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Motivation Profiles of Non-Major Computer Programmers in a Flipped Classroom Environment

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Work in Progress - Motivation Profiles of Non-Major Computer Programmers in a Flipped Classroom Environment

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Abstract **- This work in progress paper focuses on investigating different motivational profiles of students in a computer programming course that uses flipped classroom pedagogy. The flipped classroom is an educational concept that is growing in popularity, where the traditional class-lecture and home-work are inverted to home-lecture and class-work. This work focuses on the formation of motivational profiles of students participating in the flipped classroom environment. Based on the theory of intrinsic motivation, we used a portion of the Intrinsic Motivation Inventory, specifically the interest, values, and perceived choice scales, to ask students about their motivation in their programming course. Previous work reported initial responses to the IMI scales and compared these results to performance in the class. In this work, we will use cluster analysis to determine if different motivational profiles impact performance in the flipped classroom environment. Analysis of two semesters of data is on-going and will be reported in the full paper.**

Index Terms – cluster analysis, flipped classroom, motivation, performance.

INTRODUCTION

Flipped classroom implementations are becoming more popular in engineering education, where the traditional class-lecture and home-work are inverted to home-lecture and class-work. Engaging video lectures are viewed by the students before the class period, while the class time becomes a workshop dedicated to practical exercises and discussion. The flipped classroom methodology is being utilized to teach one of the computer programming courses of a large research university in the southeast. This class targets approximately 700 students between fall and spring semesters, is one requisite for the majority of engineering majors, but is not required of students majoring in electrical and computer engineering or computer science. Research in motivation and self-regulation has shown that students who are non-computer science majors that take programming courses tend to have lower motivational profiles than students who take the same course while majoring in computer science or a related field. The use of the flipped classroom model requires that students be more disciplined in completing out-of-class assignments (watching videos) in order to be prepared for the in-class activities prescribed for the course. Thus it is important that we investigate the impact that student motivation has on successful performance in our first-year flipped programming course as the difference in motivation may explain our previous study results.

LITERATURE REVIEW

I. Introductory Courses in Programming for Non-Majors

Introduction to computer methods and computer programming is a popular topic in first year engineering programs across the country. These introduction to computer programming courses are typically taught to all first year students independent of the engineering discipline they will move into after their first year. Concepts of computer programming are considered difficult conceptual material for both computing and non-computing majors [1]. One of the challenges present in learning programming is the need to learn the syntax of a particular program in addition to learning logic diagramming methods. Research has shown that many students leave introductory programming courses with low confidence in their ability to program, minimal understanding of proper programming methods, and an overall negative attitude towards the field of computer programming [1]. One reason some researchers believe that non-majors have an increased difficulty in learning computer programming is in the area of motivation.

While both computing and non-computing majors are shown to have difficulty in learning programming concepts, computing majors typically have higher levels of motivation towards computer programming than non-majors [2]. Lower levels of motivation contribute to higher DFW rates (D-grade withdrawal and failure) as well as lower enrollment rates of underrepresented minorities [2]. Non-computing major students are typically not inherently interested in computer programming, find little value in learning programming techniques for their future job prospects, and feel little autonomy in their choice to take programming courses in their undergraduate curriculum.

II. Intrinsic Motivation

Intrinsic motivation is defined as the "natural inclination toward assimilation, mastery, spontaneous interest, and exploration…" [3]. People who are driven by intrinsic motivation to complete a task are driven by their interest in the subject matter and joy in participation, not by some external factor or reward received through their participation. The Intrinsic Motivation Inventory (IMI) is one popular quantitative scale used to measured intrinsic motivation toward a particular task. The IMI is made up of a number of scales, including an interest and enjoyment scale, a value and usefulness scale, and a perceived choice scale. The interest and enjoyment scale is considered to be direct self-report measure of intrinsic motivation. The value and usefulness scale is described as a measure of how reporters internalize how particular tasks will be valuable to themselves or future pursuits. Finally, perceived choice is described as a positive predictor of self-reported intrinsic motivation. Thus these three scales are organized in a measure of intrinsic motivation toward a specific task.

In this work in progress study, we use intrinsic motivation as our theoretical framework to investigate the impact of motivation profiles on performance in a flipped classroom for noncompeting majors.

METHODS

This work in progress paper is part of a larger study looking at the effect of a flipped classroom intervention on performance in a first year programming course. Previous reports on this project have looked at performance comparisons between a flipped and control classroom [4] as well as correlating student motivation to performance in the flipped classroom [5]. This work in progress review focuses on reviewing an initial cluster analysis performed to investigate how profiles of students perform in the flipped classroom.

- **Participants:** Participants in this study include students enrolled in a first year introduction to computer methods course at a large research university in the southeast. All students have been admitted into the college of engineering and participate in an introduction to engineering course concurrently with the intro to computer methods course. Students enrolled in the computer methods course include all engineering majors except electrical and computer engineering as well as computer science.
- **Data Collection:** Data for this study was collected in two segments.
  - **Motivation Data:** At the end of the semester, a survey was distributed to all students in the class. The survey included some demographics questions as a well as a 25 question activity perception questionnaire from the Intrinsic Motivation Inventory. This questionnaire asks participants about their interest and enjoyment in the task, the value and usefulness of the task, and their perceived choice in participating in the task. For this study, the task identified was computer programming.
  - **Performance Data:** Participants who consented to the study also gave permission for the research team to access their grades for their computer methods course. Grades of interest included lab quiz grades which showed participation throughout the semester as well as midterm and final exam grades for the non-flipped and flipped portions of the class.
- **Data Analysis:** Using cluster analysis, 3 clusters were generated to evaluate the effect of motivation response to performance in the classroom. The motivation constructs of interest/enjoyment, value/usefulness, and perceived choice were used as inputs while specific grades for the flipped class were used as evaluation criteria. The grades used included:
  - **Midterm Exam:** This exam covered all non-MATLAB content covered in the course, including programming calculator basics and an overview of Excel, AutoCAD Inventor, and basics using a graphing calculator. This content was taught with a traditional pedagogy style including a traditional lecture, some active learning, and homework assignments.
  - **Final Exam:** The exam covered all MATLAB content covered in the course. This content was taught using a flipped classroom pedagogy where students watched videos, completed quizzes along with the videos, and completed short activities outside of class. In-class time was used to participate in active learning labs with the guidance of graduate teaching assistants.
  - **Average Non-Flipped Material Quizzes:** The average score of all quizzes taken over content covered in each lab meeting that utilized a traditional classroom format (Excel, Inventor, and graphing calculator).
  - **Average Flipped Material Quizzes:** The average score of all MATLAB quizzes taken over content covered in each lab meeting.

RESULTS AND DISCUSSION

The results of a two step-cluster analysis produced three distinct clusters, shown in Table 2. The clusters can be described as the following:

- **Cluster 1** was comprised of 86 participants, or approximately 20% of the total population. Cluster 1 participants tended to have high levels of interest and enjoyment, value and usefulness, and perceived choice in the task of computer programming. Cluster 1 participants performed in a similar manner on lab quizzes and an exam reviewing Excel, Inventor, and graphing calculator basics when compared to other clusters. Participants in cluster 1 performed in a similar manner on lab quizzes for MATLAB content to cluster 2 participants, outperformed other clusters on a final exam that focused on MATLAB content.

- **Cluster 2** was comprised of 250 participants, or approximately 58% of the total population. Participants in cluster 2 had mid-level responses to interest, value, and perceived choice in programming tasks as well as mid-level performance on an exam focused on MATLAB programming. All other performance measures were similar between clusters.
- **Cluster 3** was comprised of 98 participants, or approximately 22% of total population. Cluster 3 participants showed the lowest levels of interest, value, and perceived choice among all participants. Cluster 3 participants also showed the lowest level of performance on an exam focused on MATLAB content.

TABLE I

Cluster Analysis of Motivation and Performance

Cluster	1	2	3
n	86	250	98
%	19.80	57.60	22.60
Interest/Enjoyment	5.09	3.25	1.56
Value/Usefulness	6.16	4.79	3.22
Perceived Choice	4.6	3.65	2.03
Midterm Exam	87.48	86.39	83.51
Final Exam	90.29	85.46	79.81
Average Excel Quizzes	89.45	90.03	88.39
Average MATLAB Quizzes	89.59	88.48	85.9

From this analysis, we can see that participants who have higher levels of interest, value, and perceived choice towards programming tend to perform better when testing on programming concepts. It is important to note that, while midterm exam performance declined across the clusters, the amount of grade decline is less than the decline seen in programming performance.

IMPLICATIONS AND CONCLUSION

This work in progress paper described an initial cluster analysis conducted to investigate the impact of motivation profile on performance in a flipped classroom programming course for non-computing majors. Previous work has shown performance increases for some students in the flipped classroom, but not for all. While the flipped classroom pedagogy has been shown to have positive impacts on performance in many classroom settings, particularly in programming courses [6-9], this work shows that a transition to a flipped classroom model alone cannot solve low performance and retention issues in the first year. Specifically in courses intended to introduce first year students to content not integrated into their designated major, such as programming for non-computing majors, it is critical that instructors and course designers develop flipped classrooms with a specific focus on tying to student interest, identifying value of the skills learned to future careers, and providing opportunities for student autonomy in the class. By pairing the flipped classroom with pedagogy linked to interest, value, and perceived choice, instructors have the potential to reach out to a large population of students, as the mid- and low-motivation level participants in this study made up over 80% of the total population of the study. For example, focusing on student interest in computers such as game development, website design, or skills in information technology [10, 11] may lead to increased interest and thus, increased performance in the classroom.

REFERENCES

1. Bishop-Clark, C., et al., *A quantitative and qualitative investigation of using Alice programming to improve confidence, enjoyment and achievement among non-majors.* Journal of educational computing research, 2007. **37**(2): p. 193-207.
2. Forte, A. and M. Guzdial, *Motivation and nonmajors in computer science: identifying discrete audiences for introductory courses.* IEEE Transactions on Education, 2005. **48**(2): p. 248-253.
3. Ryan, R.M. and E.L. Deci, *Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being.* American psychologist, 2000. **55**(1): p. 68.
4. Jeldes, I.A., et al. *Work-in-Progress: Flipped Classroom Approach for First Year Engineering Students*. in *Seventh Annual (FYEE) First Year Engineering Experience Conference*. 2015. Roanoka, VA.
5. McCord, R. and I.A. Jeldes, *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*, in *2016 First Year Engineering Experience Conference*. 2016: Columbus, OH.
6. Saterbak, A., T. VOLZ, and M. WETTERGREEN, *Implementing and Assessing a Flipped Classroom Model for First-Year Engineering Design.* Advances in Engineering Education, 2016. **5**(3).
7. CLARK, R.M., A. KAW, and M. BESTERFIELD-SACRE, *Comparing the Effectiveness of Blended, Semi-Flipped, and Flipped Formats in an Engineering Numerical Methods Course.* Advances in Engineering Education, 2016. **5**(3).
8. WEBSTER, D.R., D.M. MAJERICH, and A.G. MADDEN, *Flippin'Fluid Mechanics*-*Comparison Using Two Groups.* Advances in Engineering Education, 2016. **5**(3).
9. Schrlau, M.G., R.J. Stevens, and S. Schley, *Flipping Core Courses in the Undergraduate Mechanical*

Engineering Curriculum: Heat Transfer. Advances in Engineering Education, 2016. **5**(3).

10. Carter, L., *Why students with an apparent aptitude for computer science don't choose to major in computer science.* ACM SIGCSE Bulletin, 2006. **38**(1): p. 27-31.
11. Kurkovsky, S., *Making computing attractive for non-majors: a course design.* Journal of Computing Sciences in Colleges, 2007. **22**(3): p. 90-97.

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