Impacts of One-to-one Computing Initiatives in Japan

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AGBANAGLO Evelyn Mawufemor and ISHIZUKA Hiroki

Department of English Education, Asahikawa Campus, Hokkaido University of Education

日本の１人１人１台端末戦略の効果

アグバナグロ エヴェリン マウフェモア・石塚　博規

北海道教育大学旭川校英語教育研究室

ABSTRACT

Education is evolving into a technology-rich environment through one-to-one computing. There is a general belief that ubiquitous computing enables students to achieve higher academic success and increase their learning motivation. A number of studies have focused on one-to-one computing; however, very little research has clearly identified its impact on student academic achievement and motivation to learn. In light of insufficient research, this study investigates how one-to-one computing impacts students' academic achievement and learning motivation among Japanese students by analyzing data obtained from 102 elementary school students and 17 teachers. The results of the study showed that one-to-one computing had a positive impact on academic achievement and learning motivation among students. There were also several effective ways teachers engage students with these digital tools. The findings will provide educators with much insight into maximizing emerging technologies to benefit students.

Introduction

In recent years, researchers, curriculum developers, educational institutions, and governments have been concerned about using digital technologies to support and facilitate learning and teaching for improved academic achievement and learner motivation. Thus, a growing number of studies have been conducted in this area.

Pedagogy has taken a more advanced turn with the digitization of education. Therefore, new and varied digital technologies are created and adopted to provide dynamic and proactive teaching and learning environments.

According to Groff (2013), these new emerging technologies are provoking a reconceptualization of

teaching while also serving as catalysts for transformation and innovation.

With the integration of digital technologies in instruction, learners can enhance their critical and analytical thinking skills and acquire the multifaceted abilities required in the digital age. Harris and Al-Bataineh (2015) state that using technology allows teachers to truly differentiate and tailor instruction to meet the needs of their students.

Since the beginning of this century, one-to-one computing has become a mainstream practice in educational technology initiatives in most countries. The USA, Australia, Canada, Europe, and Japan have significantly invested in one-to-one computing programs to create technology-rich, innovative learning that ignites significant instructional efficiency. According to Constant (2011), school districts implement one-to-one computing because they are searching for more engaging tools to impact school success, such as grade achievement, college/career preparation, and 21st-century skills attainment.

Increasingly, one-to-one computing is gaining traction. One-to-one computing has proven to provide numerous benefits to teachers and students. Bebell and Kay (2010) state that one-to-one environments can increase student engagement and motivation (as cited in Reinhart et al., 2015). One-to-one computing allows teachers to better and more quickly differentiate, administer enrichment, and dive deeper into study topics (Harris & Al-Bataineh, 2015). They continue to establish that with more technology exposure for students and more teacher professional development, one-to-one technology may be the catalyst for school districts to help their students achieve academic excellence.

While there has been a growing interest in one-to-one computing, there has generally been a need for large-scale research and evaluation studies focusing on teaching and learning in these intensive computing environments (Penuel, 2006).

Although many usually believe that students would prefer using personal computers or laptops, the extent to which these new technologies promote student motivation in learning and academic output still needs to be thoroughly investigated.

The purpose of the present study is to identify the exact effect of one-to-one computing in improving students' motivation in learning and academic achievement in the classroom. Japan has just introduced one-to-one computing in all elementary and junior high schools, and it is now seeing changes in many aspects of students' learning innovations. This study should be helpful to legislators, curriculum developers, and educational stakeholders, most specifically to the Ministry of Education, Ghana, to adopt and adapt the Ministry of Education, Culture, Sports, Science and Technology (MEXT) blueprint on ICT in Education with a focus on the implementation of one-to-one computing.

Background

The Introduction of ICT to Ghana

Over the last few decades, the Ghanaian Government has implemented some educational policies, reforms, and programs that aim to improve education quality and integrate digital technologies into learning instructions for positive educational outcomes. In the Ghana ICT for Accelerated Development (ICT4AD) Policy (2003), Ghana set out to promote an improved educational system by deploying ICT tools to facilitate the delivery of educational services at all levels of the educational system. The ICT4AD explicitly outlined the plans and strategies in a framework of how ICTs can facilitate the national goal of "transforming Ghana into an information and knowledge-driven ICT literate nation" (Ministry of Education, Ghana, 2008, p. 10).

The Education Reform 2007 saw the integration of ICT in education to facilitate effective teaching, learning, and school management. This reform saw the provision of computer labs, internet, and network connectivity to schools, supply of laptops to teachers and students, and capacity development of education. Basic School Computerization Project in 2011 saw the introduction of computers and e-learning into the entire education level for life-long learning. According to Fourth Estate (2022), the Ghana government has completed the free Wi-Fi project in 663 senior high, technical, and vocational schools and 13 public tertiary institutions. As part of the government effort to provide adequate digital learning resources, the "one teacher, one laptop" initiative in 2021 saw a distribution of 80% of laptops to teachers in senior high schools across Ghana (Ghana Education Service, 2021). Shortly, Ghana is looking forward to supplying all students with personal computers in line with the revised policy document (National ICT4AD) in 2009.

Studies on One-to-one Computing

Literature has been extensively devoted to one-to-one computing for the past few years. Richardson et al. (2013) define one-to-one computing as a learning environment in which each student has a computing device that is more powerful than a smartphone, whether a laptop, netbook, or tablet computer, and has access to that device both in and out of school, including evenings and weekends. Penuel (2006) views one-to-one computing as providing students with a portable laptop with internet access and productivity software that they can use for academic purposes.

Recently, one-to-one computing has emerged as a technology-rich educational reform where technology is not shared but where teachers and students have ubiquitous access to laptop computers (Bebell & O'Dwyer, 2010).

The growing body of research relating to one-to-one computing addresses the technology's availability and the program's sustainability. However, fewer studies focus on the impact of one-to-one computing on students' academic achievements and learning motivation. Due to the constant presence of digital devices, students today are perceived to be motivated by technology.

Impact on Students'Academic Achievement

Research on the impact of one-to-one computing on students' academic achievement in K-12 schools across the United States of America and Australia has indicated significant positive outcomes.

A comprehensive meta-analysis of one-to-one computing's effects on academic achievement conducted by Zheng et al. (2016) found significant positive effects in English, writing, mathematics, and science (p. 12).

Harris and Al-Bataineh (2015) conducted a research study on how one-to-one computing affects student academic achievement and motivation in the classroom; the study involved one-to-one implementation classrooms and the traditional classroom. The result indicated that the one-to-one implementation classroom scored significantly higher, 82.58% vs. 65.87%, on the Topic Test than the traditional classroom. They concluded that these scores could result from the newness of the laptops, the excitement of the students participating, and the ability to differentiate better using laptop computers.

In another study, Bebell (2005) recorded that the Hampshire one-to-one laptop program data significantly impacted students' academic performance and better learning retention.

In addition to Sauers and McLeod (2012) and Zheng et al. (2016), many more studies have indicated that these initiatives improved writing, science, and math performance, literacy, and higher-order thinking scores (cited in Cole Jr., 2017, p. 12).

Gulek and Demirtas (2005) examined the effects of one-to-one laptop use on students' overall Grade Point Averages (GPAs). They reported that students who participated in the laptop program earned significantly higher test scores and grades for writing, English-language arts, mathematics, and overall Grade Point Averages (GPAs) than the non-one-to-one computing schools.

Despite the significant improvements in students' academic achievement reported in the previous research papers cited above, the studies conducted by Hu (2007) and Superville (2016) found that several United States school systems that adopted one-to-one computing programs are now discontinuing them. The reason for this is the disconnection between academics and technology, causing educational results to fall short (cited in Cole,Jr., 2017, p. 1).

Student Engagement and Learning Motivation

Technology can potentially increase student learning motivation. One-to-one computing has allowed teachers to utilize various innovative strategies to achieve their instructional goals.

A study by Bebell and Kay (2010) investigated how successful one-to-one computing was in the 3-year Berkshire Wireless Learning Initiative program. The researchers utilized a quantitative approach to analyze the impact of one-to-one computing on students' achievement, engagement, students' capacity to conduct independent research, and peer collaboration. This study consisted of five western Massachusetts middle schools. The survey and interview results showed that most students were more engaged and motivated when provided the opportunity to use technology in their classes. Also, teachers overwhelmingly reported improvements in student engagement and motivation.

Gulek and Demitras (2005) reported that students in the one-to-one technology school were even inclined to miss recess to work on their projects and material in the classroom (p. 582). The students' attitude demonstrated their drive to learn and to go the extra mile to complete their tasks.

Lei and Zhao (2008) investigated students' use of one-to-one computing and their impact on student learning and school culture. The data analysis and results indicated that students' laptop use was imaginative, creative, and diverse. They also found that students used digital tools to solve daily problems such as doing homework, searching for information on school work, developing personal interests, and exploring.

One-to-one computing has not only increased students' learning motivation but has also reduced discipline issues and their attitude toward learning. A study by Owusu-Ansah (2015) assessed the impact of the pilot "One Laptop Per Child Policy; (OLPC)" on teaching and learning in basic schools in Ghana. The interview conducted among the IT teachers revealed that most students are now far better at using ICT-related tools since the implementation of OLPC. The study also reported positive changes such as increased school enrollment, decreased absenteeism, increased discipline, and more classroom participation.

Purpose of the Study

As has been examined, there are few studies trying to clarify the evidence showing how one-to-one computing affects students' academic achievement and sustains their motivation to learn despite the fast-growing use and global implementation. However, the results of these previous studies are still mixed. Therefore, further research with a more focused investigation is necessary to gain more reliable data. Japan is one of the countries that started one-to-one computing a year and a half ago in all schools. As a result, exploring the impact of one-to-one computing on students' academic performance and learning

motivation in Japanese schools is relevant to gaining more accurate information.

Hence the present study addresses the following research questions:

RQ1: To what extent is one-to-one computing effective in attaining higher students' academic achievements?

RQ2: How does one-to-one computing impact students' learning motivation and attitude in and out of the classroom?

Methods

To answer the previously mentioned research questions, two sets of Google Forms questionnaire surveys for teachers and students at an attached school to a University in a city in the northern part of Japan. Teachers and students in this school started using Google Chromebook for one-to-one computing one and a half years ago.

Participants

The participants in this study were 102 Grade 5 and 6 elementary students in an attached school to a university in a medium-sized city in Hokkaido, Japan. Thirty-nine were 6th graders, and sixty-three were 5th graders. There were also 17 teachers participating from the same school.

Materials

Questionnaire for Students

The questionnaire was prepared to examine the impact of one-to-one computing on students' academic achievement and learning motivation. The students answered 30 questions. Item 30 required them to review some educational tools and software they often use in class and at home. Question items 11, 13, 19, and 20 were taken from Bebell and Kay (2010). The authors created the remaining question items in the questionnaire. Part 1 of the students' questionnaire comprised ten items that focused on demographic information such as gender, grade, and general experiences in using laptops.

Items in Part 2 explored one-to-one computing and how it affects students' academic performance and motivation. This part of the survey examined how one-to-one computing impacts 11) teaching, 12) learning, 13) tasks and assignment completion, 14) listening and writing skills, 15) lesson comprehension, 16) access to learning materials, 17) group assignment, 18) student-teacher interaction, 19) student-student interaction, 20) class presentations, 21) saving and revision of learning materials 22) classroom attention, 23) self-paced study, 24) access to relevant information, 25) active participation, 26) engaging learning, 27) learning fatigue 28) learning anxiety, 29) concentration difficulty. Participants answered Part 2 using a five-point Likert scale of 1 = Strongly Disagree to 5 = Strongly Agree.

Questionnaire for Teachers

The questionnaire was prepared to investigate teachers' assessment of one-to-one computing and student engagement. There were 37 questions in total. The questionnaire used in this study included question items extracted from the previous study by Bebell and Kay (2010). They were question items 15, 17, 19, 22, and 30. The authors created the remaining question items in the questionnaire. The question items are in two parts, Part 1 and Part 2.

The first part of the survey included ten questions about the teachers' demographic information, such as their gender, years of experience teaching, grade(s), subjects they taught, and their experience with

one-to-one computing.

Part 2 examined how teachers engaged students in and out of the classroom and teacher beliefs on the impact of one-to-one computing on teaching and learning. This part asked whether one-to-one computing impacts: 11) educational outcomes and productivity, 12) technical skills, 13) interactive classroom, 14) access to teaching materials and visual aids, 15) organized lesson planning, 16) classroom activities to meet students' needs 17) test, quizzes, and assignments, 18) easy distribution of class materials, 19) access to information, 20) communication between teachers, administration, and parents, 21) tracking student's progress, 22) keeping students' records, 23) learner-centered instruction, 24) learning motivation 25) student's independence 26) student's quality of work 27) students' attendance, 28) teacher-student interaction, 29) classroom engagement, 30) students' comprehension, 31) peer evaluation/feedback, 32) students' grades, 33) classroom management, 34) monitoring and supervision, 35) students' attention, 36) student-student interaction. The participants used a five-point Likert scale to answer the questions in Part 2, from 1= Strongly Disagree to 5= Strongly Agree. However, item 37 demands the teacher list some educational tools and software he or she often used in class.

Procedures

The participants received Google Forms questionnaires. There was a two-week deadline for responses from the participants. All the data collected from the participants were used in the analysis.

Data Treatment

Responses to the questionnaire by students and teachers were statistically analyzed. The mean and standard deviation for all responses were calculated. The percentages of question items 7, 8, and 10 of Part 1 of the students' questionnaire and question item 7 of Part 1 of the teachers' questionnaire were calculated to obtain a more exact number distribution of the data. The means from the teachers' data were divided into two groups; thus, 4.00 and above were regarded as high, and less than 4.00 was above average.

Results

Part 1 of the Questionnaire

Table 1 presents the precise distribution of students' responses to items in Part 1 of the questionnaire. The responses to item 7 indicate students' positive perception of learning with personal laptops. The result of question item 8 indicates that 83 out of 102 participants agree with using the laptops in every lesson. As for the parents' role in using a laptop at home, more than half of the respondents agree that their parents watch what they do or study online. Meanwhile, 33.3% of students assert not being monitored by their parents.

Table 1 *Frequency and Percentages (%) of Items 7, 8, and 10 of the Students Questionnaire*

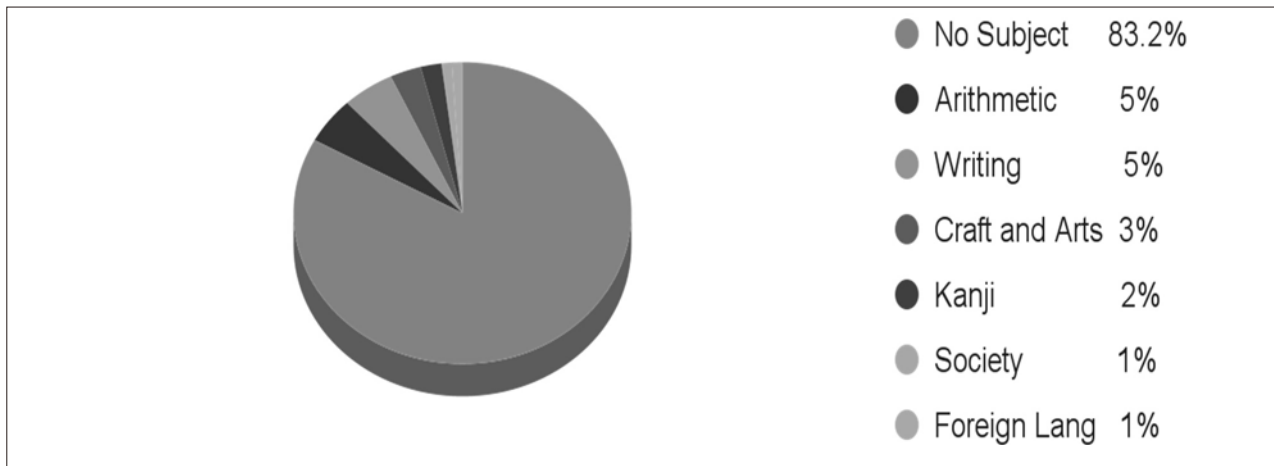| | Frequency of Responses | | | |
| | Yes | | No | |
Item	n	%	n	%
7. Do you always enjoy studying on a laptop?	93	91.2	9	8.8
8. Do you use the laptop in every lesson?	83	81.4	19	18.6
10. Do your parents/guardians keep an eye on you when using your laptop at home?	68	66.7	34	33.3

Table 2 reveals teachers' actual use of technology in every lesson delivery. From the statistics in the table, almost all the teachers strongly agree they conduct every lesson with one-to-one computing.

Figure 1 displays the distribution of students' responses to item 9, which identifies subjects or contents they believe is difficult to study using a laptop. 83.2% of the participants felt that all school subjects could be studied using laptops; however, a few percent of some participants thought otherwise in subjects such as Arithmetic, Kanji, Writing, Society, Foreign Language, Craft and Arts.

Table 2 *Frequency and Percentage Distribution of Item No.7 of Teachers Questionnaire*

| | Frequency of Responses | | | |
| | Yes | | No | |
Item	*n*	*%*	*n*	*%*
7. Do you use one-to-one computing to teach all subjects and topics?	16	94.1	1	5.9

- No Subject   83.2%
- Arithmetic   5%
- Writing   5%
- Craft and Arts   3%
- Kanji   2%
- Society   1%
- Foreign Lang   1%

Figure 1 *Difficult Areas to Use the Laptop*

Part 2 of the Questionnaire

The questions in Part 2 of the teacher and student questionnaire were to collect data on using one-to-one technology in the classroom for higher academic achievement and learning motivation.

Table 3 displays the results of students' responses. Items with high mean relate to students' access to diverse innovative resources *(Q16.Using a laptop, I can easily access documents and audio materials necessary for studying.),* creativity *(Q20.Using the laptop helps me to create beautiful and exciting content for class presentations.),* record-keeping *(Q21.By using the laptop, I can easily record everything, such as the assignments in class and what I have been taught, and revise them.)* and, anxiety *(Q28.Using a laptop makes me more nervous during class.*

Table 4 and Figure 2 display the results of teachers' responses on how they engage students in and out of the classroom with one-to-one computing and their view of the initiative. Nine question items out of 26 recorded a high mean of 4.00 and above. These items 11, 12, 13, 14, 18, 22, 24, 25, and 26 pertain to productivity, technical skills, access to diverse resources, teaching materials creation, record keeping, motivation, learner autonomy, and quality of work.

Table 3 *Mean (M) and Standard Deviation (SD) of Students' Laptop Use in Learning*

ITEMS	M	SD
11. My teacher teaches better with a laptop.	3.50	0.82
12. My laptop helps me to study better	3.88	0.82
13. The laptop makes it easier and faster to complete assignments.	3.95	0.88
14. Using a laptop, I have more opportunities to practice listening and writing	3.10	1.86
15. My laptop helps me understand the teacher's teaching better	3.75	0.91
16. Using a laptop, I can easily access documents and audio materials necessary for studying	4.19	0.81
17. By using a laptop, I am able to improve my group assignments and work not only during class but also after school	4.08	0.78
18. Using my laptop, I can share my learning difficulties with my teacher	3.71	0.93
19. My laptop allows me to interact with my colleagues better when I study	3.76	0.99
20. Using the laptop helps me to create beautiful and exciting content for class presentation.	4.02	0.81
21. By using the laptop, I can easily record everything, such as the assignments in class and what I have been taught, and revise them.	4.16	0.77
22. By using a laptop computer, I can concentrate on my work and assignments in class and work even harder	3.86	0.90
23. Using a laptop allows me to study at my own pace.	3.96	0.94
24. With my laptop, I can quickly get information about a topic online	4.04	0.88
25. My laptop allows me to participate in class activities with ease	3.89	0.91
26. Using a laptop makes learning exciting and fun	3.95	0.87
27. Using a laptop makes me feel tired during class.	3.41	1.08
28. Using a laptop makes me more nervous during class	4.41	0.75
29. I cannot concentrate in class when I am on my laptop	4.11	0.80
30. Check the apps you use in class or at home		

Table 4 *Mean (M) and Standard Deviation (SD) of Teachers' Use of Technology and the Impact of One-to-one Computing on Teaching and Learning*

ITEMS	M	SD
11. One-to-one computing positively impacts education and learning outcomes and productivity	4.24	1.10
12. One-to-one computing improved my computer skills.	4.12	1.32
13. One-to-one computing made classes more interactive.	4.00	1.12
14. Using a laptop, I can access many teaching materials and visual aids to animate my classes.	4.18	1.13
15. Creating a lesson plan is easy and more systematized due to one-to-one computing.	3.76	1.10
16. I create the latest teaching materials and activities to meet individual students' needs in one-to-one computing.	3.88	0.99
17. One-to-one computing system allows me to give each student tests, quizzes, and assignments.	3.29	1.11
18. One-to-one computing allows me to share class notes and teaching materials quickly and easily with fewer resources and less stress.	4.35	1.00
19. With one-to-one computing, I get appropriate information about the course content from various sources.	3.76	1.30
20. One-to-one computing enables accessible communication, sharing and cooperation with teachers, administrators, and parents.	3.76	1.03
21. One-to-one computing makes it easy to keep in touch with students and follow up outside class.	3.35	1.12
22. One-to-one computing allows easy storage, storage, and access to students' records.	4.18	1.02
23. One-to-one computing makes teaching and learning more learner-centered	3.88	1.27
24. One-to-one computing increases students' motivation to learn.	4.12	1.05

|		
25. One-to-one computing has improved students' ability to work independently.	4.18	1.02
26. One-to-one computing has improved the quality of students' work at school.	4.00	1.06
27. Students' attendance rate has increased since the introduction of one-to-one computing.	3.76	1.15
28. One-to-one computing has further deepened communication between students and teachers.	3.35	1.06
29. One-to-one computing allows various teaching/learning activities to engage students fully.	3.53	1.18
30. One-to-one computing helps students understand the subject content of lessons better.	3.59	1.06
31. One-to-one computing allows students to evaluate each other's assignments and projects.	3.94	1.14
32. Students produce better results and write better sentences in one-to-one computing classrooms.	3.41	0.12
33. One-to-one computing makes classroom management easy.	3.29	0.85
34. Monitoring and supervising students in a one-to-one computing classroom is tiring.	3.71	0.77
35. Students are easily distracted in class when using personal laptops.	3.18	0.88
36. Students interact more with each other when they work with their laptops.	3.35	0.86
37. List 3-5 digital devices and software applications you often use in class		
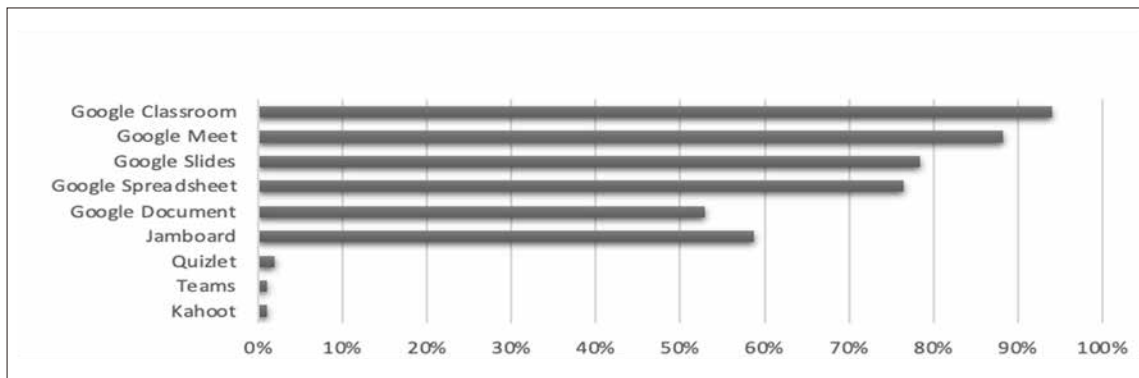
Figure 2 *Educational Software Applications Used by Students*

Discussion

To what extent is one-to-one computing effective in attaining higher students' academic achievements?

Academic Performance

This study revealed significant impacts of one-to-one computing on students' academic performance. From the data collected, the above-average score of 3.95 to question No.13 *(The laptop makes it easier and faster to complete assignments.)* and a mean of 3.88 for question No.12 (I study better with my laptop.) makes it evident that a technology-rich environment improves students' academic performance. The tools and functions of the laptop make it easier for students to work faster, organize and edit their work.

Consequently, teachers are very positive about the impact on learning outcomes. Teachers agreed with this assertion in question No.11 *(One-to-one computing positively impacts education and learning outcomes and productivity.)* with a high mean of 4.24 (Table 4). The teachers' positive responses indicate an improvement in students' academic performance. This is validated by Harris and Al-Bataineh (2015) as they noted in their study that with more technology exposure for students and more training for teachers to refine their teaching methods, one-to-one computing might help school districts improve student achievement.

Availability to Subjects

The analyses also revealed that 83.2% of students, as shown in Figure 1, strongly believed that laptops or personal computers are suitable for learning all subjects. This is in response to item 9 *(Are there any subject or lesson contents that are difficult to study using a laptop computer?)*. Consequently, many teachers confirmed this statement in item 7 *(Do you use one-to-one computing to teach all subjects and topics?)* with an affirmative response of 94.1% (Table 2). These results explain that nearly all subjects and content can be taught and learned using digital tools.

Quality of Work

Moreover, students' creativity and quality of work have been associated with using a personal laptop. The mean score of 4.02 in students' response to item 20 *(Using the laptop helps me to create beautiful and exciting content for class presentations)* made it clear that the device offers students the opportunity to explore and develop their ideas and skills. Teachers have also affirmed that one-to-one computing has improved the quality of students' work with a high mean of 4.00 as revealed in Table 4 *(Q26. One-to-one computing has improved the quality of students' work at school).*

Learning Autonomy

According to most students, this learning environment allows them to study at their own pace. It may be obvious that students take up guided exercises and tutorials to practice taught lessons or new concepts at their own pace. This is evident in item 23 *(Using a laptop allows me to learn at my own pace.)* with an above-average mean of 3.96. This result affirmed what Collentine (2011) pointed out in her work that computer-mediated learning can help students self-direct and prioritize their learning and, to an extent, promote autonomous learning. (p. 51). Teachers believed that one-to-one computing had improved students' ability to work independently with a high mean of 4.18; Item 25 in Table 4.

Teacher Efficiency

Effective technology use by teachers significantly improves students' academic performance. As illustrated in the result of Table 4, one-to-one computing has substantially improved teachers' technical skills *(Q12. "One-to-one computing improved my computer skills.")* with a mean of 4.12, easy access to relevant information, materials *(Q14. "I can access many teaching materials and visual aids to animate my classes.")*– 4.18, and class engagement (Q13. "One-to-one computing made classes more interactive.") with a mean of 4.00. Students agree that they have a better understanding of what their teachers teach. There is a fairly strong consensus among students that their teacher teaches better with a laptop (*Q11.* "My teacher teaches better with a laptop.") with a mean of 3.5.

Item 18 *(One-to-one computing allows me to share class notes and teaching materials quickly and easily with fewer resources and less stress.)* garnered the highest mean of 4.35 among the questions regarding the use of the devices for interactivity in the instructional process.

Based on the findings of this study, it is evident that teachers' technical skills are significantly related to students' academic achievement and motivation to learn. As Zuber and Anderson (2013) point out that the success of adopting one-to-one computing depends on teacher confidence, knowledge about and how to use technology, and teacher beliefs about the value and applicability of technology to classroom teaching (as cited in Schwartz and Szabo 2018).

Family Contribution

Another contributing factor to students' better academic performance is the role of the parent. 66.7% of students strongly agree that their parents monitor the use of the laptop at home (Table 1). In order to ensure positive learning outcomes, parents must take an active role in monitoring their children's activities online. This support from parents and guardians can help guarantee students' safety and privacy online.

From the different constitute factors established, it is assumed that one-to-one computing positively impacts students' academic achievements.

How does one-to-one computing impact students' learning motivation and attitude in and out of the classroom?

Fun Learning

According to the results of this study, one-to-one computing profoundly impacts student motivation and attitude in and out of the classroom. It can be seen from the mean score of 3.95 in Question 26 *(Using a laptop makes learning interesting and fun.)* that students agreed that studying with a laptop makes learning interesting and fun. As such, most of the teachers unanimously acknowledged that one-to-one computing increases student motivation to learn in question 24 *(One-to-one computing increases students' motivation to learn.)* with a mean of 4.12. This result explained the strong positive response of 91.2% to item 7 *(Do you always enjoy studying on a laptop?)*. The reason may be that students can explore the multiple applications and functions available on the device, making learning enjoyable.

Communication and Collaboration

It is also intriguing to note that one-to-one computing provides more quality teacher-student and student-student environment that positively facilitates learning in and out of the classroom. As such, many students can share their learning difficulties with their teachers for additional assistance and support. The mean score of 3.71 for item 18 *(Using my laptop, I can share my learning difficulties with my teachers.)* supports this claim. Students' response to item 17 *(By using a laptop, I am able to improve my group assignments and work not only during class but also after school.)* with a mean of 4.08 confirm the evidence that one-to-one computing has improved collaboration and teamwork among students. Students also reported fairly improved classroom networking in item 19 *(My laptop allows me to interact with my colleagues better when I study)*, with a mean of 3.76. A further interesting point to note is that teachers have observed an improvement in collaborative efforts among students: item 31 *(One-to-one computing allows students to evaluate each other's assignments and projects.)* with a mean of 3.95 (Table 4).

Technology Anxiety

Responding to the students' reversed item No.28 *(Using a laptop makes me more nervous during class.)* with the highest mean of 4.41, the students strongly agree that they feel comfortable and relaxed in one-to-one computing. This might be related to the fact that students are conversant with laptop use. They actively participate and respond to questions, form an opinion, and submit answers individually without worrying about how their peers might perceive their answers, even if it is incorrect. Using technology in the classroom requires teachers to maintain an open, empathic relationship with students about how they should complete their tasks. Bhuttah et al. (2021) somehow validated this by noting in their study that

technology significantly mediates the relationship between anxiety and engagement.

Classroom Management

The above-average score of 3.29 for items in *33 ("One-to-one computing makes classroom management easy")* in Table 4 shows teachers' partial positivity of one-to-one computing in classroom management. Even though there may be effective classroom engagement, teachers have more responsibility for ensuring students remain on task and safe online.

Attendance

Regarding student attendance due to one-to-one computing, teachers' item No.27 *(Students' attendance rate has increased since one-to-one computing was introduced)*, which amasses an average mean of 3.76 (Table 4), suggests a possible confirmation. One possible explanation is that using personal laptops and the advent of technology may significantly affect students' attendance.

Use of Application Software for Learning

The impact of educational application software on students' motivation is far-reaching. This study revealed some interesting applications such G-Suit tools, Teams, Koma Koma, and Kahoot (Figure 2) that students and teachers use to facilitate teaching and learning. The possible implication is that these applications boost students' learning experience by providing smart, clear, and consistent content in a visually appealing manner. It allows them to grasp complex concepts at a faster pace. These applications not only increase their motivation to study but also promote active learning, distance learning, creativity, and student engagement. Through the use of these applications, teachers affirmed that they incorporate different learning styles to meet the student's individual learning needs in item 16. (*I create the latest teaching materials and activities to meet individual student's needs in one-to-one computing.*) with a mean of 3.88.

Based on the multiple component factors discussed above, one-to-one computing has been shown to have a positive influence on students' learning motivation.

Conclusion

The results of the present study suggest that one-to-one computing can positively impact students' academic achievement and learning motivation. It is also important to acknowledge that educators' expertise with instructional technology can play a pivotal role in students' academic accomplishment in one-to-one computing.

The government of Ghana's international relations and partnerships with international organizations such as the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Japan, United Nations Education, and Scientific and Cultural Organization are striving to improve educational standards so that individuals can be empowered for human and national development. Several initiatives have been made to improve the use of digital educational tools in Ghana's teaching and learning process. However, research on education effectiveness provides insight into factors affecting this achievement. The findings in this study demonstrate the vast disparities in ICT for education and teacher technical skills in Ghana and Japan. Therefore, it is recommended that policymakers, curriculum developers, researchers, stakeholders and educators must reevaluate the ICT4AD policy, and do broader consultations on the

implementation of one-to-one computing.

The colleges of education must integrate comprehensive educational technology courses in their curriculum to adequately train teachers on using digital educational tools in teaching. Government must ensure quality internet access and a steady power supply and provide ICT facilities to all students.

Teachers should always keep fit by attending all professional conferences, seminars, workshops, and exhibitions on digital pedagogy in their respective fields.

Limitations and Need for Further Research

The limitation of this study includes the fact that the study only focused on Grades 5 and 6 pupils, making it hard to generalize outcomes across other Grade levels and other instructional contents. Moreover, we did not administer tests to evaluate students' academic achievement.

For further similar studies, interviews, tests, and observation may be employed to provide broader data to enhance the in-depth credibility of results findings.

The benefits of integrating digital tools in today's classroom, specifically one-to-one computing initiatives, are on the rise, yet conclusive studies remain inadequate. Therefore, further research on the impacts of one-to-one computing on the higher performance of students needs to go on unabated. The findings may help schools and educators better understand and adapt the factors that increase students' academic achievement.

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Appendixes

Appendix A Questionnaire for Students

This questionnaire asks about the relationship between using a personal computer and learning and outcomes.

Part 1, select and check the answer that closely matches your answer. For questions where you write your answers, write them freely. In Part 2, answer whether you agree with what is written or disagree, choosing from 1 (strongly disagree) to 5 (strongly agree).

    Part 1

1. Grade

2. Do you have a personal laptop computer (Chromebook or iPad)?

3. Ask those who answered yes to the above question.

4. Does the school give the personal laptop?

5. How long have you been using a laptop in class?

6. Do you take your laptop home after school?

7. Do you always enjoy studying on a laptop?

8. Do you use the laptop in every lesson?

9. Are there any subjects or lesson contents that are difficult to study using a laptop computer?

a. If you answered yes to question 8 above, what subject or content will you identify?

10. Do your parents/guardians keep an eye on you when using your laptop at home?

    Part 2

11. My teacher teaches better with a laptop.

12. My laptop helps me study better.

13. The laptop makes it easier and faster to complete assignments.

14. Using a laptop, I have more opportunities to practice listening and writing.

15. My laptop helps me understand the teacher's teaching better.

16. Using a laptop, I can easily access documents and audio materials necessary for studying.

17. Using a laptop, I improve upon my group assignments and work not only during class but also, after school.

18. Using my laptop, I can share my learning difficulties with my teacher.

19. My laptop allows me to interact with my colleagues better when I study.

20. Using the laptop helps me to create beautiful and exciting content for class presentations.

21. Using the laptop, I can easily record everything, such as the assignments in class and what I have been taught, and revise them.

22. Using a laptop allows me to concentrate on my work and assignments in class and work even harder.

23. Using a laptop allows me to study at my own pace.

24. With my laptop, I can quickly get information about a topic online.

25. My laptop allows me to participate in class activities with ease.

26. Using a laptop makes learning exciting and fun.

27. Using a laptop makes me feel tired during class.

28. Using a laptop makes me more nervous during class.

29. I cannot concentrate in class when I am on my laptop.

30. Check the apps you use in class or at home.

Appendix B Questionnaire for Teachers

The items seek to ascertain teachers' attitudes toward one-to-one computing and its impact on teaching, learning, and student academic achievement.

In Part 1, check the option that best describes your answer. Mark only one option for each question, and answer all the items.

In Part 2, indicate your agreement or disagreement with the following statements by choosing your response using the scale provided.

    Part 1

1. Gender.

2. How many years have you been teaching?

3. Grade in charge (Answer 1, 3, etc.)

4. What subject do you teach?

5. How long have you been teaching using one device per student?

6. Do you teach using a device for each student in all subjects? 7) Do you use the laptop in every lesson?

7. Do you use one-to-one computing to teach all subjects and topics?

8. Do you use one-to-one computing in all classes?

9. If you answered "No" to (7) and (8), please tell us by percentage (100%) of classes in which you use one-to-one computing.

10. How many students are there in a class?

   Part 2

11. One-to-one computing positively impacts educational and learning outcomes and productivity.

12. One-to-one computing improved my computer skills.

13. One-to-one computing made classes more interactive.

14. Using a laptop, I can access many teaching materials and visual aids to animate my classes.

15. Creating a lesson plan is easy and more systematized due to one-to-one computing.

16. I create the latest teaching materials and activities to meet individual student's needs in one-to-one computing.

17. One-to-one computing system allows me to give each student tests, quizzes, and assignments.

18. One-to-one computing allows me to share class notes, printouts, and teaching materials quickly and easily with fewer resources and less stress.

19. With one-to-one computing, I get appropriate information about the course content from various sources.

20. One-to-one computing enables accessible communication, sharing, and cooperation with teachers, administrators, and parents.

21. One-to-one computing makes it easy to keep in touch with students and follow up outside class.

22. One-to-one computing allows easy storage and access to students' records.

23. One-to-one computing makes teaching and learning more learner-centered.

24. One-to-one computing increases students' motivation to learn.

25. One-to-one computing has improved students' ability to work independently.

26. One-to-one improves the quality of students' work at school.

27. Students' attendance rate has increased since one-to-one computing was introduced.

28. One-to-one computing has further deepened communication between children and teachers.

29. One-to-one computing allows various teaching/learning activities to engage students fully.

30. One-to-one computing helps students understand the subject content of lessons better.

31. One-to-one computing allows students to evaluate each other's assignments and projects.

32. Students produce better results and write better sentences in one-to-one computing classrooms.

33. One-to-one computing makes classroom management easy.

34. Monitoring and supervising students during class in one-to-one computing is tiring.

35. Students are easily distracted in class when using personal laptops.

36. Students interact more with each other when they work with their laptops.

37. List 3-5 digital devices and software applications you often use in class.

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（アグバナグロ エヴェリン マウフェモア　旭川校教員研修生）

（石塚　博規　旭川校教授）

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