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Technology in classrooms: How familiar are new college students with the pedagogy?

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The digital information age offers endless opportunities for new learning experiences both inside and outside the classroom. Both students and teachers have access to new resources that may be leveraged to enhance how learning happens. Utilizing technology effectively in the classroom may facilitate active learning opportunities, where information and curricula can be flexible, malleable, and quick to change. Because of this potential, colleges and universities have encouraged faculty members of all disciplines to infuse learning technologies into their pedagogical toolsets. Within undergraduate engineering, learning technologies have been identified as a means to help faculty members move away from the traditional "stand and deliver" teaching method that research has shown to dominate the hard disciplines relative to the soft disciplines.[e.g., 1,2,3] Though the opportunity to enhance education via technology is promising, understanding the pedagogies that undergraduates encountered in high school before arriving to college is important. Such understanding can assist in planning the pedagogies that students will encounter during their first year of postsecondary education.

This paper investigates the familiarity of new college students with technology in the classroom—we present preliminary work that leverages a new institution-level pre-orientation survey to explore how such data might inform how we plan and structure pedagogies. Using The Academic Plan Model[4] to ground this study theoretically, our work focuses on the influence that learners should have on an instructor's choice of pedagogy. If students have grown accustomed to traditional lecture modes of delivery in high school, for example, assuming they would be able to adjust to a technology-laden pedagogy without having some support and instruction in doing so would be inappropriate. Thus, understanding first year students' past learning experiences with technology in the classroom should help shape how university teachers and programs consider their own pedagogical strategies.

Conceptual Framework and Literature Review

Lattuca and Stark (2009)[4] developed The Academic Plan Model to illuminate the influences on curricular design and ultimately students' educational outcomes (see Figure 1). Intended to inform research and practice in higher education, the model builds on foundational works[5,6,7] and incorporates a thorough consideration of factors influencing curricular activities at the course, program, and institutional levels. The model is heuristic in nature; rather than specifying a universal set of factors that will operate in all postsecondary settings and circumstances, it provides examples of potentially relevant factors to alert researchers to the kinds of influences that might be salient for the faculty and curriculum under study.

This model assumes that faculty members are key actors in curriculum development and revision—importantly, it also assumes that their curricular plans are influenced by a variety of forces both inside and outside their institutions. First, it acknowledges the influence of sociocultural and historical factors by embedding the academic plan in this temporal context. Within this sociocultural context, two subsets of influences are apparent: 1) influences external to the institution (such as accreditation agencies), and 2) influences internal to the institution. Internal influences are further divided into institutional-level influences (e.g., mission, leadership, resources) and unit-level influences (e.g., program goals, faculty beliefs, and student characteristics). In our paper, we assume that forces both internal and external to the institution, perhaps including the past educational experiences of students, might push faculty members to use educational technology in the classroom with greater frequency.

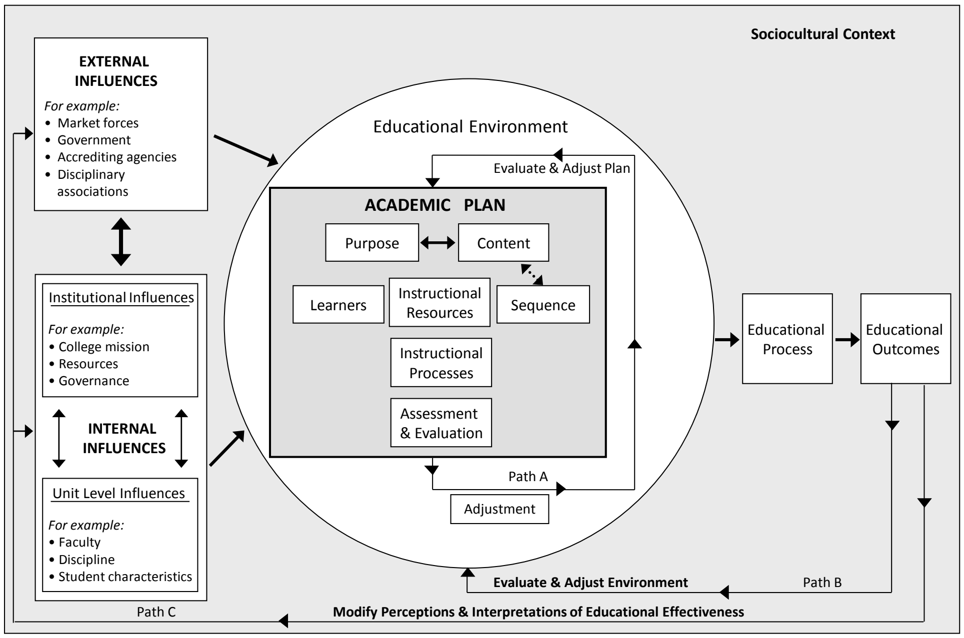

Figure 1. The Academic Plan Model

The box entitled "Academic Plan" consists of a set of eight elements, or decision points, that are addressed, whether intentionally or not, by faculty as they develop courses and programs. These eight elements are purposes (the views of education that inform faculty members' decisions about the goals of a course or program), content, learners enrolled in a class or program, sequence, instructional processes, instructional resources, assessment (of student learning), and evaluation (of the course/program). Although some individuals consider instruction separate from curriculum, this definition makes it clear that instruction is a critical element of every curriculum plan. In our paper, we explicitly consider the learners aspect of the academic plan as well as the instructional processes (and to a lesser degree instructional resources) components by considering educational technology use in the classroom. By exploring learners' familiarity with technology *before* they begin classes in an explicit manner, we can develop a greater understanding about whether it is a fair assumption that they will be adept at engaging in those instructional processes effectively without additional training.

Faculty members often may not prioritize their enrolled learners when initially crafting their course or program plans, however. Data from a national study indicate that the top two responses given by faculty members when asked to name the first steps they take in planning courses were 1) selecting course content, and 2) drawing on their own backgrounds and experiences. Students enrolled in the course were only considered first by 15% of respondents.[7] For introductory courses specifically, content and discipline of the faculty members is far more important than the context or situation in which the course is offered, though these faculty also tend to take into consideration the level of preparation of their students more than their colleagues teaching other course levels.[8]

Unpublished data from the nationally representative *Prototype to Production* study focused on the Engineers of 2020 similarly show that there is room to expand how engineering faculty and administrators rely on learning data for decision-making. 71% of engineering faculty members were either neutral, agreed, or strongly agreed that curriculum decisions are based on opinions rather than data. Program chairs only moderately agreed that programs rely on learning data for course redesign, course development, curriculum review and development, and continuous improvement processes. Associate deans and programs chairs just slightly-to-moderately agreed that programs relied on student learning data for resource distribution. As corroborated by Lockyer et al. (2013)[9], teachers tend to rely on recall, piecemeal student satisfaction surveys, or informal notes from throughout the semester in making adjustments from one year to the next; incorporating rigorous data into that process would empirically support curricular planning.

Our paper considers how data related to students' pre-college experiences can be leveraged to empirically inform academic planning with respect to educational technology. As Johri, Teo, Lo, Dufour, & Schram, (2013)[10] note, technology should not be brought into the classroom environment without having a clear sense of how that technology can add value to the learning environment. Instructors can integrate technology more appropriately and intentionally if they have a clear understanding of students' habits. Thus, it is imperative to know how students might use technology systems that are available to them. For example, in a survey of Pharmacy schools, students reported that all of the respondents used some sort of course management system, such as Blackboard. In addition, a majority of institutions reported using some sort of technology to present information to, actively engage, and assess students.[11] Other studies have examined students' experiences with course management systems[e.g., 12] or how Tablet PC's in classes might effectively promote an engaged, active learning environment[e.g., 13]. Our study contributes to this conversation by investigating the affinities for educational technology with which students arrive to universities.

Data and Methods

We analyze institution-level survey data collected from entering first year students (n=2,658, which represents a 50% response rate from the entering cohort) at a major research institution. Data were collected from students following university admission but prior to matriculation in this Pre-Orientation Freshmen Survey conducted by the university's Office of Assessment and Evaluation. Our data include responses from the incoming 2013–2014 cohort, which was the first year in which the survey was administered. The survey gathered information on expectations for the university experience, career aspirations, high school academic experiences, and affinity for community engagement. In addition, the survey collected information on respondents' personal and academic demographics (race, gender, high school grade point average, and anticipated major), as shown in Table 1 for our sample. We parsed each characteristic by those students enrolled in the College of Engineering compared to those enrolled in all other majors since many of our analyses make those comparisons. For our analyses that compare STEM to non-STEM students, we aggregate the College of Engineering students with those enrolled in the College of Science (n=486) and the College of Agriculture and Life Sciences (n=246).

Table 1. Demographic and academic characteristics of the sample

	Variable	**College of Engineering**	**Other Majors**	**Total**
Gender	Female	278	908	1186
	Male	795	483	1278
Race/Ethnicity[1]	African American	28	33	61
	Asian/Pacific Islander	138	119	257
	Hispanic/Latino	49	50	99
	Multi-racial	36	70	106
	Native American	5	3	8
	White (non-Hispanic)	760	1068	1828
Grade Point Average	2.76-3.00	1	5	6
	3.01-3.25	12	32	44
	3.26-3.50	58	70	128
	3.51-3.75	136	193	329
	3.76-4.00	324	514	838
	> 4.00	539	578	1117
Anticipated Engineering Discipline	Aerospace	121		
	Biological Systems	43		
	Chemical	112		
	Civil	113		
	Computer Engineering	90		
	Computer Science	114		
	Construction	9		
	Electrical	97		
	Engineering Sci and Mech	40		
	Industrial and Systems	52		
	Materials	21		
	Mechanical	250		
	Mining	5		
	Ocean	18		

[1]Students could also answer “none of the above” or “prefer not to answer”

Table 2. List of variables for this investigation

What percent of time were the following instructional methods used in your high school classes?

- Projects using technology[1]

In what ways have you used an eBook (electronic book) prior to coming to INSTITUTION[2]?

- Schoolwork only (e.g., electronic textbook)
- Personal reading only (e.g., novels)
- Both school and personal reading
- Neither, I have not used an eBook

Please answer the following items about your abilities and expectations.

- I am comfortable using computer technology for learning purposes.
- I expect college professors to use the latest computer technology to enhance my learning.
- I expect my college learning experiences to prepare me for a multicultural and global work environment.

[1] Response options: less than 10%, 10–25%, 26–50%, 51–75%, 76–90%, more than 90%
[2] Students selected one option
[3] 1=Strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree

For this study, we investigated students' reports on the instructional methods they encountered in high school, their level of comfort using technology for learning purposes, their familiarity with electronic books for schoolwork, and their expectations for classroom technology use during their college experience. The specific phrasing for each variable as appearing on the survey instrument is shown in Table 2.

In addition to presenting results for all entering first year students, we explore these variables by parsing data by engineering versus non-engineering fields, anticipated major within engineering, and STEM versus non-STEM. In each of these analyses we also investigate differences related to other pre-college characteristics, including a student's race/ethnicity, gender, and high school grade point average. We conduct Chi-square goodness of fit tests, independent samples *t*-tests, and analyses of variance as appropriate to determine statistical significance.

Results and Discussion

Nearly all students in our sample reported using technology for high school projects (see Table 3), with over 40% of students reporting technology use in projects 26–75% of the time. According to a Chi-square goodness of fit test ($p<.05$), there were discrepancies between STEM students and those enrolled in non-STEM disciplines as well as between students enrolled in the College of Engineering compared to all other disciplines. A greater proportion of students in the non-STEM and non-engineering groups populated the ranges greater than 76%, and a greater proportion of STEM and engineering students populated the ranges less than 25%. The present data set does not allow us to understand *why* we observed such differences. Students in different majors could have come from different school districts—at this institution, for example, a greater proportion of STEM/engineering students attend school out-of-state compared to the other disciplines, so those students may have experienced different high school instructional techniques. Alternatively, STEM and engineering students may have reported technology use differently since those disciplines may rely on technology in different ways than other disciplines. For example, using a computer to research and write a paper may have been interpreted as "technology use" for the non-STEM students, whereas STEM students may have seen such usage mainly as a tool as opposed to an essential component of the project, such as might be the case for a project relying on robotics. Future work should explore variations in the perceptions of "educational technology" across disciplines.

As shown in Table 3, we also compared the anticipated major of students within the College of Engineering. We found no statistically significant differences, which was also the case in subsequent analyses, so we do not reproduce those results in tables that follow. In addition, we made comparisons across College of Engineering students by gender and race/ethnicity (Table 4). As with the previous analyses, we observed differences at the tails of the distribution for males and females. The proportion of females at the upper end of the distribution was higher than males, and the proportion of males at the lower end of the distribution was higher than females. Similar logic calling for future research could be applied to this discrepancy. Because the proportion of females is much greater in the non-STEM/non-engineering sample, perhaps interpretations of "educational technology" vary by gender as opposed to disciplinary affinity. We also observed significant differences across race/ethnicities (Table 4). Traditionally underrepresented students (i.e., Hispanic/Latino and African American) had higher proportions in the upper end of the distribution, and White students had higher proportions in the lower end of the distribution. It is unclear why this discrepancy was observed, but it merits further investigation. If students who are traditionally underrepresented within engineering (i.e., females and Hispanic/Latino students and African American students) indeed had more experience in high school working with educational technology, perhaps increasing the frequency of its usage as a pedagogy within the first year of engineering might be considered as a potential way to recruit additional underrepresented students to the field.

Table 3. Percentage of time that students reported the use of projects using technology in their high school classes.

	Less than 10%	10 – 25%	26 – 50%	51 – 75%	76-90%	More than 90%
STEM	6.5%	20.0%	21.2%	21.4%	19.5%	11.3%
Non-STEM	4.9%	16.5%	19.1%	22.1%	22.3%	15.0%
College of Engineering	6.6%	21.7%	21.7%	21.5%	18.3%	10.3%
Other	5.6%	17.0%	19.8%	21.7%	21.9%	14.0%
Aerospace Engineering	4.1%	14.9%	23.1%	24.8%	24.8%	8.3%
Biological Systems Eng	4.7%	20.9%	25.6%	20.9%	14.0%	14.0%
Chemical Engineering	6.2%	28.3%	24.8%	20.4%	10.6%	9.7%
Civil Engineering	2.7%	27.4%	20.4%	21.2%	17.7%	10.6%
Computer Engineering	10.0%	21.1%	21.1%	17.8%	21.1%	8.9%
Computer Science	2.6%	18.3%	22.6%	20.0%	18.3%	18.3%
Construction Eng	11.1%	44.4%	22.2%		22.2%	
Electrical Engineering	8.1%	15.2%	21.2%	21.2%	23.2%	11.1%
Eng Science and Mech	15.0%	25.0%	20.0%	10.0%	20.0%	10.0%
Industrial and Systems	7.5%	30.2%	18.9%	20.8%	11.3%	11.3%
Materials Science		10.0%	25.0%	25.0%	35.0%	5.0%
Mechanical Engineering	8.8%	22.8%	20.4%	24.4%	16.4%	7.2%
Mining Engineering		20.0%		40.0%	20.0%	20.0%
Ocean Engineering	11.1%	5.6%	22.2%	27.8%	16.7%	16.7%

Table 4. Percentage of time that future College of Engineering students reported the use of projects using technology in their high school classes.

	Less than 10%	10 – 25%	26 – 50%	51 – 75%	76-90%	More than 90%
Female	4.7%	19.3%	21.1%	18.9%	20.0%	16.0%
Male	7.4%	22.2%	21.6%	22.6%	17.8%	8.3%
African American	10.7%	14.3%	14.3%	25.0%	14.3%	21.4%
Asian/Pacific Islander	11.0%	18.4%	14.7%	19.1%	24.3%	12.5%
Hispanic/Latino	4.1%	20.4%	16.3%	16.3%	30.6%	12.2%
Native American		20.0%		20.0%	20.0%	40.0%
White (non-Hispanic)	5.3%	22.1%	23.5%	22.2%	17.3%	9.5%
Multi-racial	13.9%	27.8%	13.9%	8.3%	22.2%	13.9%

Our next question related to technology asked students about their experiences using eBooks prior to arriving at the institution. Over 40% of all students had never used an eBook, either for personal or for school reasons. If college faculty in the first year assign readings to their classes using electronic sources, they should be aware of these data and recognize that those instructional resources may be a new medium for many students. Being explicit about strategies for taking notes from electronic sources, for example, might be included in early class sessions to help facilitate students' transition to the new experience. We observed statistically significant differences between STEM and non-STEM students as well as between College of Engineering and all other students ($p<.1$). Differences were only minimal, however, as a slightly larger proportion of the STEM and engineering students used eBooks for school work only, and a slightly larger proportion of non-STEM and non-engineering students only used eBooks for personal reading or had never used an eBook. Such small discrepancies should not lead to any actionable implications, though the general pervasiveness of incoming students' unfamiliarity with eBooks merits consideration within coordinated first year experience programs.

Table 5. Students' use of eBooks prior to arriving to the university.

	School work only	Personal reading only	Both school and personal	Never used an eBook
STEM	19.8%	21.2%	18.3%	40.6%
Non-STEM	17.3%	18.4%	18.1%	46.1%
College of Engineering	21.1%	19.9%	18.9%	40.2%
Other	17.6%	20.8%	17.8%	43.8%

Within the College of Engineering, we observed statistically significant ($p<.05$) differences by gender (Table 6). 7% more males had never used an eBook—this difference appears to be related to a similar 7% greater use of eBooks by females for personal reading only. A similar proportion of males and females had used eBooks for their high school work. Corroborating the previous finding, educational technology may be slightly more familiar to female students than male students. Though we found no difference by race/ethnicity, we did find significant differences ($p<.1$) by high school grade point averages (Table 6). Only 13 students reported a high school GPA less than 3.26, but nine of those students reported never using an eBook before arriving to the university. These students' academic disadvantages from the beginning could be further exacerbated if the College relied too heavily on electronic resources for learning in the first year—in addition to having to "catch up" academically, they would also disproportionately have to learn how to use new learning resources as well. On the other end of the GPA distribution, a smaller proportion of students who entered with a GPA greater than 4.0 had never used an eBook relative to their peers.

Table 6. Future College of Engineering students' use of eBooks prior to arriving to the university.

	School work only	Personal reading only	Both school and personal	Never used an eBook
Female	18.1%	25.7%	21.4%	34.8%
Male	22.0%	18.3%	18.2%	41.5%
GPA 2.76 - 3.00				100.0%
GPA 3.01 - 3.25	16.7%	8.3%		75.0%
GPA 3.26 - 3.50	25.9%	10.3%	24.1%	39.7%
GPA 3.51 - 3.75	18.4%	25.0%	14.7%	41.9%
GPA 3.76 - 4.00	17.3%	21.1%	18.6%	43.0%
GPA greater than 4.00	23.5%	20.1%	20.1%	36.3%

Finally, we asked students about their expectations for instructional methods to be used in college classes and their comfort with technology use. As shown in Table 7, students by and large did not anticipate that eBooks or electronic materials would be used in coursework (note: all means were less than 2.5 on a 5-point scale). Though College of Engineering students reported a higher level of expectation than other students (according to a *t*-test, $p<.05$), the mean of 2.42 indicates more disagreement than agreement. Because many materials in the first-year program are indeed distributed to students via course management systems, it is reasonable to conclude from these data that students arrive to college with inaccurate expectations of their educational resources. Helping students learn how to navigate such electronic learning materials appears warranted—and necessary—prior to expecting them to be able to effectively learn new content. Students across the board, and particularly in the College of Engineering, expected professors to use the latest technologies to enhance learning. Given the discrepancy between this expectation and the previous with eBooks or electronic materials, it appears as if students viewed "latest technology" as being something different. Future work should investigate how students interpreted that term—perhaps course management systems, which are largely used to deliver electronic resources to students and are large investments for institutions, do not fall within students' perceptions of "latest technology."

Table 7. Expectations for college classes and comfort with technology use. Means are displayed[1], and standard deviations are in parentheses.

	STEM	Non-STEM	College of Engineering	Other
Expect eBooks or electronic materials in coursework	2.33 (.67)	2.28 (.67)	2.42* (.70)	2.24 (.64)
Expect professors to use latest technology to enhance learning	4.10* (.80)	4.02 (.79)	4.19* (.79)	3.99 (.80)
Comfortable using technology for learning purposes	4.40* (.72)	4.31 (.74)	4.47* (.66)	4.30 (.76)

[1] 1=Strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree
* Indicates statistically significant difference between groups (p<.05)

Table 8. Expectations for college classes and comfort with technology use for future College of Engineering students. Means are displayed[1], and standard deviations are in parentheses.

	Female	Male
Comfortable using technology for learning purposes	4.38* (.74)	4.49 (.63)

[1] 1=Strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree
* Indicates statistically significant difference between groups (p<.05)

Though we observed differences between STEM or engineering students and those in non-STEM or non-engineering disciplines (Table 7), students from across the institution agreed-to-strongly agreed that they were comfortable using technology for learning purposes. We did observe significant differences between males and females within engineering (Table 8), likely because female STEM students tend to be less confident in their abilities relative to males,[14,15] but means for both male and female engineers indicated comfort with learning technologies. Students in part are driving changes to make learning environments more technology-laden and collaborative, so it is logical that they feel comfortable with this pedagogy. They may be tech savvy, but the ways in which universities most pervasively tend to use educational technology (i.e., delivering electronic reading materials via course management systems) might not align with students' past histories of learning. To bridge this disconnect, universities likely need to continue expanding how they effectively use educational technology in courses, and they should be aware that students might need some initial assistance when they arrive to campus learning how to learn from electronic resources.

Conclusion and Future Work

Technology is enabling universities to expand effective educational methods. As supported by the Academic Plan Model, considering learners enrolled in courses and their past educational experiences should be an essential aspect of curriculum planning, especially when new pedagogies are being considered. We present preliminary work that leverages a new institution-level pre-orientation survey to determine the familiarity of new college students with technology in the classroom. Though students indicate strong comfort levels with using technology for learning, significant percentages reported having never used certain electronic educational resources. Because many faculty members consider course management systems and electronic readings as "educational technology," helping students learn how to use such resources effectively might be needed during first-year classes. We intend to provide these data to faculty members who teach in the First Year Experience program so that their expectations with respect to students' prior knowledge have an empirical basis. An example of a change informed by our data would be the inclusion of a session focused on how to navigate and use the course management system during an early class session or orientation. Alternatively, required online modules could be developed for students across the institution to introduce them to this new educational learning environment.

Though our analysis includes thousands of students, it is limited to a single institution—other institutions could learn from our approach by conducting similar pre-orientation surveys to gauge the previous educational technology learning experiences of their incoming students. By gathering information from students in advance of the semester, academic plans still can be adjusted before they are finalized in a data-driven manner that takes into account enrolled learners. Thus, understanding incoming students' familiarities with learning technologies can enable university faculty members and programs to plan their own courses appropriately. Our future work will follow these incoming students throughout longitudinally to determine if prior experiences with educational technology have any relationship with technology use during their first year by linking these survey data to real-time technology usage data captured during the semester.

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