Using Time Pressure to Promote Mathematical Fluency

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Abstract. Time pressure helps students practice efficient strategies. We report strong effects from using games to promote fluency in mathematics.

Keywords: mathematics, evaluation, educational games, fluency, retention, number sense.

1 Introduction

There is a misperception that building fluency requires rote practice. Often, fluency represents the ability to rapidly recognize and apply an appropriate strategy for solving a problem [1]. For example, when deciding whether $\frac{1}{3}$ is greater than $\frac{1}{17}$, it is more efficient to picture pies than to form common denominators. The number sense depends on developing these kinds of reasoning abilities.

Some students possess the appropriate mathematical knowledge to solve mathematical problems but are relatively inflexible in their strategy selection and so pick inefficient (but correct) strategies [2]. The imposition of time pressure can force students to consider alternative strategies [3].

2 Game Frameworks

Our experiments incorporate three game “frameworks,” used for relative comparisons (race), absolute magnitude (numberline) and equivalence (matching).

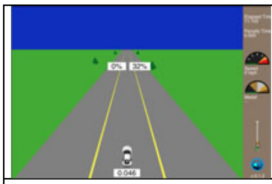

Fig. 1. Race. Students position the car relative to the lane dividers.

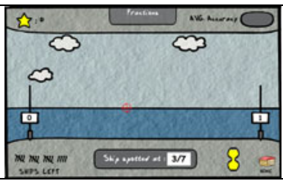

Fig. 2. Numberline. Students identify the ship’s position on a numberline.

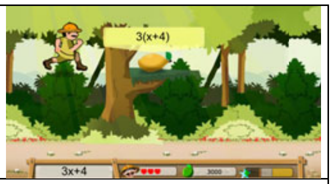

Fig. 3. Matching. Students discern equivalent and non-equivalent items.

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3 Evaluation

3.1 Participants and Method

Our evaluation was conducted at a small Catholic liberal arts university that focuses is on women's education. Sixteen of the 18 participants were women.

In each of five weeks, students played games for approximately one-half hour. They took short paper-and-pencil pre- and post-tests before and after playing, as well as a delayed test one week later. Tests were timed and designed to contain more questions than students could answer, so our main outcome is the number of questions answered correctly.

3.2 Results and Discussion

Improvements are shown in Table 1. Effect sizes are quite large, ranging from 0.4 to 2.4, indicating that these results are not only significant but substantial.

Table 1. Mean (standard deviation) correct on immediate and delayed post tests. Pretest for delayed post includes only students who took the delayed posttest. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	Ex. 1		*Ex. 2*		*Ex. 3*		*Ex. 4*		*Ex. 5*	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Immediate	13.6	23.5***	20.3	30.2***	13.3	15.3	17.6	22.2**	6.3	7.4**
	(5.9)	(5.8)	(4.8)	(7.7)	(4.6)	(3.2)	(7.6)	(8.0)	(2.7)	(2.5)
Delayed	12.4	20.7**	19.3	34.0***	13.2	14.2	17.3	22.4*	6.4	9.4 (2.8)
	(3.8)	(5.7)	(5.3)	(6.7)	(4.7)	(4.1)	(8.1)	(9.3)	(2.8)	

We may see such strong results because students are often not learning new strategies. Instead, they are practicing ways of thinking about numbers that they already possess but which have been infrequently accessed. Time pressure imposed in a game context has promise to be a highly effective method for encouraging such practice.

References

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