Perceptions of the Students toward Studio Physics

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Abstract

The purpose of this study was not only to report the development process of the studio model, but also to determine the students' perceptions about the studio model. This model retains the large lecture component but combines recitation and laboratory instruction into studio model. This research was based on qualitative analysis. The data of the study was collected with survey and interview done about studio model during two semesters in Colorado School of Mines, U.S. The results of the study showed that the students found the interactive-engagement method of learning physics to be a positive experience. They liked the integration of homework and laboratory activities, working in groups, and having the opportunity to interact, individually, with lecturers. In short, the teaching-learning method presented here, studio model had made a positive impact on students' perceptions about the physics course.

Keywords: *Active Learning Environment; Higher Education; Physics Education; Studio Model; Studio Physics*

Introduction

In recent years, researchers have realized and documented higher education students' poor understanding of various topics through traditional lectures. It was reported that traditionally taught courses were not able to improve students' understanding of the fundamental concepts even if students could solve topic-related problems (Hake, 1998). It is known that students learn more physics in lectures where they interact with faculty, collaborate with peers on interesting tasks, and are actively involved with the material they are learning (Mazur, 1997). Research on learning and curriculum development has resulted in instructional materials and teaching methods that can correct many of the drawbacks of traditional physics instruction (McDermott, 1991; Redish & Steinberg, 1999; Van Heuvelen, 1991). Careful studies of these research-based introductory curricula in small classes point out that they can significantly improve students' conceptual understanding (Hake, 1998; Redish et al., 1997; Laws, 1991; Heller et al., 1992). However, the introductory physics lecturers with large classes who want to incorporate active learning into their classrooms must typically choose between a) hands-on activities (Beichner et al., 1999) in small recitation or laboratory sections that supplement the lecture (McDermott et al., 1998) and b) interactive lecture activities for larger classes such as Peer Instruction (Mazur, 1997) and interactive lecture demonstrations (Sokoloff & Thorton, 1997) that do not allow hands-on experiments and limit faculty interactions with individual groups.

Therefore Rensselaer Polytechnic Institute "RPI" has introduced a new model for the large enrollment undergraduate courses that has been become known as the studio model (Wilson, 1994; Young, 1996). After RPI had developed the studio model, other universities and institutions developed the different studio models. For examples, Massachusetts Institute of Technology (Technology Enabled Active Learning "TEAL" see Fig. 1), North Carolina State University (Student-Centered Activities for Large Enrollment Undergraduate Programs "SCALE-UP" see Fig. 2), Dickinson College (Workshop Physics see Fig. 3), etc.

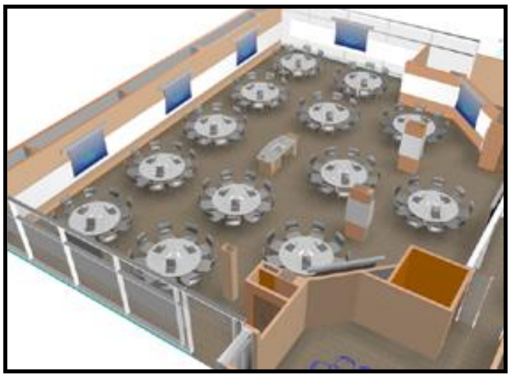


Fig. 1*:* The studio physics at MIT for the TEAL classroom and student groups working in the classroom (http://web.mit.edu/8.02t/www/802TEAL3D/teal_tour.htm Accessed 23.12.2010)

Fig. 2: The studio physics at NCSU for the SCALE-UP classroom and student groups working in the classroom (http://serc.carleton.edu/sp/pkal/scaleup/index.html Accessed 23.12.2010)

Fig. 3: The studio physics at DC for the Workshop Physics classroom and student groups working in the classroom (http://physics.dickinson.edu/~wp_web/wp_overview.html Accessed 23.12. 2010)

The studio model is based on a learning environment which was designed to facilitate students' ability to interact with one another, with the lecturer, and with the course material during their time in lecture (Wilson, 1994). The studio model was the first created, and it has since been adapted to various courses in chemistry, biology, engineering, and economics, etc. These studio courses have been introduced to replace some of the large introductory lecture-based courses in science and engineering with a format including daily lectures, in-class activities, homework assignments, hands-on activities which are more integrated and incorporate technology. These studio courses present better interactive learning environments for students and a better teaching environment for faculty (Wilson & Jennings, 2000).

A dynamic teaching environment which integrates the traditional instruction activities (lecture, recitation, and laboratory) is created by student workstations, tabletop experiments, computer software, and traditional textbooks in this system of learning. Students' communication skills are improved with the design and analysis done in workstation computers and they learn to be a part of a team. Students can discuss their results with their neighbors. The student-centered activities also offer a friendly lecture to students and even to those lecturers who tend toward the traditional style of classroom. The lecturer acts more as a guide and/or advisor and can move freely from lecture into hands-on activity in a facility with a configuration of a theater-in-the-round classroom. The studio classroom provides an excellent opportunity to introduce large-scale undergraduate level courses to students in an interactive learning environment with its technology and team-based learning (Wilson, 1994).

Many lecturers have successfully used cooperative learning in their classrooms; studio teaching is a logical extension of that approach. Studio classrooms have many different manifestations but all share common elements. They involve longer, fewer, class sessions with focused, intense, student activity. Any disconnect between laboratory and lecture time is absent because lab and lecture are combined. In fact, lectures are de-emphasized or eliminated. Students work on in-depth projects instead, generally in groups, sometimes moving from one workstation to another. Tables are arranged so students face each other instead of the front of the classroom. The interactive classrooms promote holistic skills, including thinking, inquiry, creativity and reflection by students, often involving peer review and critiquing. Table 1 compares some characteristics of a course taught as a studio class with those of a more traditionally taught physics class (Perkins, 2005).

An important feature of studio class is that students have more control and responsibility for outcomes than in traditional class. Lecturers and Teaching Assistants (TAs) are mentors, acting as learning guides, providing the learning environment and materials needed for students to create their own learning. Lecturers help students to start on projects and are on hand as resources for students to use (Perkins, 2005).

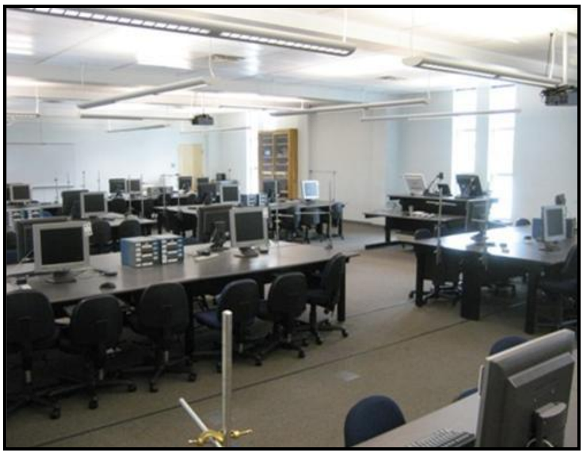
Table 1: Comparison a studio class with a traditional class

Features	Traditional Class	Studio Class
Meeting Times	Two or three 50 or 90-minute lectures and one lab per week	Two times per week in 50 min for lecture; two times per week in 90 min for studio
Lab Exercises	Completely separate from lecture; generally individual activities	Not separated from studio; generally group activities
Group Activities	Sometimes in lab sessions	The focus of the studio
Lecturer’s Role	Authority, lecturer	Learning guide, class coordinator, a resource for students when needed
Lecturer’s Time	About 3 contact hours per week; generally only in lecture sections	About 6 contact hours per week; both studio and lecture activities
TAs’ Role	Assist lecturers	Aid lecturer, acts as student resource,
TAs’ Role	About 3 contact hours per week;	About 9 contact hours per week; both

	generally only lab activities	studio and lecture activities
Students' Role	Passive learner, learn what it required, mostly work as individual	Active learner, group participant, control their own learning environment, learn by doing
Syllabus	Cover many topics but not all in great depth	Cover a smaller number of topics in great depth
Materials	Only textbook and sometimes worksheets	Most on-line materials offsite thorough web access, supplemental study guides, problems, exams, etc.
Grading	Based on class averages	Based on individuals and teams

In the studio concept, computers and developed software are used to reinforce the interactive learning with tutorials and simulations for the lecture courses. Also, computers are integrated into the experiments for data gaining and analysis in laboratories. Individualized assignments for both lecture and hands-on activities can be created by computer programs.

For this study, the features of the studio model constructed at Colorado School of Mines (CSM) were given as follows. CSM is a public university located in Golden, Colorado, serving about 4000 undergraduates. The school offers science and engineering majors almost exclusively, and all students take the same core of math and science courses. This core includes Physics I and Physics II, the first and second semesters of introductory calculus-based physics (Kohl et al., 2008). In the mid 1990s, CSM constructed a cross departmental Center for Technology and Learning Media (CTLM) building, and the department successfully lobbied for the creation of a studio room in that building. Sections of Physics I were immediately converted to Hybrid Studio Format (HSF) including two one-hour lectures per week, and two two-hour blocks of studio time. Retaining a lecture component in the course, rather than switching to a total studio mode, reduces load on the studio facilities and has also aided acceptance from more traditional elements of the institution (Furtak & Ohno, 2001). This mode strongly connects lectures and studios. Course material can be separated into two-day blocks, where new principles are introduced in the lecture in one day, and students study applications the next day in the studio. Studio Physics I resulted in significant student progress, with Force Concept Inventory (FCI) gains on the order of 50%, compared to 20-25% pre-studio. Also, student surveys, course evaluations, and exit interviews demonstrate greater student satisfaction with the studio than with the traditional format (Kohl et al., 2008).



(http://scaleup.ncsu.edu/groups/adopters/wiki/bdddf/ Accessed 23.12. 2010)

***Fig. 4**:* The physics studio at CSM for the SCALE-UP classroom and a student group working in the physic II studio

CSM, each semester, about 300 students are divided into three class sections taught by two lecturers. All students enrolled in a given course follow the same syllabus, do the individually assigned homework, and take common exams as a single group, both at finals and during the semester. A standard course design including daily lectures, in-class activities and solutions, homework assignments and solutions, and reading assignments is provided by a course supervisor for use by all lecturers.

The studio class contains ten tables for groups of up to three/four students; the chairs have wheels to increase the mobility of the students around the table. Each table (workstation) is equipped with four computers. The computers contain the LON-CAPA (Learning Online Network with Computer-Assisted Personalized Approach) software and are connected to the Internet. One printer in the room is shared by all groups. The room has daily lab demo equipment storage. Also near each table, there is a small whiteboard for chalk-talks among students or between students and lecturers. At the front center, there are two mobile lecture tables, two overhead projectors, and two large whiteboards for the lecturer. The ceiling has a grid of beams capable of supporting apparatus as showed in Fig. 4.

Each studio section of roughly 100 students is staffed by two faculty members, two graduates, and one or two undergraduate teaching assistants. The purpose of this assistant team is to communicate with students and help them. This cooperation leads to communication both in the studio physics (a certain time of the week) and outside the class. Faculty members or graduate teaching assistants then give a minilecture of 10-15 minutes that serves to introduce the basic concepts and experimental approaches that the students use to examine that day's material. During the largest portion of each class period (~two hours), students work in pairs or groups of three/four, with lecturers moving around the room, answering and asking questions. Thus, students are exposed to teamwork and active learning, and the multiple learning modalities used provide formats friendly to students with various learning styles. The last ten minutes or so of each class period are a wrap-up session in which the lecturer reviews the important concepts and student share data and summarize their findings.

As a summary, it should be known that studio physics is a model, isn't a method. The foundation of the studio model is the conviction that students learn more by "discussing and doing" than by "listening and watching." The essence of studio teaching lies in increased interaction at all levels, from peer-to-peer discussions to one-on-one exchanges between student and lecturer. A typical studio science course replaces the traditional lecture/recitation/lab, normally requiring 5-6 hours per week, with 4 hours of studio. Instead of sitting passively in large, impersonal lecture halls, students work in teams of 3 or 4 in small, 25-45 seat computer classrooms. In a given class, a brief conceptual introduction to the day's activities is followed by exercises which engage students in guided activities. The lecturer circulates through the classroom, asking and answering questions as students work on simulations, multimedia modules, web-based exercises, problem solving, and data analyses (Lister, 2005).

Previous studies on studio model the students' conceptual learning with FCI (Force Concept Inventory) (Hoellwart et al., 2005), FMCE (Force and Motion Conceptual Evaluation) (Cummings et al., 1999), and CSEM (Conceptual Survey of Electricity and Magnetism) (Kohl & Kuo, 2009) were examined. This study presents detailed investigation on studio model with students' opinions in Introductory Calculus-Based Physics II course. The perceptions of the students about studio models have not been explained in the open literature as of 2010.

Method

The purpose of this study was not only to report the development process of the studio model, but also to determine the students' opinions about the studio model. This study was based on qualitative analysis. The data of the research was collected with surveys and interview. The sample of the study consisted of 220 participants (45% male and 55%female) for both semesters (Fall 2008 "F08"-Spring 2009 "S09"). The fundamental research question of this study was given as follows. Do students find studio model as a positive learning experience?

The Data Collection Tools

The data collection tools-written survey including six open-ended questions about studio model, satisfaction survey consisting ten questions about studio model, and interview about studio model in which students asked seven questions were used in the study for both semesters.

Written Survey

The mainly goal of the study was to improve the format of the Introductory Calculus-Based Physics II course by giving the students a better learning experience, finding out their opinions. A written survey about studio model (Churukian, 2002) was given to the students during their studio time at the end of each semester. The students were informed about why the survey was given and they were under no obligation to complete it. Some students opted to take the time to study for another class rather than complete the survey. However, generally giving the students the opportunity to tell us what they would change, not only reinforced the sense that we cared about what they think, it also gave us valuable suggestions of what we could improve from the students' belief. The open-ended questions included in the written survey reflected what the students liked and disliked about studio model in general and about working in teams in particular. The author also wanted to know what the students would change about studio model. The responses of the students to six questions were grouped and analyzed statistically.

Satisfaction Survey

Satisfaction survey (seven items of ten) (Churukian, 2002) probed how well the student felt studio model met criteria such as coordination between lecture, homework, and hands-on activity work. The remaining items examined the communication among the students and between the students and lecturers. Five-level Likert item format (Table 2) was ordered as "1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree". The survey was given in both semesters (F08-S09) and the responses were analyzed statistically with SPSS software.

Interview

In the interview stage, students were asked to be interviewed voluntarily throughout both semesters (F08-S09) about studio model. The purpose of the interviews was to learn student's approaches to the exam questions, if they use the strategy that they learned in the course and comments to improve the studio model. By the end of the semesters, 125 students were interviewed (554 interviews). Seven open-ended questions (Appendix) were asked three times during the semester-after each exam except the final. The interviews were usually conducted within a week after the exams were returned to the students. The interviews were conducted in a semi-structured format. A predetermined set of questions was used as a guide so certain topics would be included in all interviews. At their first interview, the students were informed about the purpose of the interviews and how the interviews fit into the greater scheme of the evaluation process of the change made to the Introductory Calculus-Based Physics II course. They were also reminded that if, at any time they felt uncomfortable with the process they were free to withdraw from the study with no penalty. Students had the opportunity to lead the conversation. They sometimes answered questions before being asked. The exams gave a starting point of conversation as well as providing insight into the students' thinking process. The responses of the students were classified and analyzed statistically with the same procedure used in Likert scales (Table 3-4).

Data Analysis

The data of the study were analyzed by using SPSS statistical package. Data analysis for this study was reported in three subsections.

The first subsection was the analysis of the open-ended questions. For open-ended question, students were asked six open-ended questions about what they liked and disliked about studio and working in groups as well as what they would change or keep the same about the course. In analyzing the open-ended questions for each question, the researcher wrote down the individual comments and either binned them into categories of similar ideas or left them as individual comments if they were singular in thought. Then the researcher determined which of the categories comments were made by at least ten percent of the students in that course. The choice of ten percent was based on the return ratio normally expected from mailed surveys. Several of the categories were common throughout the two courses.

The second subsection was the analysis of the satisfaction survey. Students were asked ten questions in satisfaction survey. The answers of the statements were ranked from "strongly disagree" to "strongly agree". The statements were related to students' perception of the connections among components of the course, their satisfaction with physical aspects of the course, and their perceptions of how the course related to their learning of physics. The rankings were converted into numerical form where 1 is "strongly disagree" and 5 is "strongly agree" and tabulated in Table 2.

The last subsection was the analysis of the interview about studio model. The purpose of the interviews was to find out student perceptions of course content and structure as the course progressed. The interviews were also to ascertain how students approached the exams as the course progressed. To analyze the interviews, the researcher used a similar method to that which the researcher had used with the open-ended questions on the written survey. While reading through researcher' notes of the interviews, the researcher focused on what was said for six main topics: influences, likes, dislikes, distracters, changes, and collaborative teams. For analysis purposes, the students were also divided into two categories: female and male.

Results and Discussion

The results of the research were reported in three subsections as follows.

Open-Ended Questions: Six open-ended questions were asked to 220 students to learn students' opinions about learning this course with studio model. For each question, the researcher classified the responses to obtain the general opinion about this teaching/learning method. The questions and most frequent responses are listed below.

1. What did you like about studio model?
    - Hands-on nature of studio model (93% of students)
    - Homework problems solved on LON-CAPA (The Learning Online Network CAPA) (85% of students)
    - Integration and/or incorporation of the hands-on activities with going over the homework (all students)
    - Collaborative working in small teams (90% of students)
    - Experiments on the concepts discussed in lecture (92% of students)
    - Opportunity for one-on-one interaction with lecturers (98% of students)
    - No hands-on activity assignment outside the studio classroom (all students)
    - Friendly working environment (95% of students)
2. What did you dislike about studio model?
    - Individual studio periods seemed too long from time to time (91% of students)
    - Some of the hands-on activities were pointless, unhelpful, and poorly planned (9% of students)
    - The grading was unfair from time to time (12% of students)
    - Being quizzed over material that was not showed (35% of students)
    - Felt rushed to finish hands-on activities and/or homework sessions from time to time (89% of students)
3. What did you like about collaborative working in teams?
    - Everyone brought new ideas and opinions to the workstation (94% of students)

- Getting to meet new people and make new friends (93% of students)
- Learning from team members (97% of students)
- Team members helped when a member had questions (all students)
- Helped learn cooperation and communication skills (90% of students)
- Easier to work out problems and to learn (92% of students)

4. What did you dislike about collaborative working in teams?
    - Unequal effort given by team members (87% of students)
    - Some team members are easier to work with than others (%93 of students)
    - Exchange teams after each mid-term exam (76% of students)
5. For next semester, what would you change about studio model?
    - Allow more time for hands-on activity work or fewer hands-on activities (86% of students)
    - Devote more time to solving homework problems on LON-CAPA (75% of students)
    - Clarify the goals and refine the procedures of the hands-on activities (92% of students)
6. What would you keep the same about the way studio model is taught?
    - Checking out the homework problems at LON-CAPA (85% of students)
    - Collaborative working in small teams (78% of students)
    - Some hands-on activities are perfect (64% of students)
    - Incorporating homework with the hands-on activities (59% of students)

Satisfaction Survey: Five-Likert survey was given to 220 students and their responses were analyzed. The 67.40% of students agreed on the item of "interaction of problem solving and hands-on activity helped me learn physics". The 21.8% of students disagreed on the item of "there is strong communication between lecturers and teams".

According to survey results, students felt that connections between the homework, hands-on activity, and lecture parts of the course were clear and obvious. They were satisfied with the amount that computers were used in the studio as well as the physical studio classroom arrangement. In addition, they were satisfied with the amount of interaction they had with the lecturers and felt to integrate homework with hands-on activity work helped them learn physics. However, the students pointed out that, as a team, they often interacted with the teaching assistants while students less interacted with the course lecturers. The lecturers did not stay in the studio classroom the entire time and students could not ask their questions about LON-CAPA problems. But this was the main point; encourage them to work cooperatively with their team members. Also there were teaching assistants to give sufficient hints.

Table 2: Satisfaction survey about studio model and the results of analysis for both semesters

Items	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
The connections between the homework and the hands-on activity were always very clear and apparent.	2.4%	9.9%	23.8%	53.3%	10.6%
The connections between the hands-on activity and lecture were always very clear and apparent.	1.3%	1.6%	24.3%	63.7%	9.1%
The connections between lecture and homework were always very clear and apparent.	5.4%	10.1%	24.5%	54.2%	5.8%
I am satisfied with the level of use of computers in studio.	7.0%	7.3%	24.1%	53.8%	7.3%
I am satisfied with the physical arrangement of the studio classroom.	2.3%	10.9%	23.2%	50.4%	13.2%
There is more to physics than problem solving.	0.5%	12.3%	24.9%	60.6%	1.7%
The interaction of problem solving and hands-on activity helped me learn physics.	5.5%	4.5%	22.6%	58.2%	9.2%
I am satisfied with the amount of interaction I had with the studio lecturers.	5.0%	5.9%	24.8%	57.6%	6.6%
There is strong communication between teaching assistants and teams.	4.3%	12.9%	24.3%	55.1%	3.4%
There is strong communication between lecturers and teams	7.6%	14.2%	21.2%	45.3%	11.7%

Note: Total number of the students for F08 and S09 is 220.

Interviews about Studio Model: Students were asked to be interviewed voluntarily throughout the semesters. Interview questions toward studio model were modified (Churukian, 2002). The purpose of the interviews was to take student opinions about studio model. The number of 125 students attended in the interviews 554 times.

The responses were classified in six main topics: influences, distracters, changes, likes, dislikes, and collaborative teams. Studio model was found as the highest influencing factor (93.6%) for female and male students' scores. The students distracted by other classes (24%). Also they declared that they learned too much information in very short time. They mostly liked not having hands-on activity assignment outside studio classroom (96%). While the students mentioned several changes which they felt could improve the studio, they only mentioned about time deficiency for completing assignments as a "dislike" (58.4%). In the topics which they have difficulty to understand, they get help from their team members.

Table 3: Statistical analysis of interview on the influences, distracters, and changes in studio model

	Question Number	Females	Males	Total
Influences	1a, 1b, 2a, 3a, 4			
Studio Model Format		41.88%	58.11%	93.60%
Hands-on Activity		40.00%	60.00%	92.00%
Homework		42.72%	57.27%	88.00%
Review Sessions		36.98%	63.01%	58.40%
Lectures		37.50%	62.50%	44.80%
Wrap-up/Quiz		53.84%	64.86%	41.60%
Distracters	5			
Nothing		40.77%	59.22%	82.40%
Other classes		36.66%	63.33%	24.00%
Too much information too fast		27.58%	72.41%	23.20%
Time management		46.15%	53.84%	20.80%
Team Members		41.66%	58.33%	19.20%
Lack of interest/motivation		40.90%	59.09%	17.60%
Being Tired		36.84%	63.15%	15.20%
Changes	2b, 3b, 4a, 6e			
No Change		40.47%	59.29%	90.04%
Need more class sessions: lecture and/or studio		36.36%	63.63%	17.60%
Exchange the grading scale		45.00%	55.00%	16.00%
Focus more on problem solving and less hands-on activity		52.63%	47.36%	15.20%
Have weekly review/help periods		33.33%	66.66%	14.40%
Need more Faculty/Assistant helping in studio classroom		23.52%	76.47%	13.60%
Improve the hands-on activity worksheet		43.75%	56.25%	12.80%

Note: The number of the students who were interviewed is 59; "Question numbers" presents the questions of the interview (Appendix).

Table 4: Statistical analysis of interview on the likes, dislikes, and collaborative teams in studio model

Note: The number of the students who were interviewed is 59. "Question numbers" presents the questions of the interview (Appendix).

	Question Number	Females	Males	Total
Likes	6a, 6b			
No hands-on activity assignment outside studio classroom		42.50%	57.50%	96.00%
Like in general		42.60%	57.39%	92.00%
Combining homework and hands-on activity		42.85%	57.14%	89.60%
Going over homework		43.51%	56.48%	86.40%
The hands-on activities		45.37%	54.62%	86.40%
Friendly working environment		43.56%	56.43%	80.80%
Exchange the teams		40.35%	59.64%	45.60%
Dislikes	6a, 6d			
Time deficiency for completing assignment		43.83%	56.16%	58.4%
Collaborative Teams	6c			
Learning from team members		39.81%	60.18%	86.40%
Some team members not interested in doing the hands-on activities		53.84%	46.15%	31.20%

Conclusion

Studio model is important for creating active learning environment in physics education. In fact, traditional lecture classes convert to studio classes. Traditionally most of the courses included in physics education are performed in classrooms. Also, applications of the courses are implemented in laboratory. In active learning environment these two activities are combined in studio model. Students work as collaborative groups in studio class while they work individually in traditional class.

Many studies performed on studio models in U.S. focused on conceptual learning (Force Concept Inventory "FCI", Force and Motion Conceptual Evaluation "FMCE", Conceptual Survey of Electricity and Magnetism "CSEM" etc.). Also, motivation-learning strategies (Motivated for Strategies for Learning Questionnaire "MSLQ"), academic performance (homework, exams, projects etc.) and attitude (Colorado Learning Attitudes about Science Survey "CLASS", Maryland Expectations Survey "MPEX" etc.) of the students were examined. It was reported that academic performance, motivation, attitude, and conceptual learning achievement of the students enhanced by studio model (Cooper et al., 1996; Cummings et al., 1999; Gaffney et al., 2008; Hoellwarth et al., 2005; Sorensen et al., 2006).

In present study, an investigation was conducted with studio model in the Introductory Calculus-Based Physics II for two semesters *to enhance* the format of the course by giving the students a better learning experience by finding out their opinions; *to probe* how well the student felt studio physics met criteria such as coordination between lecture, homework, and hands-on activity work; *to learn* student's approaches to the exam questions.

The students declared in the interviews and surveys that they liked the opportunity for one-on-one interaction with lecturers, collaborative study, checking the problems on LON-CAPA. Further, the students felt that connections between the homework, hands-on activity, and lecture parts of the course were clear and obvious.

Studio model was observed as an effective teaching/learning method by converting novice students to more experienced students and these findings agreed with the ones reported in the literature (Churukian, 2002; Gatch, 2010; Kohl et al., 2008; Kohl & Kuo, 2009; Montelone et al., 2008; Perkins, 2005; Shieh et al., 2010). The student-centered activities also offered a friendly lecture to students and even to those lecturers who sometimes tend toward the traditional style of classroom. Studio model provided an excellent opportunity to introduce large-scale undergraduate level courses to students in an interactive learning environment with its technology and team-based learning. All of these data collection provide different viewpoints into the fabric of the science, engineering, math, and social courses etc.

Acknowledgments

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Appendix: Interview Questions about Studio Model

1. How did you feel while taking the exam?

   1a. Did you understand the questions?

   1b. Did you think you were prepared? Why?

2. You did particularly well on this problem. Which strategy did you follow?

   2a. What can you think of from studio model which relates to this?

   2b. What else could we have done to help?

3. I noticed you did not do well on this problem. What were you thinking?

   3a. What can you think of studio model?

   3b. What else could we have done to help?

4. Think about the course and the exam. What did influence you in the course while you were taking the exam?

   4a. What could we do to do better job?

5. What about the course distracts you from learning what you would like?

6. Let's consider studio model by itself for a moment.

   6a. How do you feel about studio model now compared to the beginning of the semester?

   6b. What do you like about studio model?

   6c. How do you like working in collaborative teams?

   6d. What do you dislike about studio model?

   6e . What changes would you make?

7. Do you have any further comments you want to make?

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