Work in Progress: Motivation, Non-Majors, and the Flipped Classroom: The Impact of Student Motivation on Performance in a Flipped Programming Course for Non-Majors

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Abstract - **This work in progress paper sought to answer the following research question: *Does student motivation impact performance in a first year programming course for non-majors that utilizes a flipped classroom model?* Previous work showed a decrease in performance on programming tasks when switching to a flipped classroom model, which was contrary to literature suggestions. In order to investigate this phenomenon further, this portion of the study sought to see if level of motivation played a role in the drop in performance. Using intrinsic motivation as our theoretical framework, we collected motivational data from students in a first year computer course using the Intrinsic Motivation Inventory as well as performance metrics from students' lab scores and final exams. Participants self-reported motivation in terms of interest, value and perceived choice were compared to performance data to determine a correlative relationship. Data analysis shows a strong positive correlation between student interest, value, and performance in the first year programming course.**

Index Terms - flipped classroom, intrinsic motivation, programming course, student performance

INTRODUCTION

The flipped classroom is a pedagogical approach that is gaining in popularity with the evolution of technology and an ever changing student population. As flipped classrooms are becoming more popular, it is critical that we heed the call of experts to developed focused research agendas on studying the impact of the flipped classroom model [1, 2]. Specifically, experts are calling for research focused on investigating the cognitive and socio-cognitive impacts of flipped classroom approaches. This work in progress paper aims to investigate these two factors by examining the impact of student motivation on performance in an introductory computer methods course utilizing a flipped classroom model. This work is part of a larger project seeking to investigate the impact of flipped classroom practices on student learning. A previous publication outlines limitations of the initial study that provided the focus on this particular portion of the project [3].

LITERATURE REVIEW

Flipped classrooms are a pedagogical technique employed to create a student centered learning environment where students engage in knowledge development activities outside of class and participate in active learning techniques in class where instructors are available to guide student learning efforts. This is done by shifting activities that have traditionally taken place in the classroom (e.g., lecturing) to outside of class, typically by asking students to engage with classroom content through video lectures [4]. Flipped classrooms, built on the student centered learning theories of Piaget[5] and Vygotsky[6], are theorized to increase student engagement in classroom activities and thus improve performance, though there is little research available at this point that supports these hypotheses. Some research has begun to focus on the impact of the flipped classroom on student motivation. For example, Abeysekera and Dawson [2] have studied flipped classrooms impact on the self-determination of students and suggest that this pedagogical approach is successful at meeting the needs of competence, autonomy, and relatedness in participants. While flipped classrooms are theorized to increase certain facets of motivation, such as self-determination [2] and self-efficacy [7], the model itself requires an increased amount of motivation to engage in the outside activities to prepare for the classroom activities [2].

The context of this study focuses on the development of a flipped classroom for an introductory computer programming course. Programming courses present their own challenges due to the difficult nature of material taught in the courses. Researchers have found that student motivation plays a key role in success in programming courses, in areas such as intrinsic and extrinsic motivation [8], self-efficacy [8, 9], attribution theory [10], and goal orientation and instrumentality [11].

In our context, the challenges associated with teaching programming courses are heightened due to the fact that this course is intended for non-majors, meaning students who are not majoring in electrical engineering, computer engineering, or computer science. Students in our course have the potential for low interest towards the subject of computer programming due to their declared major. Intrinsic motivation is defined as the drive to do something because the task is inherently interesting [12]. Thus, students in our course have potentially low intrinsic motivation towards the subject of computer programming.

The combination of engaging non-major students in a computer programming course utilizing a flipped classroom model necessitates the investigation of impact of motivation on student performance in this context. Thus, the research question for this study is: ***Does student motivation impact performance in a first year programming course for non-majors that utilizes a flipped classroom model?***

METHODS

Based on the literature reviewed, we began with a hypothesis that a student's self-reported intrinsic motivation would impact their performance on programming activities in the first-year computer course. The following methods were used to collect and analyze data to test our study hypothesis.

I. Participants

The participants of this study include students taking a first-semester introduction to computer methods course for non-majors. All engineering disciplines at UTK are required to take this course except students in electrical engineering, computer engineering, and computer science. We currently have data collected from five semesters of this computer course. Table 1 displays information about the participation count to date. For three semesters (S14, F14, S15), no information about sex, race or nationality was collected.

Table 1
Total number, Sex, and Race of participants

	Total	Sex		Race				
	N	Female	Male	American Indian or Alaska Native	Asian	Black or African American	White	Other
Spring 2016	**126**	34	90	0	7	15	91	7
Fall 2015	**153**	58	95	1	6	2	137	3
Spring 2015	**148**							
Fall 2014	**517**							
Spring 2014	**153**							

Students that take the introductory computer course in the fall semester typically enter UTK 'calculus-ready' and thus begin their first semester at UTK taking an introductory engineering course, the introductory computer course, calculus, and chemistry. Students taking the introductory computer course in the spring typically enter UTK 'not calculus-ready' and must take pre-calculus in their first semester at UTK. This group of student then starts the introductory engineering course, the computer course, calculus, and chemistry in their second semester at UTK. It is important to note that the same instructor coordinated this course for all semesters in question.

II. Data Collected

In order to study the impact of intrinsic motivation on the performance in a flipped programming classroom, the following pieces of data were collected:

- ***Intrinsic Motivation***: To understand the intrinsic motivation of students in the programming course, we used the Intrinsic Motivation Inventory (IMI) [13, 14]. As our goal was to ask about the specific activity of computer programming, we selected the activity perception questionnaire, which focuses on asking the participant about a specific task they engage in. The 25-question activity perception questionnaire includes constructs for interest and enjoyment, value and usefulness, and perceived choice.
- ***Performance:*** Student grades were used as performance measures. As the quizzes, practice exams, and final exams for the computer course have been similar in format and content over the course of data collection, it is believed that these are good measures for comparison across semesters. The following grade items were used for this study: average quiz grade over MATLAB programming module (8 scores), final exam practice score, midterm exam (non-MATLAB, non-flipped to use as control comparison between semesters), and final exam score (MATLAB content and flipped classroom content).

RESULTS

We began this particular study due to the results of a previous study that showed that performance declined after moving to a flipped classroom model in the introductory computer course [3]. In order to investigate this outcome further, we used the performance data collected from two semesters of data from the flipped classroom (labeled F for flipped) to compare to previous semesters where the flipped classroom model was not adopted (labeled C for control). Tables 2 and 3 summarize the outcome of the data collecting and comparison of these semesters. In comparing fall semester courses, we see a statistically significant difference in performance on all measures. While students in the control group performed better on lab quizzes, students in the flipped group performed better on both the final exam practice and during the final exam. These results are contrary to our initial results, which showed that the control group performed better on almost all measures.

Table 2
Quantitative Analysis Of Control and Flipped Samples (Fall Semester Comparison)

		N	Mean	Std Dev	t	Sig.
Average Lab Quiz Score	F15 F	145	94.14	4.72	-3.00	0.00
	F14 C	459	95.21	3.37		
Final Exam Practice Score	F15 F	152	94.41	14.00	1.27	0.01
	F14 C	498	92.43	17.62		
Final Exam Score	F15 F	152	87.74	15.45	2.72	0.00
	F14 C	517	83.09	19.31		

In comparing the Spring semesters, we see a statistically significant difference in performance on lab quizzes and the final exam practice, but not on the final exam. Again, these results are contrary the results from previous work where the control group outperformed the flipped group on all measures.

Table 3							
Quantitative Analysis Of Control and Flipped Samples (Spring Semester Comparison)							
		N	Mean	Std Dev	t	Sig.
Average Lab Quiz Score	S16 F	97	90.32	8.11	-4.24	0.00
	S14 C	137	93.78	4.27		
Final Exam Practice Score	S16 F	108	89.97	17.34	-2.58	0.00
	S14 C	150	94.80	12.73		
Final Exam Score	S16 F	126	78.80	20.92	-0.30	0.11
	S14 C	153	79.51	18.85		

The primary goal of this paper was to investigate the impact of intrinsic motivation on performance in the flipped classroom. Table shows the average response on the three constructs: interest, value, and choice. As the constructs were tested on a 7-point Likert scale, we can see that the responses for both interest and choice were low, which displays a lower than average level of interest and perception of choice in participating in computer programming activities. While responses for interest and choice were low, responses for value of the activity or task of computer programming were high.

Table 4	
Average Response for IMI	
Interest	3.361
Value	5.353
Choice	3.632

A Pearson correlation analysis was used to study that intrinsic motivation plays on the performance in the computer course. Table 5 summarizes the results of the Pearson correlations analysis between performance scores and the intrinsic motivation constructs. We see that, while intrinsic motivation was not correlated with performance on lab quizzes, there were significant correlations between the motivation constructs and the final exam practice and the final exam. For the final exam practice, both interest and choice were significantly correlated, while interest and value showed to be significant for the final exam. Interest was shown to be significant for both performance measures, this indicating that students who were more intrinsically motivated to program were more likely to perform better on programming tests. Students may have felt more perceived choice in taking the final exam practice when compared to the final exam due to the low impact of the final exam practice on their final grade.

Table 5			
Correlating Intrinsic Motivation and Programming Performance			
	Interest	Value	Choice
Average Lab Quiz Score	.055	.118	.016
Final Exam Practice Score	.182**	.091	.130*
Final Exam Score	.164**	.242**	.050
**. Correlation is significant at the 0.01 level (2-tailed).			
*. Correlation is significant at the 0.05 level (2-tailed).			

The results from Table 5 bring to light a question: could the difference in performance between the Fall and Spring semesters be explained by differing levels of intrinsic motivation. Table 6 summarizes the responses for intrinsic motivation by semester. Participants from the fall and spring semester showed similar levels of interest, value, and perceived choice for the task of computer programming. Thus, we cannot explain differences in performance among semesters with differing levels of intrinsic motivation.

Table 6						
Comparing Intrinsic Motivation Among Fall and Spring Semesters						
		N	Mean	Std Dev	t	Sig.
Interest	F15	148	3.37	1.30	0.11	0.33
	S16	122	3.35	1.37		
Value	F15	153	5.45	1.34	1.19	0.76
	S16	125	5.26	1.32		
Choice	F15	151	3.67	1.34	0.45	0.25
	S16	123	3.60	1.21		

CONCLUSION

This work in progress paper was based on previous work by the authors that showed that performance decreased in a first year computer course when shifting to a flipped classroom model [3]. Data from this study does not support the previously published results and show that two semesters of the flipped course showed an improvement in performance when compared to a traditional course. Further data will need to be collected to determine the actual impact of performance on this classroom intervention.

When looking at the impact of intrinsic motivation, we did find a positive correlation between both interest and value and student performance in the flipped classroom (Table 5). While student responses to interest in computer programming were low, responses to the value that students see in the task of computer programming were high. This shows that instructors are doing well at communicating the value of computer programming to students, even if the students are not generally interested in the task. In future iterations of the course, instructors will work towards developing activities that stimulate personal interest among students in the computer course, as interest is shown to have a positive impact on performance overall.

Differences in intrinsic motivation, value and perceived choice could not explain the differences in performance that we see in the fall and spring semesters. For future work, the authors plan to investigate other aspects of motivation to explore their impact on performance in the flipped classroom. Specifically, the authors are interested in investigating students' self-determination, extrinsic motivation and self-efficacy towards programming tasks. The authors also plan to investigate that the flipped classroom plays on student motivation, as well.

Limitations of this study (also outlined in previous work [3]) include an investigation of learning outcome consistency between the control and flipped version of the course as well as an investigation of how classroom context impacts performance outcomes. The research team plans to address these limitations in future work.

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