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Student perspectives on attendance and instructional methods in a combined lecture and laboratory course

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Introduction

Most instructors who require attendance do so with the goal of improving student learning. However, attendance does not guarantee engagement. Although attendance has been found to be positively correlated with academic performance, studies of attendance suggest a complex relationship among student motivation, attendance, and learning outcomes [1]. Providing incentives for attendance without considering student perspectives and psychological needs may indeed have counterproductive effects on student motivation [2]. Self-determination theory posits that individuals are more likely to be intrinsically motivated when psychological needs are met, specifically needs of autonomy, competence, and relatedness [3]. This suggests that class sessions can be designed to encourage attendance by supporting these psychological needs, and presumably that is preferable to extrinsic reinforcement through punishing lack of attendance with grade penalties, or even positively reinforcing attendance with grade-based rewards.

While there are many prior studies of attendance and motivation in engineering courses [4], [5], [6], there is a relative lack of studies comparing student motivation with a variety of instructional methods (e.g., different modes of active learning), especially in engineering courses [7]. The purpose of this study is to compare student motivations to attend two different types of class session in a digital systems course: lecture sessions that are primarily instructor-led with active learning in the form of guided problem solving, versus laboratory (lab) sessions that are primarily hands-on and student-led with instructors and teaching assistants available to answer questions. Attendance is not required or graded for lecture or lab sessions, both sessions cover similar class material each week, and most students are able to complete lab work outside of the classroom. Therefore, our goals in the current work are: to identify reasons that students choose to attend class sessions in the absence of attendance requirements, to determine whether and how these reasons differ for lecture versus lab, and to analyze how these reasons may change over time. Additionally, we investigate whether students prefer the combination of lecture and lab sessions, versus only lecture or only lab.

This paper discusses the results of two surveys conducted on the same population of students, with the first survey near the midpoint of the semester and the second survey near the semester end. In each survey students were asked to describe what motivates them to attend lecture and lab sessions, and to share their preferences for lecture, lab, or both. Responses to open-ended questions were analyzed using inductive content analysis to determine whether student motivations differ based on instructional methods, and whether motivations change over the course of the semester.

Theoretical Framework

Self-determination theory (SDT) provides a framework for understanding motivation in terms of types of motivation (intrinsic, extrinsic), and consideration of students' psychological needs, namely autonomy, competence, and relatedness [3]. In education there are often external

pressures that do not encourage intrinsic motivation, and can in fact decrease motivation, according to SDT. It can be a challenge to work within existing educational incentive structures while attempting to support students' inherent drive to learn. However, not all extrinsic motivation is counterproductive, and some extrinsic factors can be internalized such that they support student autonomy and improve learning outcomes. In application to educational contexts, studies have shown that supporting autonomy, competence, and relatedness leads to greater student engagement and improved learning outcomes [2].

In this work, we interpret our results within the framework of SDT, inspired by a similar analysis in [8], with the goal of making our findings more applicable in practice to potentially increase student motivation to attend.

Study Purpose and Research Questions

The purpose of this study was to investigate student motivation to attend class sessions, with the following research questions:

1. What motivates students to attend scheduled class sessions without required attendance, and how do these motivations relate to student psychological needs according to SDT?
2. How do student motivations to attend relate to instructional methods (lecture vs. lab)?
3. How do student motivations to attend change as the semester progresses?
4. Do students prefer one instructional method (lecture or lab) or a combination?

Methods

Study Setting and Participants

Data was collected by surveying students in a digital circuits and systems course with weekly lectures and laboratory sessions. As this is a required course for the Electrical and Computer Engineering (ECE) program, the class population consists primarily of ECE students, and most students are in the second year of their degree. At the time of this study the course enrollment was 65 students.

The class is structured with two 75-minute lecture sessions per week, and one 3-hour laboratory session per week. Lecture sessions are led by the instructor with active learning in the form of guided example problems. Lecture recordings are made available after each lecture. In lab sessions, students follow provided lab instructions and work at their own pace, with the instructor and teaching assistants (TAs) available to answer questions. Short (10-minute) lectures are given by the instructor or a teaching assistant to introduce each lab.

Attendance is not graded for either lecture or laboratory sessions. Completion of labs requires a demonstration of the student's solution to the instructor or a teaching assistant, but this demonstration can be performed at any time during lab, before or after class, or during office hours. Most students do not require access to classroom equipment to complete the labs, meaning they could complete the labs without attending lab sessions.

Survey Design and Data Collection

Surveys were designed based on the research questions stated above. The following open-ended questions were asked in each survey:

1. If you attend lecture, what motivates you to attend? If you do not attend, why?
2. If you attend lab, what motivates you to attend? If you do not attend, why?
3. In terms of class structure, would you prefer only lab sessions, only lecture sessions, or both? Please elaborate on your answer.

Two surveys were performed, with the first approximately halfway through the semester and the second in the last two weeks of the semester. The survey questions were similar aside from specifying the time frame for students to consider their attendance. Surveys were distributed via a unique email link for each student and responses were collected anonymously. The study was reviewed by the University of Pittsburgh IRB and determined to be exempt (STUDY24090064).

Although we interpret our survey results partly in the context of SDT, we did not design the survey questions around SDT to avoid limiting the results to one theoretical framework.

Content Analysis

Inductive content analysis was performed as described in [9], following the steps below:

1. The unit of analysis was defined as one response to one survey question, for example, a response to the question "If you attend lecture, what motivates you to attend? If you do not attend, why?" in the mid-semester survey.
2. Units were coded following an inductive approach. Multiple codes could be assigned to each response, as shown in the example in Table 1.
3. Codes were grouped into categories based on conceptual similarity.
4. Categories were associated with aspects of SDT where relevant, according to descriptions of the theory in [3], [2] and a similar analysis in [8].
5. Frequency analysis was performed to analyze motivations with respect to instructional methods and over time.

Only the questions regarding motivation to attend lecture or lab were coded into categories and related to SDT. An example of coding a response and the associated categories is shown in Table 1. The last survey question regarding whether students would prefer only lab, only lecture, or a combined course was analyzed separately, but with a similar coding process.

Table 1: Example of coding a response and resultant categories

Response text	Codes	Categories
"Even though the labs are fully accessible outside of class, having a designated time to come in-person and complete them is very helpful because they tend to be time consuming and collaborating with peers and TA's is beneficial."	1. Designated time 2. Collaborating with peers 3. Guidance from TAs	1. Productivity 2. Relationships 3. Learning

The full set of codes and categories is shown in Table 2, with examples in the table of response text for each code, and explanations of each category below:

1. **Learning:** Attendance in some way facilitates the student's learning of course material, for example through the presentation or reinforcement of material, ease of asking questions, or making it easier to focus.
2. **Productivity:** Attendance facilitates the student's completion of coursework, for example through providing a designated work time or a good working environment.
3. **Relationships:** Attendance provides opportunities to build relationships and work collaboratively.
4. **Preference:** The student attends because they enjoy something about the class, or they get some personal fulfillment out of attending.
5. **Obligation:** The student feels that they "should" attend, for example because they are paying to take the course.

Table 2: Categories and codes identified in student survey responses

Category	Code	Example
Learning	Effective learning	"New information is easier to digest when presented in lecture"
	General guidance	"Having someone to ask questions"
	Guidance from TAs	"I get help from the TA's"
	Guidance from instructor	"I can get feedback in lab by my professor"
	Focus	"I feel like I am most attentive when in lecture as opposed to normal"
Productivity	Designated time	"having a designated time to come in-person and complete [labs] is very helpful"
	Working environment	"It is a great work environment"
	Accountability	"accountability to stay on top of work"
Relationships	Building relationships	"building relationships face to face"
	Collaborating with peers	"I can work with other students"
Preference	Learning preference	"I like learning in person more"
	Enjoyment of lecture	"I like the way that the professor teaches the class"
	Interest in material	"I thoroughly enjoy the material being taught"
	Fulfillment	"even if I don't understand what's going on I feel better going"
Obligation	Obligation	"I'm paying money to take the course, I think that I should attend in person lectures"

Notes on our coding process are presented below, and findings from our analysis are presented in the following section.

We assigned the most specific code possible for a given unit of analysis. For example, a student who mentioned "building relationships" without specifying relationships with the instructor, teaching assistants, or peers was assigned the general code of "Building relationships". A

response that specifically mentioned collaborating with their peers was coded more specifically as “Collaborating with peers”. Both of these codes were then grouped into the category of “Relationships”.

Responses that mentioned learning sometimes described needing that knowledge to complete coursework, while others did not give a specific reason for why the learning was important or necessary, although the implication is that learning the material is important in some way for succeeding in the course. In either case, this was coded as “Effective learning” rather than a code related to completing coursework, because the reason for attending was interpreted as “to learn more effectively,” even if the knowledge gained would later be applied to coursework. In contrast, if a student mentioned that they attended because the environment was conducive to them completing coursework while in attendance, this was coded as “Working environment”.

Similarly, “getting help from TAs” was sometimes mentioned specifically in terms of needing the help to complete the lab, and in other cases the reason for help was not mentioned, but it can be assumed that the help was relevant to completing the lab due to the topic of the survey question. In either case, a separate code for “completing the lab” was not assigned, because access to “Guidance from TAs” was identified as the reason for attending.

We used separate codes for “Guidance from TAs” versus “Guidance from instructor” because multiple students specifically mentioned TAs, especially during lab sessions. This is something that could be a topic of future work, because TAs are often senior students in the same degree program, and may be viewed as more approachable. Responses tended to mention other students in terms of “collaboration” or “working with” them, in contrast to mentions of instructors and TAs in terms of “getting help”. So, even though interacting with instructors and TAs could be considered as a form of “Building relationships”, we coded mentions of “help” or “questions” as “Guidance”.

Findings

One end-of-semester survey submission had blank responses to open-ended questions and was therefore omitted from analysis. This left 9 usable survey submissions for the mid-semester survey, and 7 usable submissions for the end-of-semester survey. Findings organized by research question are presented in this section.

SDT Framework

Here we identify how the categories defined through inductive content analysis correspond to the psychological needs of competence, relatedness, and autonomy as in SDT [3], [2]. Attendance motivated by Learning or Productivity is most relevant to building competence through understanding and applying course material. Attendance motivated by Relationships is consistent with building relatedness. Attendance due to Preference is most relevant to autonomy. Attendance due to Obligation indicates external regulation, and does not support the three needs according to SDT.

Motivations related to instructional methods and over time

Code frequencies are shown in Table 3, and category frequencies are shown in Table 4, for both surveys (the first mid-semester, and the second end-of-semester), and for each question regarding motivation to attend lecture versus lab. For the category frequencies, rather than taking the sum of code frequencies in each category, we counted the number of question responses associated with each category, to keep the unit of analysis consistent.

Table 3: Code frequencies for lecture and lab over time

Category	Code	Mid-semester		End-of-semester	
		Lecture	Lab	Lecture	Lab
Learning	Effective learning	4	0	5	5
	Guidance from TAs	0	4	0	3
	Guidance from instructor	1	2	2	3
	General guidance	1	2	0	2
	Focus	3	1	2	1
Relationships	Collaborating with peers	0	6	0	3
	Building relationships	0	0	1	0
Productivity	Designated time	0	4	0	2
	Working environment	0	1	0	1
	Accountability	1	0	0	0
Preference	Learning preference	1	0	0	0
	Enjoyment of lecture	1	0	0	0
	Interest in material	1	0	0	0
	Fulfillment	0	0	1	0
Obligation	Obligation	1	1	2	1

Table 4: Category frequencies for lecture and lab over time

Category	Mid-semester Survey		End-of-semester Survey	
	Lecture	Lab	Lecture	Lab
Learning	7	6	5	7
Relationships	0	6	1	3
Productivity	1	5	0	3
Preference	3	0	1	0
Obligation	1	1	2	1

Learning was the highest-frequency category for lecture attendance across both surveys. Learning and Relationships were the highest-frequency categories for lab in the first (mid-semester) survey (followed closely by Productivity), while Learning was the highest-frequency category for lab in the second (end-of-semester) survey.

In terms of code frequencies in the Learning category, “Effective learning” was mentioned only for lecture in the mid-semester survey, with an equal number of mentions (and more mentions

overall) for lecture and lab in the end-of-semester survey. This was due to responses in the end-of-semester survey describing learning material from lab presentations, or reinforcement of material through application in lab. “Guidance from TAs” was only mentioned for lab, which was expected, as TAs are not typically present for lecture. There were consistently higher frequencies of Guidance-related codes for lab (General guidance, Guidance from TAs, Guidance from instructor). “Focus” was mentioned with higher frequency for lecture.

Relationships and Productivity were mentioned at higher frequencies for lab than lecture. The code “Collaborating with peers” was only mentioned for lab. Preference was only mentioned for lecture attendance, with lower frequency in the second survey. Obligation was mentioned once each for lecture and lab in the first survey, with one additional mention for lecture in the second survey.

Many lab attendance responses focused on needing to “get the lab done” (with codes categorized under Productivity), which in combination with descriptions of learning material in lecture suggested lecture as “learning time” and lab as “work time”. However, we categorize guidance from instructors and teaching assistants as a form of learning in lab, therefore learning was still the common primary motivator for attending both lecture and lab. As discussed in the following subsection, in the question about preferences for class structure, many students mentioned application or reinforcement of concepts in lab, indicating that they did feel that the hands-on labs enhanced their understanding of the material. This result is not surprising, as we would expect students to be motivated to learn course material. But, the code frequencies indicate differences in how learning occurs in lecture versus lab.

In general, students expressed that they attend lab because the environment provides access to guidance from instructors and teaching assistants, encourages productivity, and allows them to work with peers. Students expressed that they attend lecture to focus and learn the material through explanation and examples.

Student perspectives on course structure

In the first (mid-semester) survey, 8 of 9 survey responses expressed preference for both lab and lecture, and the remaining response preferred lab only. In the second (end-of-semester) survey, all 7 responses expressed preference for both lab and lecture. All responses across both surveys stated a preference but not all explained reasons for the preference. Some responses included suggestions for how to improve the current class structure, such as reducing the number of lab tasks, holding more and shorter lecture sessions, or adding more application elements to lecture. Where reasons for a preference were provided, we performed inductive content analysis, following a similar process as previously described, but without grouping into more general categories or grounding in SDT, again because this question did not ask directly about motivation.

Code frequencies are shown in Table 5. The primary explanation for preferring both lecture and lab was conceptual learning in lecture combined with reinforcement, application, or synthesis of the material in labs. This is consistent with the current course structure where material is presented in lecture prior to the lab session on that same material.

Table 5: Code frequencies across preferences for only lab, only lecture, or both

Code	Example	Mid-semester	End-of-semester
Concepts in lecture	"lecture is very important to understand the material"	3	4
Reinforcement in lab	"the labs enhance my understanding of the material"	2	2
Application in lab	"labs have something that lectures don't have, hands-on work on what we are learning in lecture"	2	3
Synthesis in lab	"labs allow us to learn more about how these concepts work with previous concepts"	1	1
General learning	"lack of either component would negatively impact my learning as a student"	1	0
Different learning styles	"Due to these two different styles of learning, it is best for there to be two styles of teaching/learning"	0	1
Building relationships	"building of friendships and connections with other members of the class / department"	0	1
Sense of accomplishment	"It's fun seeing those concepts come to life, especially since we are the ones implementing them"	0	1
Interesting lab problems	"the lab is great for … solving for interesting problems"	1	0
Guidance	"I think both are very important because they give me valuable time with TAs and professor"	1	0

Discussion

In this work, we presented the results of surveying student motivations to attend lecture and lab sessions without required attendance. The results suggest that students attend lecture to learn through presentation of material, because the environment encourages them to focus, and/or they enjoy the presentation style or material. Students attend lab for guidance from the instructor and TAs, to collaborate with peers, and because it is a productive working environment. More students mentioned learning and reinforcing material in lab at the end-of-semester versus the mid-semester survey. Students expressed preference for the combined lecture and lab course structure due to the reinforcement of material learned in lecture through application in lab.

In terms of motivations for attendance identified in this work, our results are consistent with prior studies that also identified "Knowledge acquisition" as a primary reason for attending lecture [5], and studies that found students were motivated to attend lectures with engaging presentation of material [4], [6]. The results are also consistent with prior work finding that students attend lecture to maintain focus on the material, while they attend lab for guidance and because it is a dedicated time to work [10].

Attendance motivations identified in this work correspond to psychological needs in the SDT framework, with Learning and Productivity related to competence, Relationships (especially Collaborating with peers) corresponding to relatedness, and the choice to attend due to Preference (interest or enjoyment) as an expression of autonomy. The higher frequency and variety of codes in the Learning, Relationships, and Productivity categories suggest that competence and relatedness are supported in this course, whereas there were fewer mentions of codes related to autonomy. This is of interest due to the importance of competence and autonomy in combination as encouraging intrinsic motivation [2]. Responses did often emphasize the need to get coursework done, which could indicate external pressure from assignment deadlines as form of external regulation, but could also instead support autonomy if a student believes the coursework is valuable for their future engineering competence.

As for application, our results suggest that aspects of the current class sessions do encourage attendance, and could be further emphasized according to the primary motivations identified in this study, especially aspects that encourage intrinsic motivation through supporting competence, relatedness, and autonomy. For example, we could more explicitly encourage collaboration among students during lab sessions, or implement class policies that more specifically support autonomy, such as assignment choice (or options within assignments). We also plan to continue to employ TAs, and further study may be warranted on the role and student perceptions of TAs, especially how the availability of individualized guidance factors into the lab structure.

There were several known limitations of the current work that could be addressed in future studies. Participation rate was low (<14% of students invited to participate responded), and self-selection of participants may have led the results to overrepresent high-motivation students, leading to a lack of information on why students do not attend. Due to anonymized responses, there was no way to analyze responses for the same student across the mid-semester and end-of-semester surveys; future work could involve linking responses from the same student over time. Responses to the question regarding only lab, only lecture, or combined structure may have been limited by the range of students' experiences, as evidenced by most responses commenting on the existing combined structure of the course. In our curriculum students are likely to have had lecture classes with no lab session, but less likely to have had lab classes with no lecture. The open-ended text survey format also allowed for very general or ambiguous responses, whereas an alternate format such as interviews could incorporate clarifying follow-up questions, at the expense of anonymity.

Conclusions

The results of this study suggest learning, productivity, and collaboration as primary motivators for attendance, that learning takes different forms depending on instructional methods, and that students prefer a variety of instructional methods to reinforce information, including opportunities to apply their knowledge with hands-on activities. The results are consistent with attendance motivations found in prior work, and provide additional analysis of how motivations relate to instructional methods, and insights on student preferences on course structure. Our findings can be applied by emphasizing aspects of class sessions that students identified as motivators in their responses, such as further encouraging collaboration among students, and ensuring that there are sufficient resources for students to ask questions while working through problems, as students seemed to especially appreciate the availability of teaching assistants.

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