STUDENT EXPECTATIONS FROM CS AND OTHER STEM COURSES: THEY AREN'T LIKE CS- MAJORS! OR (CS != STEM-CS) *

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ABSTRACT

Students enter a course with expectations of what will and will not happen. Understanding student's expectations is important for increasing learning and the success and satisfaction of the students. This paper outlines the development and deployment of a survey to assess student expectations at the beginning of a course. Summary results of 816 students in STEM courses are reported, and speci cally the results from 57 students in two Computer Science (CS) courses. Analysis of these results includes several breakdowns and observations. A comparison of 200-level CS, biology and chemistry courses is given for insight into speci c di erences between CS and other STEM students. Results suggest that CS instructors should consider student backgrounds in courses and whether they have non-CS students enrolled. Also, non-CS faculty teaching CS students should consider the unique mind-set of CS students.

1 INTRODUCTION

Significant changes in how Computer Science (CS) is viewed and integrated into educational curriculums is taking place in classrooms. Projects such as Engaging

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Computer Science in Traditional Education (ECSITE) [5], which brings computing to K-12 in novel ways, and the special session chaired by Ursula Wolz and Lillian Cassel to promote interdisciplinary computing [3] are two early initiatives in this effort. These initiatives stem from the reality that computers, and to a greater extent computational technologies, have permeated our lives as global citizens. This growing computational dependency has, in part, inspired the President's Council of Advisors on Science and Technology to push for a growth of Science, Technology, Engineering, and Mathematical (STEM) graduates in their 2012 recommendations [11]. However, if the desire is to increase graduates in all STEM fields there needs to be an even larger growth in Computer and Computational Sciences, a vital underpinning to other STEM fields[15].

Let us take these two drives, a changing integration of computing into curricula and increased STEM graduates, as facts. If they are successful, CS departments can expect more students from other fields, especially STEM, in their courses. It will be important to address the needs and expectations of these new students not only for their own growth, but also for the future of computer science. Addressing these expectations will help make the most of the time we have the students in the classroom and might interest them in continuing transitioning to a computer science degree. However, without understanding our current situation in the classroom it is nearly impossible to know if, or how, change is needed. In this paper, we introduce a survey that addresses the need for understanding students' initial expectations in individual courses. Results from the first deployment are presented alongside data from a specific CS course.

2 RELATED WORK

Understanding students is not a new idea, in-fact a large amount of work has been done to investigate them. Prominent among these is the National Survey of Student Engagement (NSSE), which assesses how students are engaged in learning, what practices affect this, and several other measures [9]. Similarly, Sander et al. introduce a survey called University Students' Expectations of Teaching (USET). The survey measures incoming students' hopes, expectations, and dislikes for teaching and learning methods as related to general pedagogical choices such as formal lecture, group work, or private study [12]. The major limitations of Sander's work and NSSE's are that they remain cumbersome and lacking details if an instructor wants to develop changes for a specific class.

Other work such as that by Trudeau and Barnes [14] focuses on identifying the 'teaching dimensions' taken from course evaluations that students value. Several more focused studies do exist with the most relevant being two studies surrounding technology expectations [6, 10]. In summary, we can see with a sampling of existing major works on expectations, that little to none are focused enough to be used by an instructor to redesign their course either to meet student expectations or clarify why something should not be expected.

3 SURVEY DEVELOPMENT (METHODS)

3.1 Motivation

Understanding expectations is an important key to creating both success and satisfaction for a student in a course. James comments extensively on the negative consequences of a mismatch between student expectations and reality [8]. In an effort to address this gap, the University of Illinois, Urbana-Champaign [7] has developed an initiative to increase transparency in the classroom, but only analyzes the a ect at the end of a semester. If it is important to increase transparency and close the mismatch of expectations between instructor and student, expectations must be discussed early in a semester. Keeping previous work in mind, we wanted a resource that could both inform instructors of what students were expecting in a course and begin a dialogue about what instructors themselves expected and planned to utilize in the course. We had three speci c design goals:

1. Information that can be directly related to a speci c course;
2. Components which are applicable to any course;
3. Focused content that is quickly and easily completed, but still relevant for instructors.

3.2 Content & Deployment

To satisfy the design goals, we developed two sets of questions for the survey. The first set provides context and classification for the results to help an instructor understand their population. The second set aids instructors in planning classroom management, assignments, and interactions with and among students. These non-demographic questions fell into five pedagogical and learning categories which are given in Table 1 alongside the questions and specific elements for each category. The last question asked was open-ended and allowed students to elaborate on – “What misconceptions do you believe faculty have about students?”

Table 1: Survey Summary

Categories	Questions	Selections Available	
1) Technology	Which of the following do you expect in this course?	Clickers	PowerPoint
		E-Textbooks	Social Media
	Rank the three most important components in this course for your learning.	Learning Management Systems	
2) Learning Activities	Which of the following do you expect in this course?	Demonstrations	Chalkboard/Whiteboard
		In-Class Discussion	Non-Textbook readings
	Rank the three most important components in this course for your learning.	Textbooks	Small Discussion Groups
		Study Guides	
3) Learning Assessments	Which of the following do you expect in this course?	Group Projects	Individual Projects
		Essay-Based Exams	Multiple Choice Exams
	Rank the three most important components in this course for your learning.	Written Papers	Homework
		Class Participation Points	
4)Instructor Interaction	Which of the following do you expect from the instructor of this course?	Interact with Students	Be Accessible outside office hours
		Know students' names	Hold office hours
		Other	None of the above
5) Timeliness of Actions by Instructor	How soon do you expect your instructor to: Respond to emails or phone-calls, post grades, return assignments, be available to meet	Immediately	Within 24 horus
		Within 2 Days	Within a week
		Never	N/A

The survey was originally deployed in Spring 2012 at the University of Maryland, College Park, an R-1 state university. The survey is now publicly available for instructors to use, as of Fall 2012, and is downloadable at http://www.cte.umd.edu/Resource/Surveys/. The survey's class specific use is described by Schmitt et al. in [13].

4 RESULTS

4.1 Participants

Instructors across a wide range of departments were solicited for the study with 27 instructors actually participating. This provided data from 25 different courses in 8 different departments across campus with students from all 13 undergraduate colleges and schools at the university represented. The final sample included 816 undergraduate students enrolled in STEM courses. Within this comprehensive data-set there were 57 CS responses of which we will additionally focus on one CS course: Introduction to Computer Systems (CMSC 216) which had 42 responses.

The remainder of this section will present highlights of the aggregate data including comparisons to the CS course and a more detailed comparison of four 200-level courses from three STEM departments: Computer Science, Biology, and Chemistry. For this comparison, the course (department) can be considered our independent variable. The complete results are available upon request, and are sufficient for alternative independent variable analysis.

4.2 Aggregate Data Compared to CS

Figure 1 presents a large series of comparisons between the aggregate data from all STEM courses and the two Computer Science courses surveyed. A few categories with minimal differences have been omitted. It can be seen, however, that the majority of component categories (~ 75%) did have differences. Several of these are expected from the iconic pedagogies, like programming projects, of Computer Science. They are shown in the first section of the figure, and presented to remind instructors that Non-Majors may not be expecting the amount of individual projects in a CS course or understand how to use a native (non-University wide) electronic learning system. The other clear generality that can be made is that STEM students as a whole have higher expectations.

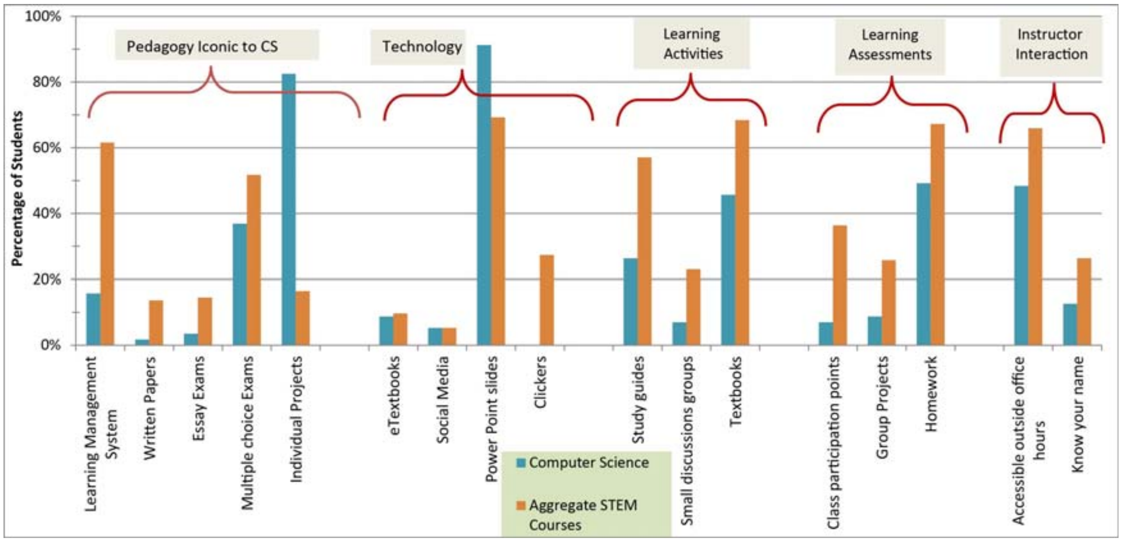

Figure 1: A subset of the aggregate data for students' expectations in courses and from instructors

Within the technology components, several unexpected results appeared. First, while many educators are exploring how to utilize e-Textbooks and social media, students themselves seem to expect very little use of them with only 10% and 5%, respectively, supporting the claims of low technology expectations by Lohnes & Kinzer [10]. This suggests that if these technologies are enhancing learning, students will require motivating and a clearer understanding of their utility. If instead these technologies are proving time consuming or marginally beneficial, it may be appropriate to discontinue work and focus on techniques that have a simpler implementation and already proven impact such as active learning. Meanwhile, PowerPoint is highly expected, more so than in other STEM courses. The need to present pre-written code might explain this however caution should be used since Craig and Amernic [4] have evaluated a significant body of literature related to PowerPoint usage and come to a very ‘clear’ ambivalence about the success of PowerPoint in enhancing learning. Alternatively, clickers, which several studies have shown to be effective for enhancing learning, are not being used or expected within CS, even in the larger CMSC 216 course, though they are clearly expected in other STEM courses.

The differences shown in Learning Assessments for Homework and Group Projects perhaps reflect the significantly higher expectation of Individual Projects in CS. However, the very low expectation of Group Projects is mildly disturbing given the prevalence of team projects in industry, and raises the question of whether we are realistically preparing our students for their future jobs. Finally, class participation points are shown as something instructors should be aware of, and make explicit for students who might have other expectations as it can create an immediate mismatch between reality and expectations (as explained in [8]) for interdisciplinary courses.

The three Learning Activities components with significant differences perhaps again harken to the different pedagogical style inherent in Computer Science, though these are certainly less iconic than the components already separated out. Both study guides and small discussion groups highlight areas where instructors might easily introduce important learning activities which will increase student engagement with materials. While study guides are frequently a source of contention, discussion groups are a successful and proven method to help students process materials in class.

The final category of instructor interaction highlights two areas for focus, especially in higher-level interdisciplinary courses. Students from other STEM disciplines fully expect instructors to be accessible (66%), while CS students have a noticeably decreased expectation (48%). They also have more than twice the expectancy for an instructor to know their name. These both mean that if interdisciplinary courses are to successfully attract and retain students, instructors must act differently than they do for CS only courses.

4.3 Comparing Computer Science, Biology, and Chemistry Courses

As our case study, we consider four different 200 level STEM courses: General Microbiology (BSCI223), General Chemistry 2 (CHM271) and Organic Chemistry (CHM231), and Introduction to Computer Systems (CMSC216). As can be seen in Figure 5, only about 5% of the students were taking the course to fulfill a core requirement (general education distributions), with the Chemistry courses being slightly higher. This low percentage indicates that the expectations in the course are not obscured by students taking the course from a widely varied background (of colleges at the university). We present the selected results below to get a view of how different majors think, remembering that introductory CS courses are frequently aimed at students from these other STEM disciplines.

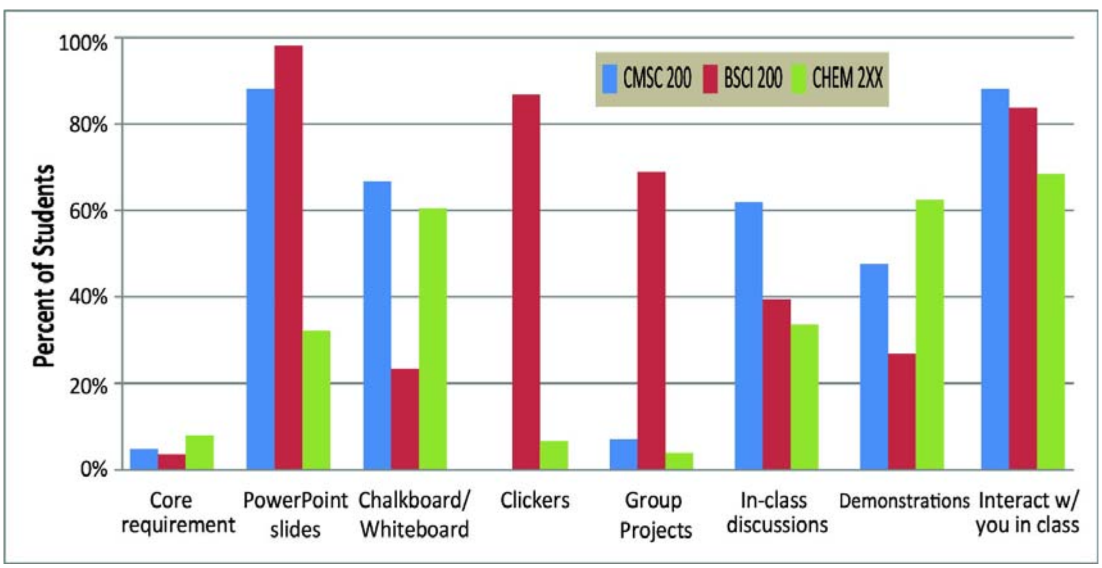

Figure 2: Comparison of 200 Level Courses

Differences existed in nearly every category we examined, many of which were similar to the comparison of CMSC to the aggregate data. Several unique differences however also existed between the courses with the most pronounced shown in Figure 5. Here there is clear evidence of different teaching methods with the higher expectations of PowerPoint for CMSC and BSCI and higher Whiteboard usage in CMSC and CHEM. A bit of insight into the higher clicker expectations for the aggregate data can also be seen with BSCI's > 85% expectation, a course that requires clickers. We also see a dramatic difference in group projects for BSCI, almost on par with CMSC's high individual projects (in Fig 1), demonstrating a very different mind set for their course work. As a final observation we see that CMSC had the highest in-class discussion and interaction, suggesting that even though all the courses are large (>30) the CMSC course does succeed in active participation and engagement with their students.

5 DISCUSSION

5.1 Impact on Curricula

The survey itself was originally designed to aid instructors in improving their courses. While the results in Section 4 point out several interesting trends, the story should not end here. We started out by examining the increasing necessity of computer science in all STEM courses and even outside of STEM disciplines. As more students take introductory courses, those courses can be designed to capitalize on the different expectations that Non-STEM students have. Further, if departments choose to offer courses specifically designed to interest non-majors, as suggested by Adams and Pruim [1], or higher level interdisciplinary courses as suggested by Anthony[2] the courses can be tailored in such a way that the students will leave with a higher satisfaction and level of learning. It is vital to remember that while the students might be novices in Computer Science, they are not novice thinkers or learners. As one student responded in the open ended question:

> "[Faculty believe] [t]hat we don't want to learn–if we show up to class, we are there to learn– it is not hard to 'skip' a class. In that vein, if we are in class, please do not baby us, do not mock us for asking questions, and do not waste your time or ours going into information that is irrelevant..."

5.2 Limitations of Results

While the report results produced several interesting insights and conclusions, there are some inherent issues that need to be discussed. The instructors administered the survey after the first week of classes and the syllabi had been distributed (and presumably discussed). Thus, we would expect students to have a fair idea of what things to expect in the course. However, in many courses, categories were often not "expected" 100% or 0%. This suggests that even though students had jointly experienced a course there was no consensus on what was expected among students. This may be a fault of self-reporting, or of confusion on the students' part. Another limitation is that the data was only collected at a large R-1 school. While we would expect similar results due to pedagogies iconic to the sciences, the expectations in some categories might change slightly at smaller colleges or universities.

6 FUTURE WORK

The results we obtained so far definitely suggest several further studies. The first of these is to understand how useful the survey will be for instructors as they begin a semester. For example, one faculty member responded on their feedback form with the following:

> "I thought this survey was great at getting a cross section of what my students expected from a class. . . I was surprised at some of the expectations. . . "

However, due to the timing and slightly delayed deployment of the survey, faculty members generally were not able to make modifications to the course in which the data was collected. Though they did receive the results, the collection and turn-around time forced the data to be returned midway or later in the semester. With the survey fully in place now, future turn-around times will be significantly reduced.

Beyond understanding the impact, the data we collected dealt only with STEM courses. Conventional wisdom suggests that the expectations in Humanities courses will differ. Is this true? While we saw some evidence of different expectations from Non-STEM majors in STEM courses we cannot anticipate if STEM students will carry their expectations back into Non-STEM courses, or if their expectations will differ based on the college from which the course originates. Several other dimensions such as a longitudinal study or increasing the breadth of universities and colleges surveyed could also provide interesting comparisons.

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