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The Role of Student Choice Within Adaptive Tutoring

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Abstract.

While adaptive tutoring systems have improved classroom education through individualization, few platforms offer students preference in regard to their education. In the present study, a randomized controlled trial is used to investigate the effects of student choice within ASSISTments. A problem set featuring either text feedback or matched content video feedback was assigned to a sample of 82 middle school students. Those who were able to choose their feedback medium at the start of the assignment outperformed those who were randomly assigned a medium. Results suggest that even if feedback is not ultimately observed, students average significantly higher assignment scores after voicing a choice. Findings offer evidence for enhancing intrinsic motivation through the provision of choice within adaptive tutoring systems.

Keywords: Choice, Adaptive Tutoring, Feedback Medium, Learning Outcomes

1 Introduction

Although the perception of autonomy has been proven as an intrinsically motivating factor for learning [10, 3, 9, 5], student preference is rarely employed in education. Perhaps traditional classroom practices have failed to capitalize on student choice due to limitations in materials or resources. However, adaptive tutoring systems offer unique opportunities for students to invest in their learning experience. These platforms are becoming a staple for the modern classroom, serving to individualize the learning experience while providing students with more powerful feedback and teachers with more powerful assessment. One of these systems, ASSISTments, is fast growing platform used for homework and classwork by over 50,000 students around the world.

The present study was influenced by Cordova & Lepper's landmark study that unveiled the beneficial effects of choice within educational computer activities [1]. Coupled with findings from previous work surrounding feedback mediums within ASSISTments [8], the present study examines 1) how learning outcomes are affected if students are able to choose the feedback medium they will experience within a mathematics assignment, 2) whether a particular feedback medium is more popular or more effective, and 3) if an interaction exists between choice and feedback medium as measured by a variety of performance outcomes.

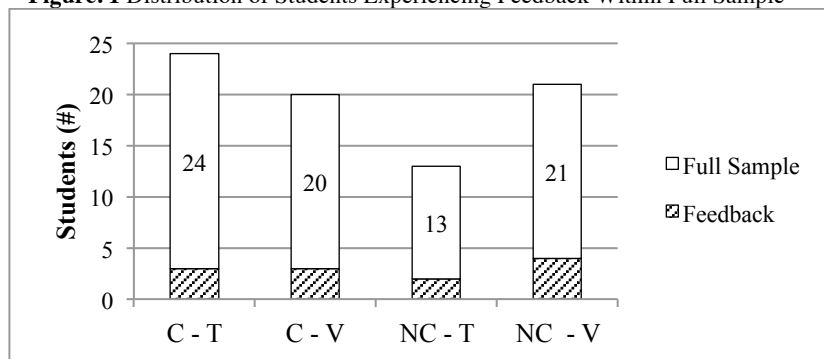
2 Methods

A randomized controlled trial was designed using problem content aligned to the fifth grade Common Core State Standard of Multiplying Simple Fractions. Two isomorphic problem sets were created within ASSISTments: a set of 40 problems, each containing three hints presented as text feedback, and an isomorphic set of 40 problems, each containing three hints presented as short (15-30 second) video snippets. For each problem, regardless of feedback medium, the first two hints served as a static worked example and its solution. The third and final hint for each problem walked students through the solution to the original problem. All problem content and feedback is available at Ostrow [6] for further reference. These problem sets were then embedded in a complex experimental design within ASSISTments, establishing a solitary assignment with multiple conditions. At the beginning of the assignment each student was randomly assigned to either the Choice (experimental) or No Choice (control) conditions. Those assigned to the control were immediately reassigned to either video or text feedback. Students who were assigned to the experimental condition were asked to choose the type of feedback they wished to receive while working on their assignment. The student experience is available at Ostrow [6] for reference.

3 Procedure

The study problem set was made openly accessible to all teachers for assignment to their students, allowing for natural and unbiased data collection. Log files were accumulated approximately one month after the release of the experiment. A total of 82 students from 4 classes spanning 2 middle schools in suburban Massachusetts had been assigned the problem set. All students within the sample were familiar with the ASSISTments platform. Of the 82 students originally assigned this problem set, 78 completed the assignment, following the distribution depicted in Figure 1. As shown, regardless of condition, the majority of students did not actually request hint feedback during the assignment. Thus, the results presented herein are primarily intended to guide future work.

Figure. 1 Distribution of Students Experiencing Feedback Within Full Sample



Note. Condition labeled as C (Choice, $n = 44$) and NC (No Choice, $n = 34$),
Feedback Medium labeled as T (Text, $n = 37$) and V (Video, $n = 41$).

4 Results

It was hypothesized that students would excel when provided choice, and that those receiving video feedback would outperform those receiving text feedback. A MANOVA was conducted to examine the interaction between condition and feedback medium across a number of dependent variables measuring student performance within the assignment. Within the 78 students who completed the assignment, there was no significant interaction effect, Pillai's Trace = 0.110, $F(6, 69) = 1.416$, $p = 0.221$. Further, although there was no significant main effect of condition, Pillai's Trace = 0.077, $F(6, 69) = 0.962$, $p = 0.457$, Table 1 reveals that students who made a preference about their feedback medium had significantly higher correctness on average than those in the control condition, $p < .05$, $\eta^2 = 0.05$. Further, students who were given choice were more likely to master their assignment than those in the control condition, trending toward significance $p < .10$, $\eta^2 = 0.04$, they used fewer hints and attempts, and spent longer working on each problem. While these findings were not significantly reliable, they emphasize that providing choice within adaptive tutoring contexts should be explored further. Feedback medium was less relevant to student performance than hypothesized, as no significant differences were observed within any of the dependent variables.

Table 1. Means, SDs, & Univariate Results for Main Effect of Condition (Intent-To-Treat)

<i>Variable</i>	<i>n</i>	<i>Choice</i>	<i>n</i>	<i>No Choice</i>	<i>F (1,74)</i>	<i>p</i>	η^2	R^2
Ave. Correctness	44	0.95 (0.10)	34	0.87 (0.25)	4.03	.048	0.05	0.05
Ave. Hints	45	0.23 (0.68)	36	0.35 (1.15)	0.61	.436	0.01	0.02
Ave. Attempts	45	3.48 (1.19)	36	3.76 (1.74)	0.89	.348	0.01	0.02
Mastery	45	1.00 (0.00)	36	0.94 (0.24)	2.83	.097	0.04	0.04
Ave. Time (sec)	44	44.94 (45.76)	34	40.29 (34.52)	0.55	.461	0.01	0.04
Med. Time (sec)	44	36.45 (42.24)	34	27.00 (16.33)	1.90	.172	0.02	0.09

Note. Averages represent average student performance across all problems experienced in the assignment.

Across the full sample, only 12 students actually requested hint feedback (14.6%). A MANOVA of treated students lacked enough power to suggest a significant interaction effect, Pillai's Trace = 0.724, $F(6, 3) = 1.31$, $p = 0.445$. The main effect of feedback medium trended toward significance, Pillai's Trace = 0.889, $F(6, 3) = 4.02$, $p = 0.141$, with students requesting more hints ($M = 2.80$, $SD = 2.05$) and using more attempts ($M = 6.20$, $SD = 2.17$) when receiving text than when receiving video ($M = 1.14$, $SD = 0.90$; $M = 4.86$, $SD = 2.91$). Further, although there was no main effect for condition, Pillai's Trace = 0.641, $F(6, 3) = 0.89$, $p = 0.588$, the means and univariate results presented in Table 2 suggest that students showed consistently better performance when they were able to choose their feedback medium.

Table 2. Means, SDs, & Univariate Results for Main Effect of Condition (Treated)

<i>Variable</i>	<i>Choice, n=6</i>	<i>No Choice, n=6</i>	<i>F (1, 8)</i>	<i>p</i>	η^2	R^2
Ave. Correctness	0.74 (0.02)	0.66 (0.35)	0.23	.647	0.03	0.04
Ave. Hints	1.67 (1.03)	2.00 (2.19)	0.57	.472	0.05	0.33
Ave. Attempts	5.83 (1.72)	5.00 (3.41)	0.02	.895	0.00	0.30
Mastery	1.00 (0.00)	0.83 (0.41)	0.47	.512	0.05	0.18
Ave. Time (sec)	24.72 (10.14)	59.26 (37.92)	3.99	.081	0.33	0.34
Med. Time (sec)	14.52 (5.93)	35.30 (23.86)	3.49	.099	0.30	0.31

5 Discussion & Contribution

This study served as an initial foray into implementing student choice within ASSISTments, an adaptive tutoring platform that was previously unable to individualize learning via student preference. Results suggested that students who were able to invest in their learning experience outperformed those who were not asked their preference. Those provided choice averaged higher correctness on the assignment while using fewer hints and attempts. Further, choice significantly impacted performance, even when the outcome of choosing was not ultimately experienced. Aside from small sample size, this study was also somewhat limited in that the experimental design utilized feedback that was only provided upon the student's request. As such, proper analysis of main effects would require a much larger treated sample. The results of this study inspired infrastructure changes within the ASSISTments platform that will allow for future research in this area. Similar hypotheses can now be examined using ASSISTments on larger samples and within additional content domains. Findings offer evidence in support of allowing student autonomy within adaptive education.

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