



The Effect of Digital Teaching on Learning Gains: Evidence from a Quasi-Experimental Study at a private School in Abu Dhabi, UAE

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This study investigated the effect of using iPad on ICT learning gains and explored students' perception of iPad usage in the ICT teaching-learning process. The study employed a quasi-experimental method using pre-test and post-test design. The study sample (N= 84) were 10th grade students in a private school in Abu Dhabi. They were divided into a control group (n=42) who was taught traditionally via the didactic approach, and an experimental group (n=42) who was taught via iPad classroom model. SPSS was used to analyse the data collected from the ICT achievement-tests. The results showed that participants in both groups obtained similar mean scores in the pre-test at the beginning of the experiment. Meanwhile the results showed significant difference in the ICT achievement post-test between the experimental group and the control group with mean scores of 61.67 and 57.86 respectively. The attained "t" value of both groups' post-test score comparison was found to be significant at $p=0.011$ (< 0.05). Moreover, the effect size of the intervention was practically important, at Cohen's $d = 0.56$. Likert Scale Questionnaire was also conducted to see if participants had enjoyed the intervention experience. The findings of the study proved that using iPad in learning ICT has a definite positive effect on the learning gains of 10th grade students compared to the conventional method. The findings revealed that students have positive perceptions of using iPad in the classroom.

Keywords: ICT subject, iPad, learning gains, perceptions, quasi-experimental, teaching

INTRODUCTION

With the new technological advances, the use of technology has become an important tool in the classroom (Last, 2016) as it enhances and facilitates the learning process. Digital technology encourages students to learn more meaningfully, and prepares them for effective learning (Hlas et al., 2017). The use of digital technology in the classroom helps in eliminating traditional approaches such as rote learning which is fundamentally based on memorization and repetition. Thus, students used to rote learning may not understand the concept of meaningful learning. Magrabi et al. (2018) suggested that the

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instructor can enhance students' critical thinking skills by using instructional strategies that actively engage students in the learning process rather than relying on lecture and rote memorization. Magrabi, Pasha, & Pash (2018) suggested that the instructor "can enhance students' critical thinking skills by using instructional strategies that actively engage students in the learning process rather than relying on lecture and rote memorization, focusing instruction on the process of learning rather than solely on the content". Thus, focusing the instruction on the process of learning rather than on the content solely. So, students must be trained to undertake problem-solving projects, evaluate the appropriateness, accuracy, and usefulness of information from a variety of resources, develop inquiry strategies, think critically and constructively, develop and communicate results and solutions (Badran, 1999). Furthermore, Bradbury (2016) argued that the "traditional lecture has come under fire for its perceived lack of effectiveness".

Problem Statement

The proper use of technology is one of the most important means of development and it contributes to raising the rates of national economic growth. Unable to develop their technology, most developing countries, including the Arab world, have resorted to obtaining such technology from advanced industrial countries. With the advent of technology, huge progressive changes resulted in the Arab world economically, scientifically, and educationally, and technically. The teaching-learning process has developed vividly, and exciting inventions used by teachers and students alike, have been added to the learning resources. This enabled teacher to convey information interactively and entertainingly. In addition, technology has also enhanced the learner's capacities and aptitude (Alsalkhi, 2013).

The significant role education plays in building future generations makes the integration of digital technology and the latest educational inventions a necessity. As a result, various patterns and methods of teaching and learning have emerged. However, new problems appeared and addressing them is essential (Alsalkhi, 2013). Consequently, technology can become an integral part of the learning process and reshape teaching. Hence, numerous studies were conducted in the Arab world to examine the effect and mode technology is implemented and integrated into the teaching-learning process (Bingimlas, 2017). However, very limited studies have tackled the adoption and use of iPads in United Arab Emirates (UAE) schools. Accordingly, the present research seeks to bridge a gap in the literature by examining the impact of using digital teaching (iPads) on the learning gains and perceptions of grade 10 learners in ICT classes in the UAE.

Research Question

This study aims to answer the following research questions:

1. Is there any academic gain in integrating digital teaching in ICT class?
2.
 - a. Were there any differences in the participants' ICT achievement pre-test scores before digital teaching intervention?
 - b. Were there any differences in the participants' ICT achievement post-test scores after digital teaching intervention?

3. What is the students' perception of using digital teaching in learning ICT?

Literature Review

Since its introduction in 2010, the iPad has been used in many fields including education. Integrating the iPad in the teaching-learning process provides students with independent and interactive self-learning (Brand & Kanish, 2010). It also promotes favorable social behavior, such as sharing the device with others (Halabi, 2015). The iPad has fundamentally changed the mode of traditional education and blurred "the lines between assistive technology and instructional technology" (O'Malley et al., 2013).

Numerous iPad applications are designed especially for teaching and learning purposes, many of which are free. In addition, cooperation between educators and application developers helps create new innovative applications that best suit students' needs. According to Alsalkhi (2013), the iPad offers "learning opportunities for students by creating group activities and promoting work cooperation". iPad application can also help sharing ideas through creating an active and engaging online learning environment.

There are several advantages of using the iPad as a learning tool in education. It can improve students' academic achievement (Alsalkhi, 2013), creativity, and active learning. With iPads, students can perform their class activities and homework, find extra resources, and acquire immediate feedback, while teachers facilitate students' learning online.

The iPad enables students to learn at schools without being seated in front of a computer in a laboratory (Brand & Kinash, 2010). The iPad has most of the laptop or desktop computer competencies, yet with additional unique characteristics, such as a multi-touch screen and a variety of applications (Hutchison et al., 2012). Additionally, using iPads contributed to enhancing teaching via motivational entertainment activities through e-games and 3-D images (Alsalkhi, 2013).

Hutchison et al. (2012) indicated that digital interactive books, provided by iPad, are useful for literacy classrooms, where they interactively engage students in course content. In the same context, Brand and Kanish (2010) argued that the iPad allows students to cooperate interactively with their books, an important function that is typically absent in traditional teaching methods. As for cost, Miller (2012) found that e-books are less expensive than printed ones and are more interactive and accessible especially if they are installed and displayed on iPads.

In short, the iPad main advantages are that it provides students with quick and easy access to information and enhances collaboration. The exceptional popularity and swift adoption of the iPad have been astounding (Swicegood, 2015). iPads have become an integral part of learning in the average classroom and have helped assist some of the most challenged learners to read, talk, and connect (Halabi, 2015).

Previous Research

Using iPads in digital teaching learning environments has drawn researchers' attention. Some have conducted research to investigate the ways integrating iPad changes the

learning outcomes and attitudes. Most of the recent research discuss the importance and impact of using digital technology, including the iPad, on the learning process.

A current quasi-experimental design study by Aldossry (2020) aimed to explore the effects of using iPads on learning achievement of two 10th grade classes (A and B). At the beginning of the study, a pre-test was done, and the first post-test followed four weeks later, then the intervention was switched. At the end of the quasi-experimental period, the two groups had taken the second post-test. When the mean of 'within-group A', 'within group B', and 'group A and group B' are calculated and analysed, it was clear that using the iPad made a statistically significant and practical difference ($p < 0.05$) in participants' achievements compared to the conventional methods of teaching.

More studies such as Brand and Kinash (2010) aimed to compare two groups of students registered in the same course; the experimental group used iPads while the control group did not. The results indicated that the experimental group attained higher marks, their self-study period was twice that of the control group, and their understanding of the material was significantly better. Pilgrim et al. (2012) studied iPad applications and their impact on student's performance and learning. They found that iPad applications need to be further improved and developed to create a more effective instructional environment.

Sekiguchi (2013) examined the effect of integrating tablets on Japanese students' academic achievement in the English class, and their attitude towards learning English. The students were given iPads to use inside and outside school to support self-derived learning. The results showed a significant improvement in students' English language results after using the iPads. Similarly, Aronin and Kim (2013) conducted a study to examine how integrating iPads as a teaching tool in the learning environment affects students' learning of English. The results showed a positive impact, especially in the early stages.

In an experimental study, Kiger et al. (2012) explored the effect of using iPads on the learning achievement of 3rd grade students in learning mathematical multiplication. Two groups were examined for a period of nine weeks. The first group used the traditional way of learning multiplication, and the second group was given iPads to practice multiplication. The results showed that the students who used iPads achieved better learning outcomes.

Milman et al. (2012) examined the impact of using iPads on enhancing students' engagement, communication, and collaboration, and if it supports differentiated learning. They found that using iPads and allowing students to choose their activities, after being prepared by their teachers, enhances their creativity and engagement. Williamson-Leadley and Ingram (2013) examined the use of iPads among students in grades two to five in New Zealand. They found that students were more engaged and motivated when using iPad applications versus traditional worksheets.

Crichton et al. (2011) investigated the effect of iPads on students' motivation, interaction and attitude toward learning, and also on teachers' performance in K-12 schools. The results showed that using iPads encouraged students and teachers to find more applications that can be used to enhance the learning process. Rossing et al. (2012)

explored the effect of using iPads on the teaching-learning process. They found that iPads enhance active learning, increase students' perception, allows them to effectively share their findings, and easily receive their teachers' feedback. The results indicated that using iPads highly motivates students and improves collaborative learning.

Swicegood (2015) investigated the impact of using iPads on elementary students' mathematical skills and attitudes. The study reported that students generally enjoyed doing mathematics on the iPad and that their performance improved. Meanwhile, teachers indicated that iPads helped students to stay engaged in mathematics, spend more time doing tasks, and it also enabled more differentiated instruction. Glikzman (2011) examined the effect of using iPad applications on learning history, religious studies, and science among American high school students. The results showed that most of the participants found the iPad is easy to use, helpful in learning, and was preferred to the laptop.

In a study by Riconscente (2013), iPads were given to grade five students at two separate schools, to teach them the concepts of mathematical fractions. The study found that iPads helped students understand mathematical fractions and improved their attitudes toward mathematical concepts. Haydon et al. (2012) conducted a study of high school students' performance using iPad in learning math compared with learners using worksheets. They found that students who used iPads correctly solved a greater number of math problems in a shorter time, showed a higher level of class participation, and favored using iPads to worksheets.

Based on our wide-ranging literature review, it was found that the iPad has a positive impact on instruction, and it also supports mobile and blended learning. However, existing research on the topic was not able to provide solid evidence that can confirm that the iPad has a positive academic effect on learning gains. Therefore, this quasi-experimental research is designed to address this existing gap in the present literature.

Theoretical Framework

Methods of Teaching, Learning, and Assessment

According to Edgar Dale's Cone of Experience (Dale, 1969), people learn, retain, and remember 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say and write, and 90% of what they say as they do a thing as shown in Figure 1 below. Dale suggests that when choosing an instructional method, it is important to involve students in the process to maximize their information retention (Anderson, n.d). Further, the more sensory channels involved in interacting with a resource, the better the chance that numerous students can benefit and learn from it (Davis & Summers, 2015). Dale's Cone of Experience is a tool that can guide teachers to choose and use appropriate resources based on their students' learning experience to help boosting learning gains and maximize their information retention.

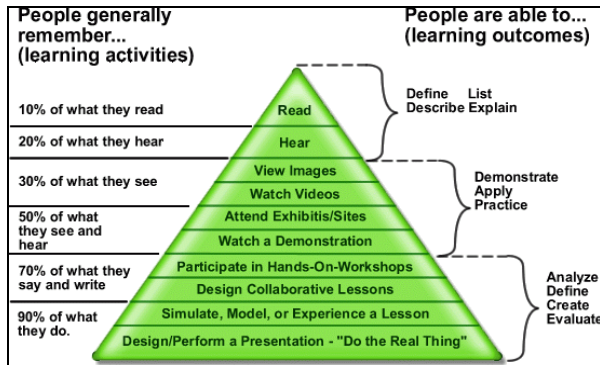


Figure 1
Edgar Dale’s Cone of Experience

Based on the above-mentioned facts, the following hypothesis was suggested.

H1: Digital teaching shows better learning gains than traditional teaching does.

H0: There is no statistical significance between the effect of digital and traditional teaching on learning gains.

METHOD

A pre-test/post-test design was adopted in this quasi-experimental study. The researchers examined participants’ ICT performance before (pre-test) and after (post-test) the iPad intervention. During the intervention, the experimental group participants (n=42) were taught ICT using the iPad, while the control group participants (n=42) were taught using the traditional teaching method. At the end of the intervention, participants of both groups were post-tested. The research design is illustrated and presented in Figure 2 below:

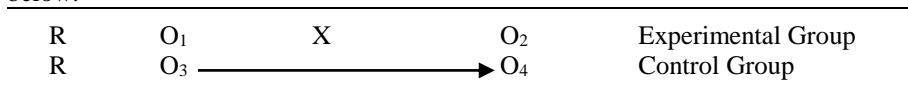


Figure 1
Illustration of the study’s pretest-posttest control group design where R = Random Assignment; X = Treatment (Digital Teaching); O₁ and O₃ = Pretest; and O₂ and O₄ = Posttest.

Additionally, the researchers used a 10-items questionnaire to assess participants’ perceptions of using the iPad after the experiment.

Study Setting and Sample

The study was conducted at Dhafra School, a private school in Abu Dhabi during the second semester of the academic year 2019/2020. The researchers used purposive sampling to select 84 students from grade ten who were attending ICT classes. The participants were divided equally into two groups, the control group (n=42), taught by the traditional teaching method, and the experimental group (n=42), taught by the iPad

intervention. The same teacher taught both groups using the same assigned curriculum for the ICT class, learning activities, and same assessment tools and techniques.

The Instrument

The main instrument used in this research is an ICT achievement test that was used before and after the iPad intervention to compare the ICT academic achievement level of the experimental group with the participants of the control group. The preparation of the test and questionnaire was based on the following factors:

- Thorough comprehension of curriculum material included in the textbook for the second term for the academic year 2019/2020.
- Using verbs aligned to Bloom's Taxonomy to create questions.
- Using a Table of Specifications (TOS) to ensure that the test measures the required content and skills.

Test Validity

The test was reviewed by a panel of five IT teachers and IT coordinators to measure its validity. After drafting the test according to the above-mentioned criteria, it was edited and modified several times until it was approved by all members of the panel. The panel confirmed that the test was well prepared and that it comprehensively covered the allocated curriculum material as per the assigned stated objectives.

Pre-Test and Post-Test

The test was given to all participants of both groups at the beginning of the study as a pre-test before the iPad intervention to affirm that the participants were at the same ICT academic level at the starting point of the study. The same test was given to all participants after the intervention as a post-test to check if there is any improvement in the participants' ICT attainment due of the iPad intervention. The test consisted of 30 items, one point was given for each correct answer.

Questionnaire

In order to examine students' perceptions of iPad usage in learning ICT, a questionnaire was used. It consisted of 10 statements using a three-point Likert scale measuring students' level of agreement. The questionnaire was written by the researchers and verified by a panel of professionals, and it was modified according to their comments and feedback. They confirmed that the questionnaire final version measured the students' perceptions. The questionnaire was sent to the experimental group participants (n=42) through EDMODO. The total number of respondents was 38, yet three students did not complete their questionnaires, and thus they were omitted. Consequently, a total of 35 valid questionnaires were analyzed to answer the second research question.

The Intervention Using iPad

The intervention lasted for four weeks during the second semester of academic year 2019/2020. The material, which was taught by the iPad, was prepared based on a chapter in the textbook on networks, flash drawings, and videos per the following steps:

- A good understanding of the content of the chapter on the network.
- Identifying and analyzing the objectives of learning outcomes.
- Choosing the study material content including core concepts and main points in texts that meet the objectives.
- Uploading copies of the content on the iPads, making sure the iPads are working properly.
- Making sure that each student understands and knows how to correctly use the iPads.
- At the end of each lesson, the students were asked to answer online evaluation questions, and were encouraged to ask questions relevant to the lesson.

FINDINGS AND DISCUSSION

Statistical Package for Social Sciences (SPSS) was used to perform statistical analysis of pre-test and post-test data as well as the questionnaire items to answer the research questions:

Is there any academic gain in integrating digital teaching in ICT class?

Were there any differences in the participants' ICT achievement pre-test scores before digital teaching intervention?

Were there any differences in the participants' ICT achievement post-test scores after digital teaching intervention?

What is the students' perception of using digital teaching in learning ICT?

Pre-test Analysis

To detect any significant difference between the control and experimental groups pre-test scores prior to intervention, independent sample T-test was used to compare the participants' level of academic performance before the intervention. The results are displayed in Table 1 below.

Table 1
Results of the independent T-test of pre-test scores

Test	Group	N	Mean	Std. Dev.	t	df	P-value
Pre-test	Control	42	58.10	7.40	0.45	82	0.651
	Experimental	42	57.38	7.01			

*Significance at 0.05

The results in Table 1 indicate that participant in both groups had similar mean scores in their pre-test (G1: 58.10, G2: 57.38). Moreover, the P-value was (0.651) for the ICT pre-test scores, which is greater than the significance level (0.05). Consequently, there was no difference in the participants' ICT level prior to the experimental intervention.

Post-test Analysis

To detect any significant difference between the two groups' post-test scores, an independent sample T-test was used. The results are displayed in Table 2.

Table 2
Results of the independent T-test of post-test scores

Test	Group	N	Mean	Std. Dev.	t	df	P-value
Post-test	Control	42	57.86	7.17	-2.602	82	0.011
	Experimental	42	61.67	6.21			

*Significance at 0.05

Table 2 presents the mean scores of ICT post-test, showing obvious difference in the mean scores of G1 and G2 participants (57.86 and 61.67 respectively) in favor of the experimental group. Moreover, the P-value is (0.011) for the ICT post-test scores, which is less than the significance level (0.05). Accordingly, the statistical analysis of post-test scores of the two groups showed that students in the experimental group significantly outperformed control group students in the ICT achievement post-tests.

Therefore, the first research question 'Is there any academic gain of integrating digital teaching in teaching ICT for 10th-grade students?' can be answered through the followings:

1- Effect of the Digital Teaching: Independent Samples T-Test Results

As indicated by the statistical analysis in Table 1 and 2, the control group started off with a score ($M = 58.10$, $SD = 7.40$) on the topic and ended up with the score of ($M = 57.86$, $SD = 7.17$). While the digital teaching intervention group was able to make a difference starting with ($M = 57.38$, $SD = 7.01$) and ended up with ($M = 61.67$, $SD = 6.21$). Accordingly, we can conclude that although the two-population means was identical before the intervention, the experimental group's performance improved over time and increased by 3.83, while the control group scores remained the same

2- Practical Importance and Magnitude of the Digital Teaching Effect

A successive effect size analysis of the groups' difference in gain scores produced a Cohen's $d = (61.67 - 57.86) / 6.707198 = 0.568046$, suggesting a good/ intermediate impact of the digital teaching intervention. A Cohen's d that is equal or bigger than 0.5 indicates that the difference between the two means is larger than half standard deviation. For the present study, the digital teaching had produced a mean difference of larger than 0.568 standard deviation between the treatment and control groups. What the result means is with a Cohen's d of 0.56, more than half of students in the digital teaching/experimental group were above the mean of the control group. (Cohen, 1988).

Consequently, it can be inferred from the results of this study that using the digital teaching (iPad) in teaching ICT subject for 10th-grade students definitely affect and improves their academic achievement. Accordingly, the study's hypothesis (Digital teaching shows better learning gains than traditional teaching does) was empirically supported.

The result of this study is aligned with several previous studies that examined the integration of iPad in the teaching-learning process and its impact on academic achievement (Alsalkhi, 2013; Aronin & Kim, 2013; Haydon et al., 2012; Kiger et al., 2012; Sekiguchi, 2013; Swicegood, 2015). These studies confirmed that using the iPad in teaching and learning can affect student's learning positively, through its ability to enhance their interaction with the subject and content.

Questionnaire Analysis

To measure the respondents' perceptions, the students were asked to answer a questionnaire after the intervention indicating their level of agreement to ten statements. Data collected were analyzed using descriptive statistics to answer the second research question 'What is the students' perception of using iPad in learning ICT?'. Results of the students' responses in percentage are shown in Table 3 demonstrating that majority of the students agreed to the questionnaire statements.

Table 3
Students' perceptions of iPad usage in learning ICT

#	Item	Agree %	Neutral %	Disagree %
1	My iPad helps me study more efficiently	81	12	7
2	My iPad gives me more opportunities to collaborate	88	7	5
3	My iPad helps me learn more creatively	88	7	5
4	My iPad helps make learning more fun	83	12	5
5	My iPad makes me more motivated to learn ICT	86	7	7
6	My iPad makes me better connected to others	81	12	7
7	My iPad extends my learning outside class	93	7	0
8	My iPad helps me communicate better with others	90	7	3
9	My iPad makes me more productive	83	12	5
10	My iPad is invaluable to my studies	86	12	3

The results indicated that majority of the participants responded positively to integrating iPad in teaching and learning ICT. This suggests that students were quite satisfied with their experience using the iPad in their learning process, and that they noticed an improvement in their academic achievement. Therefore, the results confirm that students' have positive perceptions of the iPad as a teaching tool. However, the researchers could not help noticing that very few of the students still prefer the traditional leaning techniques. Figure 3 below also displays the results in a graph.

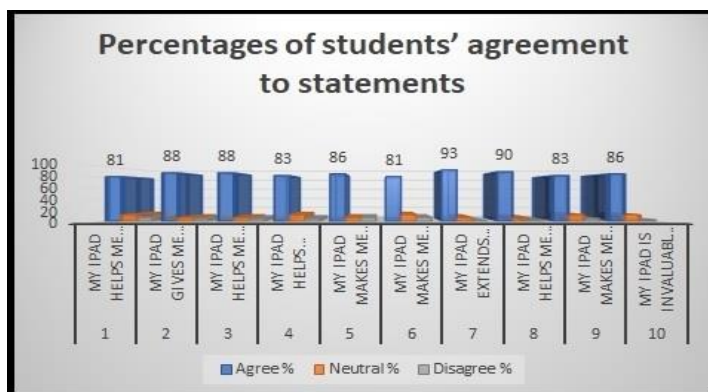


Figure 3
Percentages of students' agreement to iPad statements

CONCLUSION

Learning ICT via the digital teaching approach was an enjoyable and beneficial experience for the Grade 10 students involved in the study. The students were taught using didactic, teacher-centred methods for most of their schooling years. Thus, digital teaching was not an approach that they were acquainted with. In a typical, conventional system, most students would understand or perceive ICT class as being equivalent to listening to teacher talk and watching teacher explanation of important concepts and demonstrations of main tasks. In contrast with the digital approach, students are provided with a platform to activate their different levels of cognitive thinking ranging from memorization to creation. Thus, students feel more in control over their learning, which leads to relevant, interesting, useful, or meaningful experience to the learner. The use of the iPad led students to increasingly reduce dependency on the teacher, “an active rather than passive experience” (Geist, 2011, p. 766). Therefore, the result of this study showed a noticeable difference between the post-test mean scores of the participants who were exposed to the iPad intervention compared to those who did not. This generated result was further supported by the effect size of the gain. Cohen's *d* was more than half a standard deviation suggesting that the digital teaching was effective in improving students' learning of and performance in ICT.

Moreover, the findings revealed that the students had positive perceptions of using the iPad in their learning process, which was reflected in strongly agreeing to the statements of the questionnaire. Consequently, it can be interpreted that the iPad is generally a good tool to use in the teaching-learning process especially ICT subject. This study is like previous studies such as (Hariadi et al., 2022; Atwa et al., 2022) that significantly confirmed a definite positive effect of digital teaching on learning gains and in making the learning experience more appealing and better perceived by learners.

A final word would be to assure that schoolteachers should always search for new strategies and instructional methods to ensure high quality teaching and learning. They should, in fact, make themselves competent in the use of 21st century instructional approaches and strategies, such as digital teaching to increase students' thinking ability and their preparedness to enter the challenging world of the future. Thus, using the findings and recommendations of this study, conducting large-scale research could be more efficient.

LIMITATIONS

The limitations of this study are: (1) the participants were all from a single school in Abu Dhabi, (2) the sample was relatively small, and (3) the concerned subject was restricted to ICT only. Therefore, the generalizability of the results must be carefully taken into consideration.

The significance of this study lies in that the results would likely benefit the educators and researchers concerned with implementing the proper digital technology in education field in the UAE. The study provides evidence and more assurance that technology in general and iPad in particular supports and helps in teaching. Furthermore, adopting

usage of iPad in instruction by ICT teachers in all kinds of public or private schools would positively affect students' perceptions and hence their academic gains.

RECOMMENDATIONS

Finally, the researchers would like to recommend replicating this study to determine if this intervention would yield the same results in other settings and with similar population. Moreover, more studies are desired in different schools, with different educational levels, subject areas, and a larger group of participants. Furthermore, since learning opportunities typically occur over an extended period, studies about intervention with iPad instruction could be applied for a long time to trace changes in variables, mainly academic achievement.

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