of the course.

The third objective for the study was to determine if there was a difference of opinion in the integration level of the lecture and laboratory portion of the class between the students taking the online lecture class versus the face-to-face lecture class. In total, 55% (n =58) of students were enrolled in the face-to-face version of the lecture class and 45% (n =48) of the students were enrolled in the online version of the lecture class. Table 4 depicts the analysis of variance (ANOVA) performed, which revealed that there was no statistical significance between students in the face-to-face and online versions of the course concerning their perceived level of integration between the lecture and laboratory class.

Figure 2 displays the mean scores for each of the five scales used in the SLEI. The figure depicts scores based on student's enrollment in a face-to-face or online class and their actual and preferred environment.

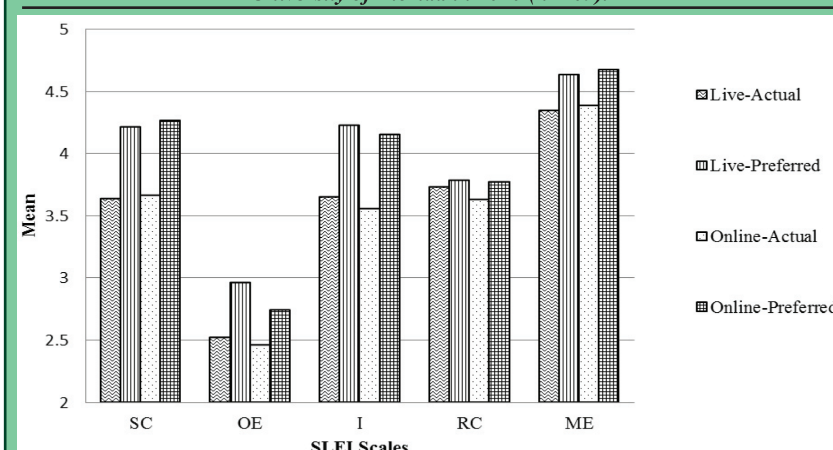
Discussion

The SLEI indicated that there was little congruence between the actual and preferred classroom environment, thus indicating that students would prefer for there to be more student cohesiveness, greater open-endedness, greater integration, greater rule clarity and better laboratory facilities. Students had a greater score in the preferred column in each of the scales, which could indicate a variety of preferences. These students could prefer more self-initiated activities and greater cohesiveness as found by Byrne et al. (1986) in a similar study. If greater cohesiveness is desired, students may prefer a more positive classroom environment (positivity is associated with the relationships between student-teacher and student-student), which is a common request of students as found by Dorman (2008).

In addition to the desire for a more cohesive classroom, this study also found that this laboratory classroom was dominated by close-ended activities (e.g., laboratory activities guided by exact procedures, presribed laboratory experiements with no room for deviation). Fraser et al. (1995) also found this when evaluating the science laboratory classroom. Students in this study would prefer for there to be greater open-endedness than what they are currently experiencing (e.g., the opportunity to pursue students' own interest within the relam of the course, the opportunity to design students' owen experiement and procedures). However, this desire for greater open-endedness is disimilar to the work of McRobbie and Fraser (1993), as those researchers found that the students did not desire more open-ended activities.

Students in this study would prefer better laboratory facilities, which can result in an enriched learning environment, which includes a setting that results in greater involvment in purposeful activity (Ainley, 1990). Purposeful activity promotes greater student learning, which can be accomplished through science laboratory facilities if they are operated in a manner that is exciting and encouraging for students (Freedman, 1997). Exciting

Figure 2. Mean scores for each scale of the Science Laboratory Environment Index(SLEI) administered to students in an Intoduction to Entomology course at the University of Florida in 2010 (n=109).



Note: SC= Student Cohesiveness, OE= Open-Endedness, I= Integration, RC= Rule Clarity, and ME= Material Environment

Scores were based on a 5 point scale, with "1"= Almost Never and "5"=Very Often.
Note: Actual indicates how the practices were actually occurring the laboratory and preferred indicates how the student would prefer for those practices to occur in the laboratory; Live is those students who took the lecture course face-to-face and online indicates those students who took the lecture course online.

and encouraging environments can promote more positive attitudes toward science (Freedman, 1997).

Fraser et al. (1995) found that greater student achievement occurred when there was greater congruence between the actual and preferred classroom environment, as evaluated by students. Results in this study, indicated that students would prefer for greater congruence between the actual and preferred classroom, in all five scales of the SLEI, therefore, student achievement could have been low, due to the lack of congruence between each scale. If student achievement had been measured using a numerical score, or letter grade, obtaining the grades from each of the five course sections would have been beneficial to use in determining if there was an affect from the reported lack of congruence in actual and preferred classroom environments.

The integration scale was evaluated alone to determine if there was adequate integration between lecture and laboratory portions of the course. The data indicated that there was a significant difference between the actual and preferred level of integration, thus showing that students would prefer for there to be more integration between the laboratory class and the lecture or theory portion of the class. Integration may be the most important aspect of the laboratory environment that was evaluated with respect to student learning. Research (Bliuc et al., 2009) has shown that integration of knowledge is imperative to student learning. If information is not integrated, students can perceive material as unrelated and not important to the overall learning goal (Bliuc et al., 2009).

When evaluating the integration of a face-to-face or online lecture with the laboratory classroom, it was predicted that students in the face-to-face lecture course would perceive greater integration of the material than that of the online lecture students. However, both categories of students felt the same way about the integration of the material into the laboratory portion of the course. There was no significant difference between their attitudes concerning integration. As seen earlier, students did not feel the level of integration was adequate, however, there was no difference between those students in the face-to-face course versus those in the online course. These results were not consistent with those found by Johnson et al. (2000) and Summers et al. (2005). However, Summers et al. (2005) discussed the idea that technology has the ability to greatly influence an online course simply by choosing technology that will enhance the curriculum of the course. Since online students have expressed attitudes that are very similar to that of face-to-face students, the instructor for this course has adapted technology in order to meet the needs of the learners. These results could indicate that the course instructor was the same for both the online and face-to-face versions of the course, thus there was greater congruence between course versions.

Recommendations for instructors include facilitating activities that promote a positive learning environment and creating activities that allow students more freedom to explore their interests, while still accomplishing the same learning goals. In an effort to create activities that allow an extension of thinking, but are not entirely open-ended, instructors may try directing the focus of students by offering potential areas to explore, or experiments to perform, but giving students freedom to choose within the guidelines. By doing this, there is an element of open-endedness, but not too much that students may develop less favorable attitudes toward the classroom.

Although it may not be feasible to provide better laboratory facilities, instructors should make better use of the facilities available to accomplish the goals of the course. In instances where facilities are not available, activities should be created that promote learning in the same manner. These activities should be hands-on, but may only be a simulation of an experiment that could be performed in the laboratory. Experiments and activities do not have to be elaborate in order for student learning or integration to occur, but they should present the information students are learning in an additional format so that the student will be better able to comprehend the material.

Overall, an instructor should set goals to increase the level of integration between the lecture and laboratory portions of the course. When courses coincide students are able to make connections between the information presented in each course. In order to do this, an instructor should format the laboratory in a logical order that follows the order of the information presented in the lecture portion of the course. As students cover material in lecture, they will be applying that knowledge in their laboratory course. Instructors in the lab should consistently reference the information presented in the lecture portion of the course so students are better able to assimilate information.

In the future, this study should be replicated with a larger sample and in different subject areas. Both hard science laboratory courses (e.g., chemistry, physics, etc.) as well as applied science laboratory classes should be evaluated. The researcher should obtain achievement scores at the semester end to determine if student achievement is affected by the perception of differences in the actual and preferred classroom environment. In order to more adequately evaluate the integration scale, information should be obtained about the instructor for each lecture course. Further information of the curriculum can provide insight into the presentation order of material as well as the depth to which each topic is covered.

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