

Motivation and Identity in C++

The Effects of MUSIC in an Engineering Classroom

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Abstract— Beyond engaging students in the classroom, keeping them motivated and maintaining their identification with engineering has become a well-known challenge, particularly among underrepresented minority groups. Numerous methods have been utilized within the field including the use of more active pedagogy and course designs to combat this challenge. This study will employ a well-defined model of academic motivation as a guide for course design within an introductory programming class in an attempt to increase engineering identity and sense of belonging among engineering students. The MUSIC model will be incorporated into an already flipped engineering classroom. The aim is to see a quantified change in the motivation, engineering identity, and sense of belonging among students who have participated in the course. Data is represented through structural equation models (SEM) to demonstrate the relationships between the components of motivation and identity and sense of belonging. The outcomes of its investigation will shed new light on the broad impacts that a flipped classroom can have on students within an engineering classroom.

Keywords—course design, motivation, identity flipped classroom;

I. INTRODUCTION

While retention in undergraduate courses continues to be a problem, faculty are utilizing new approaches to motivate students in their courses. Jones [1] argues that course design is the key in engaging students in learning within a course. This project explores one such course design, flipped, to understand its impact on students' identity and sense of belonging. Previous works by Jones has drawn the lines between motivation, identity and sense of belonging among students through specific types of course design, particularly engineering students. Jones' MUSIC model of academic motivation serves as the foundation of this study tying the constructs of motivation to the design of a flipped classroom.

In a flipped classroom, the traditional teaching methods of a classroom are reversed. Students review lectures at home and devote class time to performing exercises with the instructor present. Bishop and Verleger [2] have defined the approach as "interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom" (p.15). Implementation of the flipped classroom allows the student to have some self-paced instruction, while also engaging with the material, their peers, and the instructor.

Benefits to the flipped classroom have been proven to include improved learning and course attendance[3]. Understanding of the structure of the flipped classroom suggest that it would provide many of the components of motivation defined in the MUSIC model. Therefore alignment of the five motivational components of the MUSIC model (empowerment, usefulness, success, interest, and caring) will be identified and measured within this a flipped engineering course. The purpose of this study was to use a model of academic motivation to investigate the effects of a MUSIC model infused course design on students' motivational beliefs, engineering identity, and sense of belonging. This investigation will seek to answer the following question:

RQ1: To what extent do engineering students' perceptions of the MUSIC model components affect their engineering identification and sense of belonging?

II. LITERATURE REVIEW

The MUSIC model of academic motivation[1] was designed to help instructors design their courses in a way that motivates their students. The model measures five components of motivation which make up its acronym: eMpowerment, Usefulness, Success, Interest, and Caring.

Each of these components are supported by research and theory in the field of motivation. *Empowerment*, which is a component of the self-determination theory[4], reflects the perceived amount of power that a student feels they have with their own learning. This personal sense of autonomy is provided to the students by allowing them some choice in what they learn and what they do within the learning environment. *Usefulness* represents the level that students feel that the course is necessary in order to achieve their short-term and long term goals. Usefulness is associated with utility value found in expectancy-value theory[5], which focuses on how the students find value in the things they do. *Success* is the level to which students believe that they can succeed by putting forth the appropriate effort. Self-efficacy theory explains that a student's perception of how successful they can be in a course can be largely effected by the student's self-concept [6]. Specifically in engineering education research self-efficacy has played a large role in the retention of women[7]. *Interest* focuses on the situational or immediate interest by providing short term enjoyment in the activities conducted in class. Often

faculty will select topics based on current events or hobbies specified by the students. The benefits of inciting student interest include attention, memory, deeper cognitive engagement, and achievement [8]. Finally, *Caring* measures how much the student's believe that the instructor actually cares about them. The caring component supports research in areas of sense of belonging, sense of community and commitment [9], each of which can lend themselves to improving retention within a course or major.

Within engineering the MUSIC model has been utilized in several studies not only to evaluate cornerstone engineering courses, but also to measure student's domain identification, course effort, course grades, and career goals [10-12]. Defined as the extent to which an individual defines them self through a role or performance in a particular domain, domain identification within engineering is very important particularly among underrepresented minorities (URMs). The engineering field has long been a white, male-dominated field despite the nation's recent efforts to promote diversity within the STEM fields. The benefits of domain identification have been shown to include classroom participation and achievement [13], and deep cognitive processing [14]. As the literature on motivation, domain identification and sense of belonging have shown, these components are all important in the success of students. More specifically the focus on motivation within a classroom plays a large role on the domain identification and sense of belonging of students.

III. METHODS

In the spring of 2016, data was collected within an introductory programming course for electrical and computer engineering students, which has seen high drop/fail/withdrawal (DFW) rates in the past. An overview of the demographics of the students included in the study is presented in Table 1. Of the 125 students enrolled in the class, 93 completed the survey and 80 were qualified, based on being enrolled in the engineering program and consenting to the study. More than half of the students were electrical engineering majors. Another unique demographic about the class is that over 50% were transfer students. The demographics represented in the course are reflective of the broader departmental population. A high level of transfer students is also reflective of the larger university population.

A. Course Design

The MUSIC model was utilized for this study because of the belief that the flipped classroom was an approach that lent itself most appropriately to incorporating each of its components. The inverted nature of the course design allowed for more time in class to engage with students and provide them with opportunities to increase their motivation. Some specific examples of how each of those components were integrated into the course design will be described here. The empowerment component was employed by giving the students choices concerning their homework and allowing them to control the pace at which they learn by giving them online activities to complete on their own time.

An online textbook zybooks© was the main source of instruction for the course that students could complete outside

of class before each lecture. The instructor targeted usefulness by showing the students how the material they are learning could be utilized in the engineering workforce. Videos about coding with cameos from a diverse group of engineers, celebrities, entrepreneurs, and programmers was shown early on to demonstrate the importance of the material and its real life applications. Throughout the course the instructor identified how current topics would be necessary for future concepts learned in the next course as well as everyday applications.

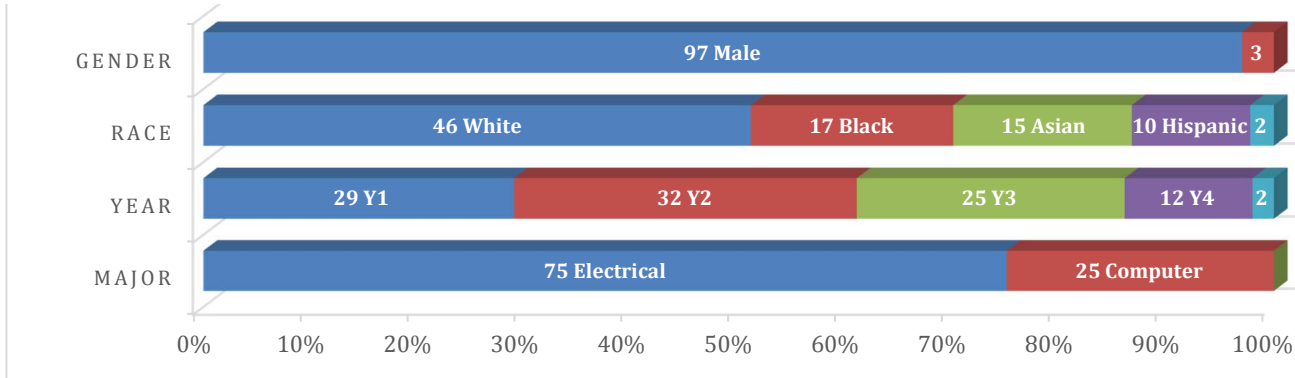
Each student's success was dependent on the other students in the classroom. The students were frequently split into groups to practice problems with their peers, often forcing them to learn and teach each other. The goal was to make sure no student was left behind or left struggling with the material by creating a supportive community environment. The instructor catered to the student's interest by asking them on the first day about their favorite hobbies, shows, activities and interests. The instructor then proceeded to create in class activities based on student's interests. Problems were developed around, Football, Shopping, The Big Bang Theory, cooking Ramen noodles, and getting to class on time. Finally, the instructor showed a genuine interest in each of her students. Simple gestures such as asking about the most exciting adventures of the weekend on Monday mornings, showing empathy at being in an 8 am class, making accommodations for students when appropriate, and always being willing to help with any issue, showed the students a genuine sense of care.

B. Data Collection & Analysis

A quantitative analysis was employed to measure changes in motivation, identity and sense of belonging. A pre and post course survey based on the motivational aspects of the MUSIC model, the engineering identity of the students, and their sense of belonging in the college of engineering was give through Qualtrics. The survey will include the 26 item MUSIC model inventory questions in addition to the 4 item scale of Engineering Identification by Schmader, et al. [15] and the 8 item scale of engineering program belonging adapted from the 18 - item Psychological Sense of School Membership Scale[16]. The combination of these three scales has been validated and utilized within an engineering context as well[10].

Data was analyzed using SPSS and Amos 21, to develop a structural equation model (SEM) of the relationships between the motivation components and identity and belonging. Statistical hypothesis tests such as the Chi Square, and the Comparative Fit Index can be accurately modeled in the software, which is an essential key in comparing the variables that are involved in this research experiment. After analyzing the models created in SPSS Amos 21 we will be able to realize if the components of the MUSIC model effect a student's engineering identity as well as their sense of belonging.

TABLE I. COURSE DEMOGRAPHICS



IV. RESULTS

Table 2 shows the change in perspective of students at the beginning and end of the course. For most of the components, which were measured on a scale of 1-7, were initially measured to be fairly high. The lowest component measured was belonging. At the post, most of the components showed some level of increase except for caring and belonging, which both decreased.

The correlation of students perceptions of the MUSIC components on belonging and identity are illustrated in Figures 2-4. Figure 2 demonstrates significant correlation between the MUSIC model components and engineering identity. In essence students had a greater sense of engineering identification when they felt empowered, that the content was useful, they could be successful, they were interested, and that the instructor cared about their wellbeing. Figure 4 shows that this relationship between the components and identity was maintained throughout the course. There were however two notable differences. 1) a decrease in the correlation between empowerment and identity, and 2) a decrease in the correlation between success and identity.

Figure 3 and 4 illustrate the correlations between the MUSIC components and sense of belonging. Both figures continue to show significant correlations between the components and belonging and identity.

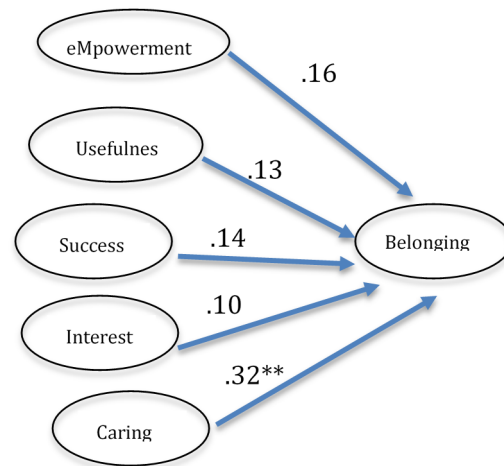


Figure 1 Pre Pearson Coefficient for significant relationships between the MUSIC components and sense of belonging ** $p < .01$

TABLE I. DESCRIPTIVE STATISTICS

Components	Mean		Std. Deviation	
	<i>Pre</i>	<i>Post</i>	<i>Pre</i>	<i>Post</i>
Empowerment	5.55	5.74	1.27	1.03
Usefulness	5.78	5.93	1.35	1.12
Success	5.92	5.92	1.29	1.12
Interest	5.63	5.85	1.32	1.14
Caring	6.22	6.11	1.17	1.12
Belonging	4.70	3.88	.77	.62
Interest	6.43	6.51	.93	.61

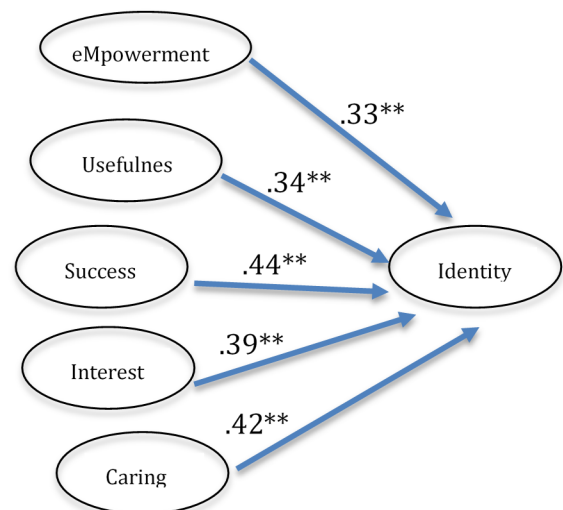


Figure 2 Pre Pearson Coefficient for significant relationships between the MUSIC components and ** $p < .01$

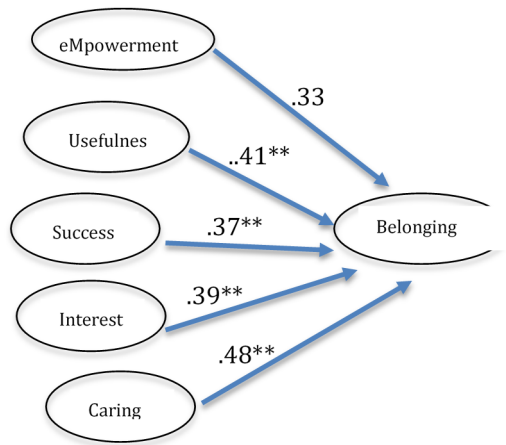


Figure 3 Post-Pearson Coefficient for significant relationships between the MUSIC components and sense of belonging **p < .01

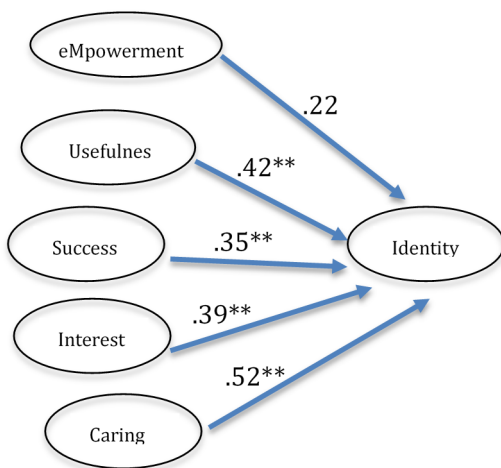


Figure 4 Post-Pearson Coefficient for significant relationships between the MUSIC components and **p < .01

V. DISCUSSION & CONCLUSION

Current results show that students entered the course with fairly high levels of motivation, identity and sense of belonging. These high levels corresponded clearly to the relationship between the MUSIC components and students sense of identity and belonging. Post data show some unexpected variations that may require some additional investigation. Although students showed an overall increase in most of the components the correlations between each of the MUSIC components and both identity and belonging showed areas of decrease. This was particularly true in regards to belonging. It is possible that although the design of the course lent itself to increasing motivation the new design did not effectively allow students to develop a stronger sense of belonging.

A. Limitations & Future Work

These initial perspectives documented students' initial conceptions of how the class would be conducted and their

initial impressions of the instructor. As is to be expected, over the course of the semester students grades both rose and fell, some students withdrew and others will inevitably fail. This in mind the post analysis demonstrates students overall perspectives of the course just before the final exam. Additionally, the student enrolled during this semester were mostly students who were considered 'University college' students who were trying to declare their majors in engineering and were therefore, not fully enrolled within their respective departments, but trying to meet all of the requirements to be fully considered electrical and computer engineering majors. This status may have played a large role in these students sense of belonging in both the course and their programs. In future studies this investigation will encompass more fully declared students.

The hope is that the design of the course was able to maintain a majority of the students' motivation and enable them to endure and succeed in the course. Future work will also be to investigate the success of these students in the following courses and their levels of identity and sense of belonging at later points in the curriculum. As this is the only flipped class in the curriculum it would be interesting to investigate how long the impacts of this course will be held by students throughout their academic journey.

Although the literature presented earlier indicates that sense of belonging and domain identification play a vital role in the retention of URM's in engineering much like many data samples in the field the number of URM's is not large enough to make any statistical conclusions about how this classroom design impacted those populations in this course. It is the hope of the researchers that future classes will have larger representations of these groups as the college and department continue to grow and expand their diversity efforts.

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