# USING COMPUTER-ASSISTED INSTRUCTION TO IMPROVE EARLY LITERACY SKILLS FOR STRUGGLING STUDENTS

**Haya Shamir[1], Kathryn Feehan[2], Erik Yoder[3]**

*[1]Waterford Research Institute (UNITED STATES)*
*[2]Waterford Research Institute (UNITED STATES)*
*[3]Waterford Research Institute (UNITED STATES)*

## Abstract

The Waterford Early Reading Program (ERP) is a computer-assisted instruction program that ensures individualized learning for kindergarten through second grade students. This study consisted of 1,114 first and second grade students enrolled in a public school district in Indiana during the 2015-2016 school year. Analysis revealed statistically significant higher percent gains from beginning of year DRA scores to end of year DRA scores made by first grade and second grade students that used ERP. Across demographics, students in the experimental group outperformed students in the control group on end of year scores in both grades. Multiracial students in the experimental group significantly outperformed control students in second grade, and students with free and reduced lunch status in the experimental group significantly outperformed control students in second grade. Overall, these findings suggest that CAI, when combined with an existing school curriculum, assist elementary school students in acquiring the early literacy skills needed to succeed in school more than school curriculum alone.

Keywords*:* literacy, early childhood, computer-assisted instruction (CAI)

## 1 INTRODUCTION

Being an effective reader is an individualized skill that should be strengthened with practice: To successfully read, students need to be able to confront problems as they go along and apply knowledge across multiple academic domains [1]. When children are unable to read proficiently by fourth grade, they are on the track towards dropping out of high school, and this gap in reading proficiency is pronounced among low income children [2]. From 2013 to 2015, the nation's average reading score for fourth grade students did not significantly improve, and the average reading score for eighth grade students decreased [3]. Family income and student performance on reading standardized test performance show the widening income achievement gap between low- and high-income families [4]: Only thirty-six percent of American students scored at or above proficiency in average reading scores in 2015 [3]. This low, stagnant percentage of students scoring at or above reading proficiency is troubling, for students shift from learning to read to reading to learn in third grade [5]. Early literacy skills are necessary for later school success, and these skills need to be taught early on. For example, story comprehension is more difficult for early readers than vocabulary acquisition, so literacy education needs to account for all of the variations in difficulty level of the curriculum, the cognitive abilities of the student, and the skill level of the student [6 & 7]. Fourth grade reading skills have been found to predict change in vocabulary growth through tenth grade, meaning that the early literacy gap in elementary school widens if not addressed as early as possible [8]. In fact, gaps in literacy skills can only be adjusted slightly after second grade according to Heckman's research [9]. Research into education with the aim of improving reading skills for all students should, accordingly, focus on approaches which can close the gap in literacy skills before children enter fourth grade.

### 1.1 Computer-assisted Instruction

Computer-assisted instruction (CAI) is the presentation of different forms of educational media material in an interactive, instructional way. While teachers conduct large group instruction meant for many students to learn a subject, CAI allows individual students to take control of their learning which increases students' flexibility, interactivity, and engagement [10 & 11]. According to research of CAI in the classroom setting, early childhood instruction using CAI can improve mathematical performance [12] and literacy performance

[13 & 14] in comparison to a typical public classroom setting. Moreno (2006) suggests a cognitive theory of learning with media, wherein students learn better when given opportunities to reflect on information they have learned, where multimedia presentations of material are more conducive to retention, and where words and graphics expand working-memory capacity [15]. CAI presents material with animation and immediate feedback, individualizing the learning process.

Early literacy instruction ideally balances attention to the skills required for reading with opportunities to develop students' individual vocabulary knowledge [16]. Additionally, individualized educational technology programs need to target students of all demographics: Students from low-income families are less likely to be reading proficiently and to graduate from high school [5]. Children from low-income families have been found to have improved early literacy skills when computer-based curriculum is combined with interactive activities [17]. Literacy instruction should address not only basic reading skills but develop students' vocabulary and comprehension [16].

## 1.2 Technology in the Classroom

Technology-based literacy instruction could prove to be the individualized education that children with learning disabilities need for academic success [18 & 19]. Poor readers, students with disabilities, and children at risk of a learning disorder can have significant improvements in their word recognition and reading comprehension skills through computer-based interventions [7, 13, 14, & 20]. In previous research, computerized training programs were found to improve the reading skills of second grade students with reading disabilities, with longitudinal effects showing that one year after the reading intervention, the majority of students in the group that received both the computerized instruction improving phonological abilities and the computerized instruction improving word and sentence levels did not need special education [18]. CAI technology has also been found to significantly improve alphabet recognition and increase attentive behaviors in preschool children with autism [21]. Overall, previous research has shown that computer-assisted instruction can improve the early literacy skills of at-risk children and children with reading disabilities, but further research is needed to investigate the impact of and evaluate the developmental appropriateness of CAI technology when incorporated into the classroom [11].

The purpose of the present study is to evaluate the effectiveness of the Waterford Early Reading Program (ERP) in improving early literacy skills of kindergarten through second grade students. This computer-assisted instruction program, we predict, will improve reading scores when incorporated into early elementary school programs.

# 2 METHODS

## 2.1 Participants

This study consisted of 1,114 students enrolled in a public school district in Indiana during the 2015-2016 school year. The majority of students in the study are Caucasian, and approximately half of the students qualify for free lunch. For first grade, the experimental group consisted of 103 students, and the control group consisted of 534 students. For second grade, the experimental group consisted of 70 students, and the control group consisted of 407 students.

## 2.2 Materials

### *2.2.1 The Waterford Early Reading Program*

The program offers a comprehensive computer-adaptive pre-reading and reading curriculum for kindergarten through second grade students. The software presents a wide range of multimedia-based activities in an adaptive sequence tailored to each student's initial placement and his or her individual rate of growth throughout the complete reading curriculum.

### *2.2.2 Developmental Reading Assessment (DRA)*

The DRA is a standardized reading test used to determine a student's instructional level in reading. The DRA is administered individually to students by teachers and/or literacy coaches. The test identifies whether the student is below, meeting, or exceeding grade level reading expectations.

## 2.3 Procedure

Students in the experimental group were expected to use ERP for thirty minutes per day, five days per week, throughout the 2015-2016 school year. The control group consisted of students who did not use ERP during the 2015-2016 school year. The DRA was administered at the beginning and end of the year.

# 3 FINDINGS

## 3.1 Group Differences Using an Independent Samples *t*-test – First Grade

The experimental group for first grade ($n = 103$) consisted of students that used ERP during the 2015-2016 school year. The control group ($n = 534$) consisted of students that did not use ERP during the 2015-2016 school year. An independent samples *t*-test examining percent gains between beginning of year and end of year scores was conducted (see Fig. 1). Analysis of percent gains revealed a significant difference between groups $t(1, 126) = -2.86$, $p < .01$, due to higher percent gains made by students who used Waterford ($M = 205.78$) than by control students ($M = 156.06$). Effect size ($d = 0.37$).

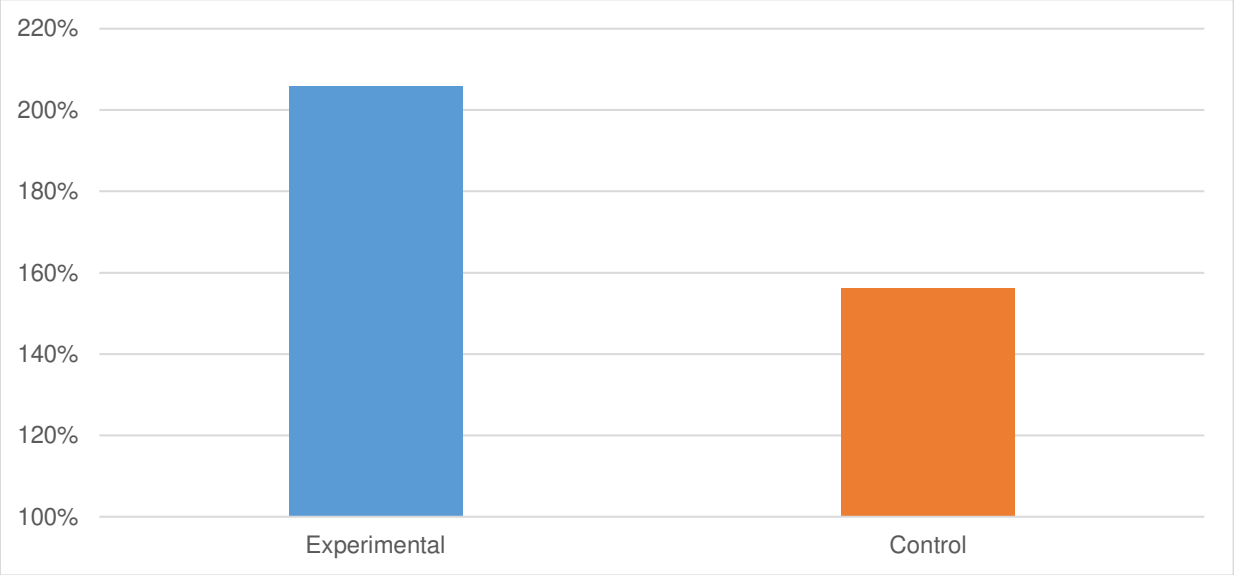


*Fig. 1:* First Grade DRA Percent Gains

## 3.2 Group Differences Using Two-Way Analysis of Variance – First Grade

Three separate ANOVAs were conducted that examined the effects of Waterford curriculum and demographics on DRA percent gains (see Fig. 2).

### *3.2.1 Gender*

There was no significant interaction between the effects of gender and Waterford curriculum on DRA percent gains, $F(1, 632) = 1.27$, $p = .261$. Simple effects analysis showed that for females, students' percent gains in the experimental group were significantly higher than in the control group. Male students' percent gains in the experimental group were higher than in the control group, approaching significance.

### *3.2.2 Lunch Program*

There was a significant interaction between the effects of lunch program and Waterford curriculum on DRA percent gains, $F(2, 630) = 4.71$, $p < .01$. Simple effects analysis showed that regular lunch students' percent gains in the experimental group were significantly higher than in the control group. Free lunch and reduced

lunch students' percent gains in the experimental group were slightly higher than in the control group, but the difference was not significant.

### *3.2.3 Special Education Status*

There was no significant interaction between the effects of special education status and Waterford curriculum on DRA percent gains, $F(1, 631) = 2.49$, $p = .115$. Simple effects analysis showed that students with no special education status in the experimental group made significantly higher percent gains than the control group. Students with an active special education status in the experimental group made slightly higher percent gains than the control group, but the difference was not significant.

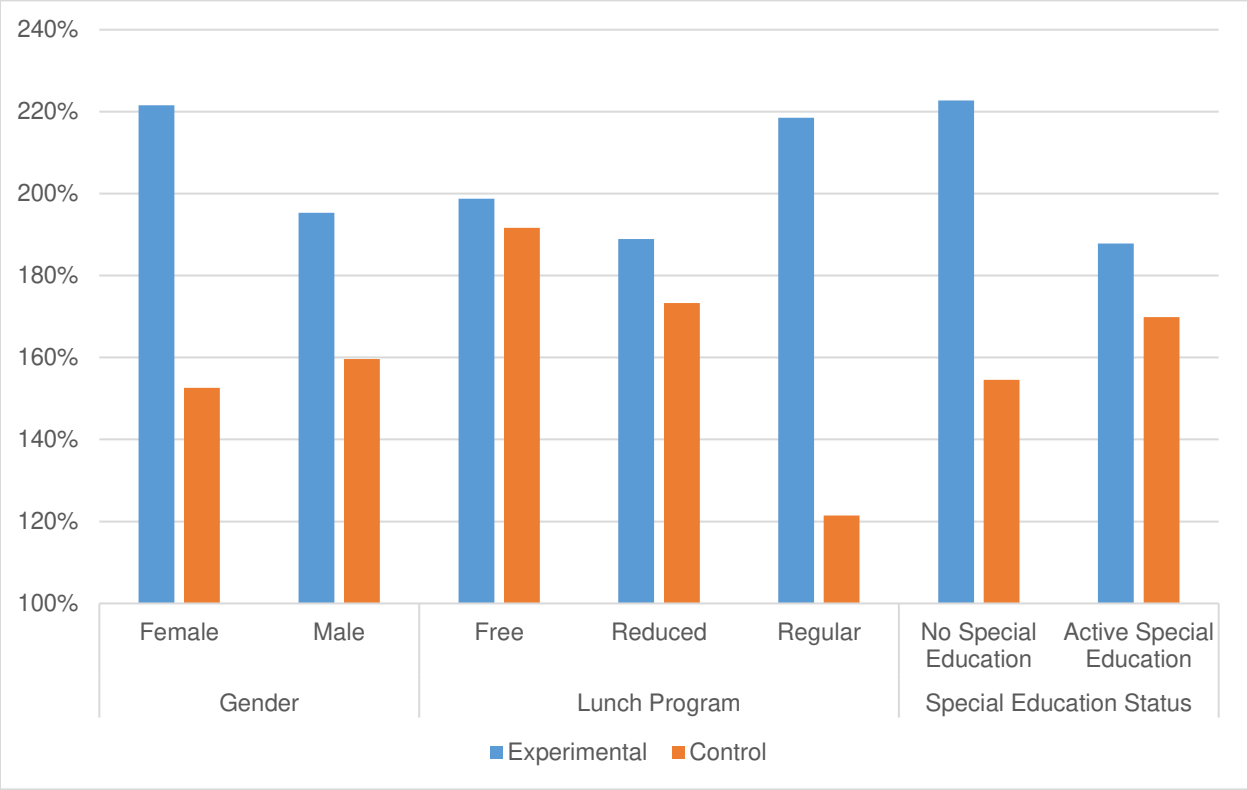


*Fig. 2:* First Grade DRA Percent Gains by Demographics

## 3.3 Group Differences Using an Independent Samples *t*-test – Second Grade

The experimental group for second grade ($n = 70$) consisted of students that used ERP during the 2015-2016 school year. The control group ($n = 407$) consisted of students that did not use ERP during the 2015-2016 school year.

An independent samples *t*-test examining percent gains between beginning of year and end of year scores was conducted (see Fig. 3). Analysis of percent gains revealed a significant difference between groups, $t(1, 82) = -4.31$, $p < .01$, due to higher percent gains made by students who used Waterford ($M = 56.32$) than by control students ($M = 37.70$). Effect size ($d = 0.70$).

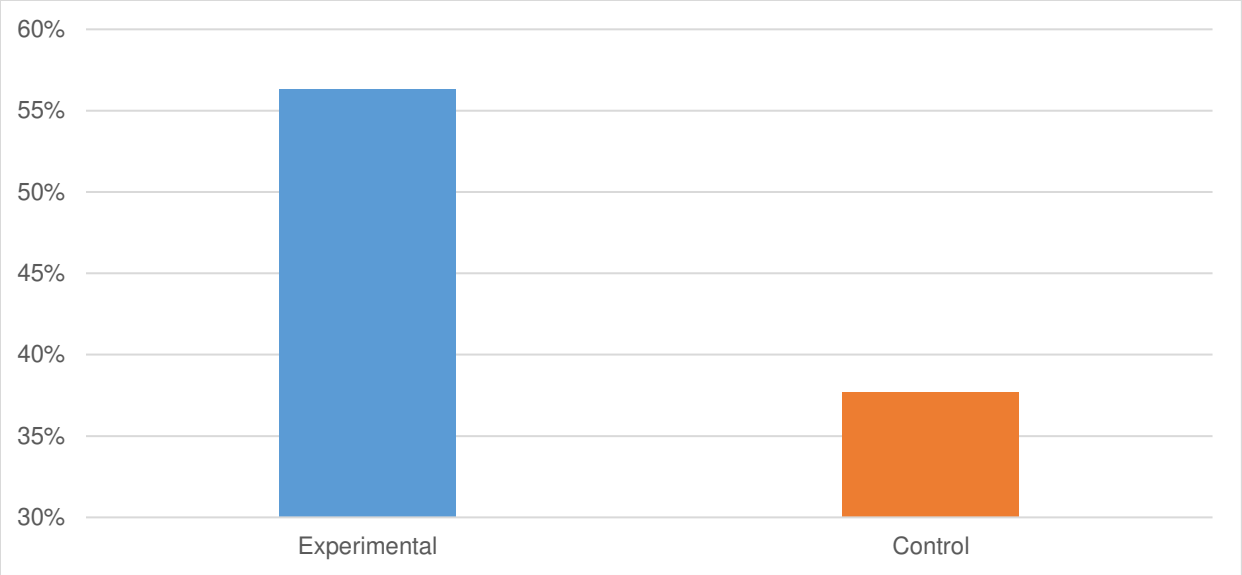


*Fig. 3.* Second Grade DRA Percent Gains

## 3.4 Group Differences Using Two-Way Analysis of Variance – Second Grade

Five separate ANOVAs were conducted that examined the effects of Waterford curriculum and demographics on DRA percent gains (see Fig. 4).

### *3.4.1 Gender*

There was no significant interaction between the effects of gender and Waterford curriculum on DRA percent gains, $F(1, 472) = 0.25$, $p = .619$. Simple effects analysis showed that for females and males, students' percent gains in the experimental group were significantly higher than in the control group.

### *3.4.2 Ethnicity*

There was a significant interaction between the effects of ethnicity and Waterford curriculum on DRA percent gains, $F(4, 464) = 2.74$, $p < .05$. Simple effects analysis showed that Multiracial and Caucasian students' percent gains in the experimental group were significantly higher than in the control group. Asian and Black/African American students' percent gains in the experimental group were slightly higher than in the control group, but the difference was not significant.

### *3.4.3 Lunch Program*

There was a significant interaction between the effects of lunch program and Waterford curriculum on DRA percent gains, $F(2, 470) = 3.77$, $p < .05$. Simple effects analysis showed that free, reduced, and regular lunch students' percent gains in the experimental group were significantly higher than in the control group.

### *3.4.4 Limited English Proficiency (LEP) Status*

There was no significant interaction between the effects of LEP status and Waterford curriculum on DRA percent gains, $F(1, 472) = 0.01$, $p = .930$. Simple effects analysis showed that Non-LEP students' percent gains in the experimental group were significantly higher than in the control group. LEP students' percent gains in the experimental group were slightly higher than in the control group, but the difference was not significant.

### *3.4.5 Special Education Status*

There was a significant interaction between the effects of special education status and Waterford curriculum on DRA percent gains, $F(1, 472) = 6.12$, $p < .05$. Simple effects analysis showed that students with no special education status in the experimental group made significantly higher percent gains than the control group. Students with an active special education status in the experimental group made slightly higher percent gains than the control group, but the difference was not significant.

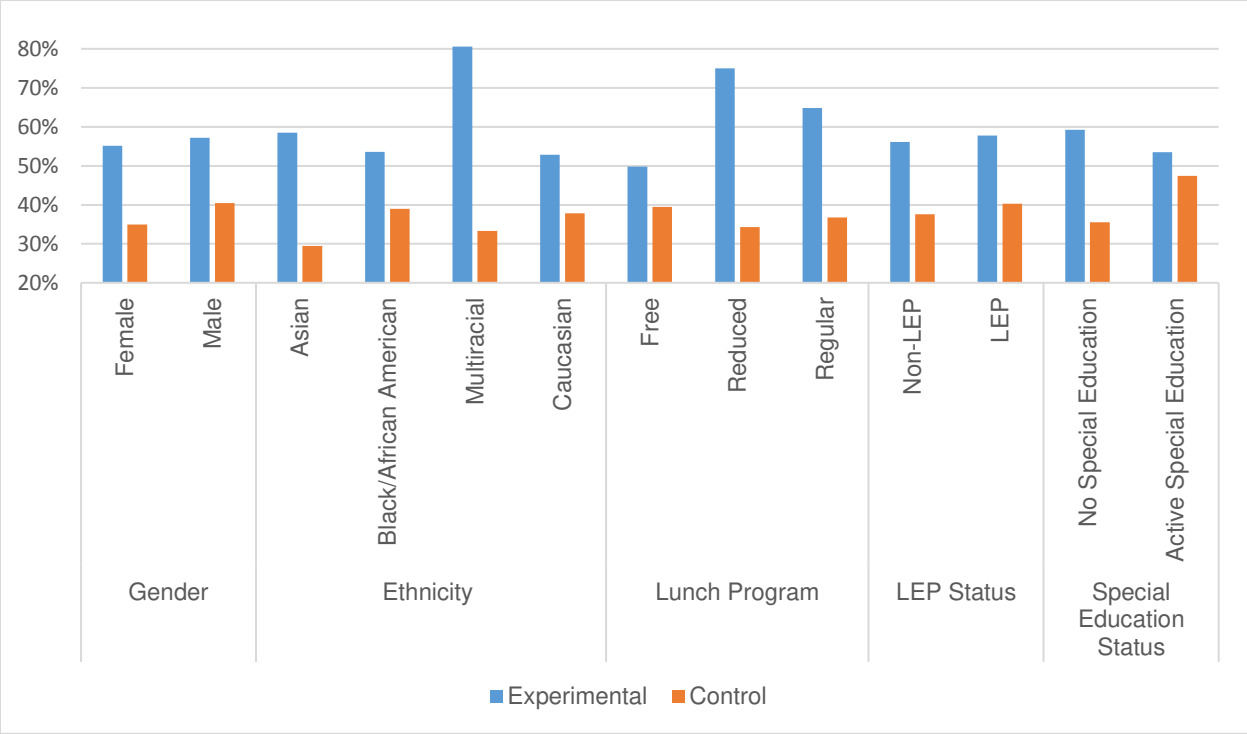


*Fig. 4.* Second Grade DRA Percent Gains by Demographics

## 4 DISCUSSION

Consistent with prior research, this study found that computer-assisted instruction, when combined with an existing school curriculum, improves the literacy skills of elementary school students [11, 22]. The findings support the hypothesis that CAI technology, when incorporated into the classroom, will improve the literacy scores of students learning to read. First and second grade students in the experimental groups had significantly higher percent gains than students in the control groups. Students with active special education status in the experimental group outperformed control students in both grades, parallel with similar studies investigating the impact of computer applications improving early literacy skills of students with active special education status [7]. Additionally, the results of the current study supported previous studies that indicated that at-risk students' early literacy skills are improved by CAI technology: Multiracial students in the experimental group significantly outperformed control students in second grade, and students with free and reduced lunch status in the experimental group significantly outperformed control students in second grade [23]. First grade and second grade students that used ERP made statistically significant higher percent gains from beginning of year DRA scores to end of year DRA scores, indicating that Waterford curriculum improves early literacy skills.

Research shows that academic achievement through fifth grade can be predicted by kindergarten readiness, indicating that effective early literacy education is necessary for students of all demographics to succeed in school [24]. ERP improved experimental group scores significantly in most areas. Greater percent gains could have been seen perhaps had students used Waterford curriculum more consistently

with the expected usage goals. Additionally, this study only included one elementary school district, so further research should compare students from multiple districts to increase generalizability of research results. These findings suggest that computer-assisted instruction, when combined with an existing school curriculum, assist elementary school students in acquiring the early literacy skills needed to succeed in school more than school curriculum alone. Overall, the use of adaptive, individualized technological instruction in school is an effective method to enhance the teaching of literacy skills to early readers.

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