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EVALUATING STUDENT PERCEPTIONS AND LEARNING OUTCOMES: DIFFERENCES BETWEEN SLA-ABLE AND NON-SLA-ABLE INTRODUCTORY PROGRAMMING COURSES

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Abstract - Engineering, computer science and subsequently knowledge of programming language is an increasingly vital skill in today's workforce. First year engineering students are introduced to programming in addition to rigorous course loads in their first year. Second Language Acquisition (SLA) has been applied to programming course content delivery and has shown promise as an effective means of better educating new students. Results will be presented from a NSF funded study conducted over the past two years. SLA was applied to an introductory engineering course that teaches basic programming skills in a Blended learning environment (SLA-aBLe). This study examined four semesters worth of course evaluations and three semesters worth of grades to better understand differences between SLA-aBLe and Non-SLA-aBLe form of delivery in the course EGR 115, Introduction to Computing for Engineers. Students recorded difficulties associated with hybrid learning (online and face-to-face classes) in both SLA-aBLe and Non-SLA-aBLe sections. Despite these difficulties students learning outcomes and perceptions are positively correlated with SLA-based delivery.

Keywords - Computer, programming, second language, engineering, MATLAB

I. INTRODUCTION

Learning computer programming is often required for engineering and computer science degrees. However, teaching programming can be challenging. Undergraduate students find learning a programming language to be difficult, especially without previous exposure [1,2]. Since most programs do not have prerequisites for entry into the programming degree, freshmen students learn word processing, spreadsheets, computer communication, engineering, mathematics and higher-level programming language in the first semester of their undergraduate education [3]. This leads to students feeling overwhelmed with a wealth of programming syntax and computer formatting language. Computer science is not required for high school graduation in 41 states of U.S., despite computer programming jobs doubling the pace of other jobs [4]. Tech moguls Bill Gates, Eric Schmidt (Google), and Meg Whitman (Hewlett-Packard) agree coding, computer programming and computer science will be the new language of the 21st century and everyone should have some exposure and learn this new language [5].

II. SECOND LANGUAGE ACQUISITION

Children who have had prior experience with computer programming excel earlier in computer courses. This may partly be due to the availability of certain programs in high school education. Some states like Kentucky are trying to allow students to earn foreign language credits by taking computer programming courses [6]. Unfortunately the current methods for teaching programming are not ideal, as student's struggle learning the material [8]. Learning a programming language has many similarities to learning a foreign language. Teachers can correlate parts of speech, such as spoken and written language components like syntax, grammar, and punctuation. Research conducted by Natitia Naigles found exposure to foreign languages correlates with increased mastery of language later in life [9]. Justin Solomon proposes programming leads to similar outcomes [8]. He also discusses the idea of forming a connection between the language we already speak and computer language to increase retention for coding.

III. BLENDED LEARNING

Blended learning is an increasingly common course design, particularly seen in student's first year experience at many institutions. Blended learning is a combination of face-to-face and online instruction and can be used in a variety of applications [10]. The role of the e-learning environment is meant to compliment the traditional classroom style teaching [11]. Blended learning courses are typically taught to first year undergraduate students who are still determining their level of commitment to learning the material and where class sizes are typically larger [12]. Blended learning offers novel applications within SLA course instruction to enhance learning of programming language content. This project utilized blended learning extensively in its course design and implementation.

IV. PROJECT

The current paper describes a project that integrated SLA-aBLe into an introduction to Computing for

Engineers course, EGR115, which teaches engineering students a programming language, MATLAB. The project was funded by the National Science Foundation's Research Initiation Grants in Engineering Education (RIGEE) program from 2014-2017. Student perceptions of the SLA-aBLe, as well as course outcomes were tracked across 4 semesters from 2016 to 2017, and compared to the same outcomes for students in non-SLA-aBLe based sections of the same course. For the current paper, four semesters of course evaluation data is presented. This paper will present descriptive analysis concerning final grades and student perceptions for EGR115. This includes differences between SLA-aBLe and Non-SLA-aBLe content delivery and student perceptions of hybrid/blended learning environments. The data was collected at the end of each semester through course evaluations.

V. METHODS

Data used in this study was collected from course evaluations and final grades in an introduction to programming course. This first level engineering course, EGR115 was taught by three professors across four semesters and varied in its content delivery. All classes utilized a blended learning environment featuring both online course work and face-to-face class meetings. The SLA-aBLe (second language acquisition-based) sections consisted of 11 classes and utilized SLA techniques in its course instruction. SLA-aBLe courses utilized a framework that stresses fluency by dividing course content into five main stages: preproduction, early production, speech emergence, intermediate fluency, and advanced fluency. The Non-SLA-aBLe sections consisted of 11 classes and did not utilize any SLA techniques in its course instruction. End of course evaluation surveys were administered after each semester and data was recorded. Grades for each semester were also recorded to better understand learning outcomes. Results presented in this paper compare outcomes on end of course evaluations and final grades between SLA-based and non-SLA-based sections of the EGR 115 course.

VI. RESULTS

End of course evaluation data was collected across four semesters of course instruction (N = 22 classes) in two forms (SLA-aBLe vs. Non-SLA-aBLe) from multiple instructors for the course EGR115. The average class size is 26. The SLA section consisted of 11 classes and the Non-SLA section consisted of 11 classes. Course evaluations consisted of questions gauging student's perceptions of clarity of presentation, content, structure, course organization, learning outcomes, and student/instructor interaction. Students were asked to respond in a Likert-type scale

1. Strongly Disagree,
2. Disagree,
3. Agree,
4. Strongly Agree.

Additionally students were requested to select statements that corresponded with their perception regarding blended environment learning and frequency data was collected. Table 1 presents data concerning student perceptions of hybrid learning instruction in both SLA-aBLe and Non-SLA-aBLe sections, collected from end of course evaluations. These end of course evaluation items were only collected for two semesters. Table 2 presents mean data from student end of course evaluation questionnaires related specifically to perceptions of instructors and learning outcomes for the course. Figure 1 presents frequency data about students' final grades in the EGR115 course.

The results presented in Table 1 indicate that more students in the SLA-aBLe sections felt they were able to review online materials at their leisure. SLA-aBLe students also expressed higher perceptions of difficulty maintaining self-discipline and staying motivated than the Non-SLA-aBLe students. SLA-aBLe students reported more difficulty in completing online activities on time. SLA-aBLe students also reported more difficulty in resolving technical issues than Non-SLA-aBLe students and expressed a greater preference for traditional face-to-face course instruction. Non-SLA-aBLe students' perceptions indicated more ease in regards to working on course activities when and where they wanted. Non-SLA-aBLe students reported more difficulty in communicating with their instructor and classmates.

Descriptive Statistics			
Question	Type	Response	N
I can work on course activities *when* I want to	SLA	64.75%	5
	NSLA	77.97%	6
I can work on course activies *where* I want to	SLA	70.34%	5
	NSLA	76.11%	6
I can go back over online learning modules whenever I	SLA	88.80%	5
	NSLA	85.32%	6
Difficulty maintaining self-discipline and staying motivated	SLA	55.25%	5
	NSLA	54.44%	6
Difficulty completing online activities on time	SLA	53.56%	5
	NSLA	44.47%	6
Difficulty in resolving technical issues	SLA	49.41%	5
	NSLA	30.44%	6
Difficulty in communicating with the instructor	SLA	31.74%	5
	NSLA	34.64%	6
Difficulty in communicating with classmates	SLA	27.62%	5
	NSLA	29.77%	6
Preference for totally online courses	SLA	0.91%	5
	NSLA	1.45%	6
Preference for hybrid courses	SLA	31.56%	5
	NSLA	35.20%	6
Preference for traditional face-to-face courses	SLA	67.53%	5
	NSLA	63.35%	6

Table 1: Average Percentages for Students' Perceptions of Hybrid Learning

Non-SLA-aBLe students also reported higher levels of preference for totally online and hybrid course content

delivery. =The results presented in Table 2 indicated high levels of satisfaction regarding both SLA-aBLe and Non-SLA-aBLe course instruction. Average student responses were above a level of 3 (Agree on the Likert-type scale) on every response item. Average student responses were higher for SLA-aBLe sections in regards to clarity of stated learning outcomes, and learning outcome assessment.

The results presented in Figure 1 show higher course grade outcomes for SLA-aBLe students than Non-SLA-aBLe students. In particular, SLA-aBLe sections reported a higher frequency of A's and B's than Non-SLA-aBLe sections. Conversely, Non-SLA-aBLe sections reported higher frequencies of C's and F's in end of course grades.

Descriptive Statistics

Question	Group	Mean	Std. Deviation	N
The instructor taught the course content in a manner that made it understandable	SLA	3.1073	.22843	11
	NSLA	3.1864	.20868	11
The instructor showed expertise in the subject matter	SLA	3.5464	.15532	11
	NSLA	3.6436	.15958	11
The instructor showed enthusiasm for teaching	SLA	3.4400	.20130	11
	NSLA	3.4936	.27204	11
The instructor provided clear instructions for completing class assignments	SLA	3.3527	.12109	11
	NSLA	3.3909	.22057	11
The instructor assessed my work according to clearly communicated criteria	SLA	3.3882	.12632	11
	NSLA	3.4518	.15458	11
The instructor's materials enhanced my understanding of the course content	SLA	3.1955	.13516	11
	NSLA	3.2700	.24083	11
The instructor kept the class engaged	SLA	3.1636	.28776	11
	NSLA	3.2127	.29230	11
The instructors feedback on my work helped me better understand the subject matter	SLA	3.2218	.12513	11
	NSLA	3.3009	.17026	11
The learning outcomes were clearly stated	SLA	3.5082	.09152	11
	NSLA	3.4936	.18332	11
The learning outcomes were assessed via the learning activities in the course	SLA	3.4700	.09349	11
	NSLA	3.4682	.11321	11
I achieved the learning outcomes for this course	SLA	3.2836	.23682	11
	NSLA	3.3445	.21566	11
I am satisfied with the instruction in this course	SLA	3.1900	.21619	11
	NSLA	3.3064	.18854	11
The instructor encouraged an environment of mutual respect	SLA	3.4755	.18716	11
	NSLA	3.5609	.21277	11
The instructor encouraged an atmosphere in which I felt comfortable participating	SLA	3.4545	.21727	11
	NSLA	3.4936	.20622	11
The instructor was available for consultation during office hours or by appointment	SLA	3.6191	.15063	11
	NSLA	3.6400	.12798	11
The instructor was well-prepared for class	SLA	3.5491	.12934	11
	NSLA	3.5836	.13381	11

Table 2: Mean Course Evaluation Responses

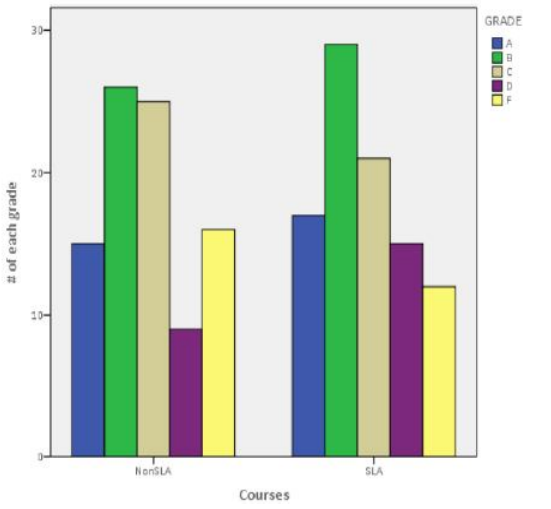

Figure 1: Frequency Count of Grades in SLA-aBLe and Non-SLA-aBLe Courses

DISCUSSION

Students across both forms of content delivery reported positive perceptions of hybrid learning. Frequency data suggests that the flexibility involved with blended learning environments is beneficial for students' success. This is likely due to increased autonomy, as seen in the ability to work on course activities when and where students choose. Additionally, students are able to review course content at their leisure, further increasing their autonomy. However, consequences of hybrid/blended learning environments are seen in student responses regarding self-discipline, timeliness, technical issues, and communication. Over half of student responses indicated difficulty maintaining self-discipline and motivation regarding completion of online components, which could be caused by a series of videos that students have to watch each time. Nearly half of all student responses indicated difficulty completing online activities on time, especially when the program writing problem was added to the SLA-aBLe classes, which required students to type in the program and was time consuming comparing to the regular multiple choice questions in non-SLA-aBLe classes. However, because of the program writing problem in SLA-aBLe classes, we see higher grades in their grades comparing to the grades in non-SLA-aBLe classes.

Communication also proved to be a concerning factor in student perception. Nearly one third of students claimed they experienced difficulty communicating with their instructors. Additionally, over a quarter of students in both SLA and Non-SLA classes experienced difficulty communicating with their classmates. These difficulties regarding communication may be rooted in technical problems, as 49.01% of students in the SLA sections reported difficulties resolving technical issues, compared to 30.44% of students in Non-SLA sections. There were no significant differences in student perceptions of SLA vs. Non-SLA content delivery, however students responded more favorably towards SLA content delivery regarding clarity of learning outcomes.

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

The results from this project show great promise for the utilization of SLA in introductory programming course content delivery. Students perceive blended learning environments favorably across SLA and Non-SLA course instruction. End of course evaluations indicate that students in SLA-aBLe sections experienced problems related to technical difficulties more often, this could be solved by including a Q&A session and introductory video online. The difficulty maintaining self-discipline and motivation regarding completion of online

components can be solved by keeping the length of the videos to be 10 minutes or under. Average student responses were higher for SLA-aBLe sections in regards to clarity of stated learning outcomes, and learning outcome assessment. Student learning outcomes were measured through grade data, and students participating in SLA-aBLe sections reported higher grades than students participating in Non-SLA-aBLe sections.

The sample size for this evaluation is limited (N = 22 classes). The SLA-aBLe sections consisted of 11 classes and the Non-SLA-aBLe sections consisted of 11 classes. There was little standardization of course evaluation questions between instructors throughout the study, and completion of course evaluations were not mandatory for students. As the study progressed, more questions were added to the course evaluations by instructors. As a result of this, data regarding student perceptions of hybrid learning were only available for two of the four semesters. Future studies should include a standardized form of end-of-course evaluations which are consistent across the duration of the data collection period. Future research should also consider the implementation of SLA techniques to other programming languages and advanced concepts.

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