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Empirical Validation of an On-line Literacy Program using DIBELS for Title I Students

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Abstract

The aim of this investigation was to examine the effect an online game based reading program called *SkatekidsOnline* (SKO) had on Title I students' reading skills. The effectiveness of this cognitively based interactive learning program was compared for third grade students who were defined as High (mean of 16.8 hours) or Low (mean of 5.7 hours) SKO users. DIBELS Oral Reading Fluency (ORF) scores were nearly identical at pre-test but ANOVA results indicated that the High Use group improved significantly more than the Low Use group (Wilks' Lambda = .77, F (1, 64) = 19.11, $p < .001$). The effect size for the High SKO Use group (1.16) was about twice as large as the Low Use group (.57). Additionally, while only 33% of students in the High Use met ORF benchmark at the pre-test phase, 67% met the benchmark after exposure to SKO. This first empirical examination of SKO suggest that the program appears to be an effective method for improving DIBELS Oral Reading Fluency scores for Title I students and, importantly, that the more children played the game the greater their improvement.

Computer games have become a mainstay of modern culture mainly for the entertainment value they offer. A growing body of research suggests, however, that computer games can be used to improve academic skills (Flowers, 2007; Pillay, 2003; Pivec, 2007). Using computer games to promote learning did not simply evolve from children playing computer games for fun to children playing computer games for learning. In fact, using computer games as a learning tool was pioneered by fields that are anything but child's play. Industries like computer engineering, to major corporations such as Chrysler have found success in digital game-based learning (DGBL) geared to adult learners (Prensky, 2005; Connoly, Stansfield, & Hainey, 2007; Sieberg, 2001).

One of the biggest proponents for DGBL has been the United States Military (Sieberg, 2001). With 2.4 million men and women in the four branches of the military plus another one million civil employees, the military is the world's largest user of DGBL as a means of training and recruiting its employee population (Prensky, 2005). The military has found success in using DGBL to train personnel for combat, humanitarian missions, and response preparedness for everything ranging from biological terrorism to natural disasters. The military also uses DGBL technology to train soldiers to operate expensive equipment like fighter jets, teach senior officers strategic thinking, and to teach midlevel officers military logistics (Prensky, 2005).

Why have major industries, corporations and world military powers invested billions of dollars into using DGBL to train and educate? The answer to this question rests in the amount of evidence of the effectiveness of this instructional method. The US military has funded a number studies to support its use of DGBL, and, in fact, is one of the largest sources for research on DGBL (Holmquist, 2004). For example, a 1981 study by the U.S. Naval Biodynamics Laboratory found video games were helpful in the acquisition of learning skills and were found to aid in military pilot selections. Specifically, scores on air combat maneuvering video games accounted for 46 to 68 percent of the variance in the glide-slope tracking scores in a carrier-landing flight simulator. Additionally, a 1998 US military study entitled *Combat Vehicle Identification* found that subjects who used a computer-based training system incorporating a hybrid adult learning model and rich imagery achieved higher scores than subjects training with a lecture presentation style without the rich imagery (Holmquist, 2004).

The question still remains to why DGBL is an effective learning tool. Learning theories have been used to explain the value of DGBL. Humans learn through observation, imitation and play. This approach to learning, often referred to as modeling, frames the DGBL experience within a natural learning context because players learn while initiating and playing different digital scenarios in which they are fully immersed (Van Eck, 2006). Modeling and context dependent learning also helps to explain why people learn foreign languages much faster when they live in a culture where that language is the predominately spoken versus learning a language in the classroom. Successful and effective DGBL engages and immerses the learner in the tasks, while traditional classrooms are more restricted to lectures and books that limit the learning to an audience-based experience (Foreman, 2004).

In the wake of DGBL's growing popularity as a learning tool, research on DGBL's effectiveness in elementary and secondary school settings has become more prevalent. One educational area that has shown promising results is the use of DGBL to help students' literacy development (Din & Caleo, 2000; Flowers, 2007; Segers & Verhoeven, 2005). Segers and Verhoeven (2005) found that time spent playing rhyming and blending sound computer games was related to learning gains in phonological awareness in 100 kindergarteners. Din and Caleo (2000) found that kindergarteners who played learning video games over an eleven week period made significant gains in spelling and decoding compared to kindergarteners who did not play the video games.

Promoting literacy development is important for all children, but is especially important for children who are at greater risk for poor academic development. One segment of the population that is at greater risk for poor academic development is children from economically disadvantaged environments. It is well documented that living in poverty has substantial negative effects on school achievement (Garner & Raudenbush, 1991; Duncan, 1994; Ensminger, Lamkin, & Jacobson, 1996; Ainsworth, 2002). Government funded programs have been established to address the adverse effects of poverty on children's academic achievement. One widespread program is the Title 1 federal funding provided to public schools that serve economically disadvantaged children (Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998). Despite the existence of programs like Title 1, researchers continue to find that low socioecomonmic status remains a powerful predictor of poor academic achievement, especially in areas of reading and math (Woolley et. al, 2008). Thus, finding a literacy development program that is effective for economically disadvantaged children is a high priority.

A strength of using DGBL as a learning tool is that children are attracted to this media (Pivec, 2007). Even children who may not have much access to computer games in their home due to financial restraints or various other reasons are still exposed to the mainstream cultural which embraces video games as an attractive activity. However, even if children are generally inclined to play video games, one of the major criticisms about academically enriching DGBL has been that they do not excite children enough to make them want to play repeatedly or as frequently as mass-marketed, recreational computers games (Egenfeldt-Nielsen, 2007). Some examples of problematic characteristics that DGBL games have been criticized for include unimaginative games and drill-and-practice regimens (Egenfeldt-Nielsen, 2007; Garris, Ahlers and Driskell, 2002). To address this problem, Wartella (2002) suggested that DGBL motivation could be enhanced by blurring the lines between learning and playing using an integrated action/adventure and role-playing format.

The current educational gaming marketplace has a variety of computer software programs that are designed to improve children's reading skills. Some popular educational computer games include HeadSprout (http://www.headsprout.com),Scientific Learning Software(http://www.scilearn.com),and Clicknkids (http://www.clicknkids.com). Despite the variety available in this market, educational computer games are still regarded as less exciting and engaging than recreational video games by children (Egenfeldt-Nielsen, 2007). One educational computer game that seeks to change this perception is Skatekidsonline (SKO; http://www.skatekidsonline.com).

SKO is an online educational program that not only incorporates scientifically based reading research, but also uses principles from cognitive psychology and learning theories to help children learn while they are engaged in a character based interactive gaming environment. In order to avoid drill-and-practice regimens, SKO integrates learning within the gaming activity such as getting points while snowboarding down a hill. Thus SKO presents an online, interactive learning environment that is designed to promote the acquisition of reading skills within a recreational gaming format intended to be as entertaining as it is educational (http://www.skatekidsonline.com).

Many of the educational games available in the gaming market place today are said to be based on scientific based research, but have not been subjected to empirical studies. For example, *Clicknkids* is reportedly based on the findings of the National Reading Panal, which was established by the National Institute of Child Health and Human Development to examine the effectiveness of different approaches of teaching children how to read (www.clicknkids.com). Yet little research has been conducted to examine the relationship between *Clicknkids* use and reading achievement in children. SKO also is in need of research to support its effectiveness on reading achievement. Although establishing a relationship between SKO use and children's reading skills is important, it is especially important to establish this connection between SKO use and children who are at risk for poor reading achievement, such as students from schools who receive Title 1 funding. Thus, the purpose of this study was to begin to examine the effectiveness of SKO using pre and post-intervention scores on the Dynamic Indicators of Basic Early Literacy Skills in Title 1 students (DIBELS; Good & Kaminski, 2002) as one indicator of reading proficiency.

Method

Participants

The participants of this study were 66 third grade students who were enrolled in two elementary public schools located in the southern Atlantic region of the United States. The 66 students came from five different third grade classes that were classified as regular educational settings in schools designated as Title I due to the high percentage of students from low-income families. There were 33 students from each elementary school. More than 40% or more of the students come from families that qualify under the United States Census definitions as low-income Title 1 schools. Although the specific student demographics such as ethnic and socioeconomic status were unavailable, demographics from the schools' zip code were obtained through the U.S. Census Bureau. The U.S. Census demographics from the area of the first elementary school, School A, consisted of 88% White, Non-Hispanic; 7% Black, 3% Hispanic, 1% Asian, and 1% other. The U.S. Census demographics from the region of the second elementary school, School B, consisted of 60% White, Non-Hispanic; 37% Black, 1% Hispanic,1% Asian, and 1% other. Due to differences in logistical constraints at the two schools, the students at School A were able to access SKO considerably more frequently than those at School B and will be referred to as High Use and Low Use schools, respectively.

Instruments

SkatekidsOnline. SKO is an online literacy computer program that consists of ten games embedded in a role-playing setting where each child is able to become a character that travels through an imaginary world playing games, while also being able to engage in other activities such as shopping at a mall and playing at an arcade. Each of the ten games targets a combination of reading skills recommended by the National Reading Panel (see SKO website for more information). Importantly, SKO incorporates fundamental concepts of literacy development such as phonemic awareness, phonological processing, word decoding, and reading comprehension within the ten games (http://www.skatekidsonline.com). Additionally, SKO encourages cognitive skills such as thinking strategies liked to basic psychological processes based on a combination of theories including Vygotsky's sociocultural theory (Tzuriel & Shamir, 2007) and the cognitive processes described by Naglieri and Das (1997, 2004), and the neuropsychological work of A. R. Luria (1966, 1973, 1980, 1982).

Dynamic Indicators of Basic Early Literacy Skills. DIBELS (Good & Kaminski, 2002) are a set of measures used to assess the development of early literacy skills in kindergarten through sixth grade children. The test was designed to be used as monitoring system that could be given multiple times throughout the school year in order to track the development of early literacy and reading skills. According to the authors, the DIBELS measures important skills related to reading outcomes such as phonological awareness, fluency, vocabulary and comprehension. In this study Oral Reading Fluency was used to assess accuracy and fluency with connected text. The raw score is based on the number of words read correctly in one minute. The benchmarks for the end of second and third grade are 90 and 110 words correct per minute, respectively.

Procedure & Data Analysis

Each of the 66 students was administered the DIBELS at the beginning of their third grade school year (late August to early September) by a trained public school employee using standard administration procedures and at the end of their third grade year. Data were checked for accuracy. During the school year, students were given access to SKO over a period of seven months between pre and post-tests beginning in October and ending in May. There were differences in how each school allowed their students to access SKO. At the High Use school, students were allowed to participate in a before-school program in the computer lab where they could access the online program. At the Low Use school, computer access (e.g., problems with the internet connection) and logistical problems limited the students' access to SKO to available time during the school day with no after school access. These issues led to the formation of two groups who accessed the game for different amounts of time. There is a substantial difference between the means and *SD*s of SKO use for the High Use and Low Use groups. In hours the means and *SDs* are 16.8 (6.7) and 5.7 (2.9), respectively, (effect size of 1.56).

Pre and post Oral Reading Fluency mean raw scores were computed and the differences between the means for the High and Low SKO Use groups were first examined by computing effect sizes. This statistic provided a value for the differences between the groups expressed in standard deviation units using the formula:

$$(X_1 - X_2) / SQRT [(\underline{n}_1 * \underline{SD}_1^2 + \underline{n}^2 * \underline{SD}_2^2)/(\underline{n}_1 + \underline{n}_2)].$$

The significance of the differences between the groups was examined with a 2 (High and Low use groups) x 2 (Oral Reading Fluency) Repeated Measures ANOVA. We also conducted an individual analysis of each student's scores at pre and post testing using ORF benchmarks scores of 89 and 109 for third graders at fall and spring. These scores are best considered rough estimates, like a grade equivalent, based on a sample of students that is inadequately described by the authors making comparison to the US population imprecise. We did, however, use these benchmark scores to assess whether the students meet the benchmark standards at pre and post test intervals. Additionally, we calculated the number of children in each group that met benchmarks pre and post intervention. Finally we created local norms based scores are Oral Reading Fluency standard scores using the mean and *SD* for all 66 subjects at pre-intervention. These values were set to have a mean of 100 and *SD* of 15 and were calculated using the formula ((Obtained Score - Pre-Intervention Mean)/Pre-Intervention *SD*) X 15 + 100) to allow for better understanding the amount of pre-post change between the two groups.

Results

Table 1 provides the means, *SD*s and effect sizes for the High and Low SKO use groups. The two samples were very similar at the time of pre-testing but not similar at post-testing. The pre-post effect size for the High SKO Use group was 1.16, which is about twice as large as the effect size of .57 for the Low SKO Use group. The post test means using locally normed values were 115.5 and 109.1 for the High and Low Use groups, respectively; which again suggested that the two groups benefited differently. Taking into consideration that benchmarks for the beginning and end of third grade are 89 and 109, respectively, the pre-test means of about 82 were somewhat below benchmark for both groups but the post-test means were above the benchmark of 109 for the High SKO use group only. The crudeness of these benchmark statistics limits an understanding of the extent to which these groups deviate from a national normative expectation. However, statistical testing showed that there was a significant interaction effect (Wilks' Lambda = .77, F (1, 64) = 19.11, $p < .001$) between pre and post scores for the two groups indicating that the High SKO Use group improved more than the Low SKO Use group.

Tables 2 and 3 provide a more in-depth analysis of the findings for each subject. Raw scores and standard scores for words per minute at per and post intervention stages are provided, whether each student met DIBELS benchmark status at pre and post, individual effect sizes, and total time spent in SKO are included. The Low SKO Use group showed a modest difference in the percentage of students who met benchmark at pre (45%) and post (55%) intervention stages. In contrast, 33% of the High SKO Use met benchmark at pre test while 67% met benchmark at post test. Thus, the percentage of students in the High Use group who met benchmark after intervention doubled. These differences in pre-post attainment of benchmark scores is also reflected in the individual effect sizes. Interestingly, of the 33 students in the High SKO Use group, two earned WPM standard scores less than 90 at pre and post test stages; indicating a resistance to this intervention and suggesting further examination of their particular academic needs might be warranted.

Discussion

The goal of this study was to examine the effect an online game based reading program had on Title I students' reading skills. The effectiveness of this interactive learning program was compared for third grade students who were defined as High or Low SKO users based on the number of hours spent in the game. The High SKO Use and Low SKO Use groups differed considerably on the number of hours online. DIBELS Oral Reading Fluency raw scores were nearly identical at pre-test but ANOVA results indicated that the High Use group improved significantly more than the Low Use group. Effect sizes for the High Use group were very large and about twice as big as the Low Use group. Although fewer of the High Use students met ORF benchmark at the pre-test phase, twice as many met the benchmark after exposure to SKO. This first empirical examination of SKO suggest that the program appears to be an effective method of improving DIBELS Oral Reading Fluency scores and, importantly, that the more children played the game the greater their improvement. These results should be considered tentative, however, given the limitations of this study.

This research, like most studies of instructional effect, has limitations that must be recognized. First, the sample sizes for the High and Low use groups were sufficient but modest. Second, the use of DIBELS Oral Reading Fluency raw scores and benchmarks do not provide an indication of how far each group's raw scores deviated from normal expectations. Additionally, because these benchmarks were computed on samples that are inadequately documented, it is impossible to determine how closely the values match those that would be obtained from a nationally representative sample of US children. The DIBELS benchmarks, therefore, should be considered gross estimates and, like grade equivalent scores, lacking in precision. For these reasons, the Oral Reading Fluency scores were only used for comparing change over time between the High and Low SKO Use groups; a purpose for which that test was developed. Third, the comparison group was a low use group rather than a no use group or a sample that was given a different type of online instruction. Despite these limitations, these results offer an encouraging view of SKO that suggests researchers should further examine this game based approach to reading development.

The current study suggests that additional research on SKO may prove fruitful especially because it improved the performance of Title I students who are, as research suggests, at greater risk for low academic achievement (Duncan, 1994; Ensminger, Lamkin, &Jacobson, 1996; Ainsworth, 2002; Woolley et. al, 2008). Future research studies should compare SKO with other online but non-game based learning programs to assess the value added by the gaming environment. SKO should also be compared to other supplementary reading instruction to assess the relative value of online versus traditional remedial efforts. Future studies should continue to study the SKO usage in Title 1 students and in other student populations as well. Researchers should also examine children's satisfaction with the game and any possible gender, race, Ethnic, or socioeconomic level differences in effectiveness. Importantly, future research should examine the relationship of SKO use with a wider range of reading skills especially reading comprehension as well as spelling and with nationally standardized and well normed instrumentation to avoid problems that occur when tests that are not adequately standardized and normed are used (see Naglieri & Chambers, 2008).

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Table 1.
Means, *SD*s, and Effect Sizes for Pre-Post DIBELS Oral Reading Fluency Raw Scores for High (n = 33) and Low (n = 33) Use Groups.

Group	Oral Reading Fluency				Effect Size
	Pre		Post		
	Mean	*SD*	Mean	*SD*	
Raw Scores					
High Use	81.94	29.75	116.15	29.28	1.16
Low Use	82.61	36.16	102.27	33.31	0.57
Local Norm					
High Use	99.85	13.58	115.47	13.37	-
Low Use	100.15	16.51	109.13	15.21	-

Table 2

Oral Reading Fluency Pre-Post Words per Minute, Standard Scores, Benchmark Status, Effect Size, and Total Time on Task For High SKO Use Sample.

	Words Per Minute - Raw Score		Words Per Minute - Local Norm		Benchmark Met			
ID	Pre	Post	ORF SS	ORF SS	Pre	Post	Effect Size	Total Time
1	53	111	88	104	No	Yes	1.1	1916
2	48	84	86	92	No	No	0.4	1802
3	80	112	99	104	No	Yes	0.3	1729
4	83	117	100	107	No	Yes	0.5	1723
5	96	133	106	114	Yes	Yes	0.5	1632
6	116	142	114	118	Yes	Yes	0.3	1387
7	132	161	120	126	Yes	Yes	0.4	1342
8	118	160	115	126	Yes	Yes	0.7	1155
9	103	168	108	130	Yes	Yes	1.5	1155
10	132	143	120	118	Yes	Yes	-0.1	1098
11	73	114	96	105	No	Yes	0.6	1092
12	91	128	103	112	Yes	Yes	0.6	1010
13	65	110	93	103	No	Yes	0.7	982
14	86	125	101	110	No	Yes	0.6	896
15	140	151	124	122	Yes	Yes	-0.1	871
16	90	110	103	103	Yes	Yes	0.0	870
17	78	120	98	108	No	Yes	0.7	851
18	77	104	98	101	No	No	0.2	829
19	85	105	101	101	No	No	0.0	814
20	127	155	118	124	Yes	Yes	0.4	810
21	80	100	99	99	No	No	0.0	796
22	80	103	99	100	No	No	0.1	780
23	108	119	111	108	Yes	Yes	-0.2	769
24	89	141	103	117	No	Yes	0.9	754
25	47	85	85	92	No	No	0.5	723
26	55	101	89	99	No	No	0.7	703
27	63	116	92	106	No	Yes	0.9	668
28	72	112	96	104	No	Yes	0.5	659
29	79	124	99	110	No	Yes	0.7	580
30	45	75	84	88	No	No	0.3	480
31	46	90	85	94	No	No	0.6	469
32	63	96	92	97	No	No	0.3	427
33	4	18	67	62	No	No	-0.3	316

Note: Words Per Minute Local Norm values are set at mean of 100 and *SD* of 15. Effect Size was computed using the formula (Post - Pre Words Per Minute Local Norm)/15.

Table 3.
Oral Reading Fluency Pre-Post Words per Minute, Standard Scores, Benchmark Status, Effect Size, and Total Time on Task For Low SKO Use Sample.

	Words Per Minute Raw Score		Words Per Minute Local Norm		Benchmark Met			
ID	Pre	Post	ORF SS	ORF SS	Pre	Post	Effect Size	Total Time
34	80	98	99	98	No	No	-0.1	977
35	162	158	133	125	Yes	Yes	-0.5	919
36	87	112	102	104	No	Yes	0.1	813
37	130	130	120	112	Yes	Yes	-0.5	810
38	127	139	118	117	Yes	Yes	-0.1	803
39	130	150	120	121	Yes	Yes	0.1	704
40	104	119	109	108	Yes	Yes	-0.1	692
41	106	134	110	114	Yes	Yes	0.3	640
42	133	131	121	113	Yes	Yes	-0.5	575
43	104	120	109	108	Yes	Yes	-0.1	551
44	90	92	103	95	Yes	No	-0.5	507
45	33	69	79	85	No	No	0.4	499
46	77	92	98	95	No	No	-0.2	462
47	110	132	111	113	Yes	Yes	0.1	458
48	95	115	105	106	Yes	Yes	0.1	438
49	74	111	96	104	No	Yes	0.5	397
50	39	83	82	91	No	No	0.6	395
51	75	122	97	109	No	Yes	0.8	348
52	105	128	109	112	Yes	Yes	0.2	344
53	84	80	101	90	No	No	-0.7	340
54	48	65	86	83	No	No	-0.2	329
55	38	54	81	78	No	No	-0.2	329
56	44	84	84	92	No	No	0.5	309
57	58	68	90	85	No	No	-0.3	281
58	91	123	103	109	Yes	Yes	0.4	259
59	77	97	98	98	No	No	0.0	256
60	92	110	104	103	Yes	Yes	-0.1	241
61	125	141	118	117	Yes	Yes	-0.1	194
62	38	64	81	83	No	No	0.1	188
63	49	69	86	85	No	No	-0.1	187
64	8	9	69	58	No	No	-0.7	146
65	27	55	77	79	No	No	0.1	56
66	86	121	101	108	No	Yes	0.5	10

Note: Words Per Minute Local Norm values are set at mean of 100 and *SD* of 15. Effect Size was computed using the formula (Post - Pre Words Per Minute Local Norm)/15.