A case study of how using laptops in a primary classroom facilitated Higher Order Thinking

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Abstract— **Research about 1:1 laptop school initiatives highlight benefits for learning, however, there is little research about the impact of such initiatives in the primary school context. This case study reports how a 1:1 laptop program facilitated Higher Order Thinking (HOT) in an upper primary classroom in Australia. The class was observed during one unit of work and Bloom's taxonomy of HOT was used as the analysis framework. Results showed that Higher Order Thinking was evident when laptop tasks encouraged students to take an active role in their learning. HOT was facilitated by students being able to make decisions on applications to use to complete tasks and class discussion facilitated by the teacher. Technical problems experienced using laptops also promoted HOT from students. This study suggests that a 1:1 computer initiative can promote HOT but is dependent on the pedagogical practices of the teacher. This small-scale study highlights that the teacher is key when implementing laptops in the classroom and further research is warranted to inform future 1:1 computer initiatives in primary schools.**

***Index Terms*—1:1 laptop programs, primary school education,**

I. Introduction

Internationally, 1:1 laptop programs are becoming widespread in schools but are yet to be mainstream. Particularly in the United States, there are large-scale initiatives in many states such as South Dakota, Pennsylvania, Texas, Georgia, Louisiana, California, Kansas, Maine, Massachusetts, and Michigan [1, 2]. One of the largest 1:1 laptop initiatives in America, targeting five western Massachusetts Middle Schools, was the Berkshire Wireless Initiative, a longitudinal pilot study conducted over a three-year period. Findings from this study highlighted that 1:1 laptop programs allowed the uptake of current teaching approaches, increased student motivation and engagement, improved student collaboration and research skills and positive impacts on student achievement [3]. The positive effects of laptop programs on students‟ academic achievements have also been shown in other studies, e.g., [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17]. For example, a large study conducted on a 1:1 laptop program in Maine, which involved over 16 000 students, found that 1:1 laptop programs had a significant impact on student achievement [14]. The study explored writing proficiency compared a laptop and non-laptop classroom and found that once the 1:1 laptop program had been implemented for five years, 41.4% of these students reached the Maine Educational Assessment Writing Proficiency Standard [14]. Although research exists on the positive effects of 1:1 laptop programs on student learning outcomes, these studies have only addressed one aspect of learning, such as literacy and therefore are not representative of laptop learning in all curriculum areas. For example, the study by Bebell and Kay [3] highlighted that laptops had minimal impact on learning in mathematics and science classrooms, and hence did not assist students in achieving learning outcomes.

Within Australia, the largest laptop initiative is the Digital Education Revolution, introduced by the Australian Government in 2008 to provide high school students (Years 9-12) in one state, New South Wales, with their own laptops by December 2011. This initiative has invited reform to school teaching and learning in Australia, and has encouraged teachers to engage in professional development to ensure they can competently address 1:1 laptop programs in the classroom [18, 19, 20, 21]. A recent study by the Australian Government surveying principals of schools where the Digital Education Revolution initiative had been implemented found that these principals perceived the laptop program has having positive effects on learning, as students had access to computers that could engaged them in the learning process [18, 19, 21]. There is, however, minimal evidence to support these perceptions, as research about this initiative has also highlighted students leaving their laptops at home and/or not using them in the classroom [22]. There are calls for governments to work in collaboration with teachers to help teacher develop strategies to successfully integrate computers in the classroom [23]. Therefore, further research is needed to determine the effects of the Australian Digital Education Revolution on students' learning outcomes.

A current worldwide initiative is the One Laptop per Child, designed to provide laptops to students in disadvantaged areas, so they can participate in educational experiences allowing access to the internet and software applications available on laptops [24, 25, 26, 27, 28]. In Australia, this initiative has targeted Indigenous children in remote areas. Findings from a study investigating the impact of this program in an independent Aboriginal school, found that students were more engaged in the learning process and felt a sense of worth after completing laptop tasks and receiving recognition from their peers and the teacher [25]. This shows that laptops can be effective tools for learning, allowing students to develop positive attitudes towards their education. On the other hand, international research conducted on the One Laptop per Child

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initiative in Colombia found that the distribution of these low cost laptops did not appear to assist students in gaining access to social improvements, such as jobs [29]. Further research is needed to unpack these contradictory findings in order to identify effective strategies for future classrooms.

In regards to primary school classrooms, there has been little research conducted about the influence of 1:1 laptop programs [30]. Thus, the research reported in this paper examined how laptops were used in an upper primary classroom in an established 1:1 laptop program and whether the laptop-based tasks supported Higher Order Thinking (HOT). The focus on HOT was taken because of the little research that has taken this particular focus and yet HOT skills are what teachers strive for their students to demonstrate.

II. Laptop-based tasks in an upper Primary Classroom

A. Methodology

The case study comprised one classroom of 27 students (11 boys, 16 girls) and 2 teachers (one was a pre-service teacher conducting professional experience) in an Australian primary school within an established 1:1 laptop program. The research question was: How can laptops be used in the classroom to promote HOT? A cross-curriculum unit of work (9 lessons averaging 90 minutes in duration) about Australia's Identity was observed. Students used their laptops in each lesson and created a number of work samples on their laptops that were assessed by the teachers. Each lesson built on knowledge from the previous lesson and the teachers created laptop-based learning tasks (both individual and group tasks) that involved students creating artifacts such as an advertisement, digital portrait, Venn diagrams, responses to questions, and graphs.

Data collected included: 9 classroom observations, student work samples from each lesson, interviews with teachers (before and after each lesson) and student focus groups (after each lesson).

Data was analysed based on Bloom's taxonomy [31] to identify evidence of Higher Order Thinking. Bloom's Taxonomy divides educational objectives into three domains: Cognitive, Affective, and Psychomotor (often described as knowing, feeling and doing respectively). A goal of Bloom's Taxonomy is to motivate educators to focus on all three domains, creating a more holistic form of education. However, for the purpose of this study, only the cognitive domain was drawn upon as the focus was to examine whether laptop based tasks created by teachers enabled students to engage in Higher Order Thinking [31]. Within the cognitive domain, learning at the higher levels, and thus demonstrating HOT (create/synthesis, evaluation, and analysis) is dependent on having attained prerequisite knowledge and skills at lower levels (apply, understand and remember) [31]. A coding system was devised whereby each level was numbered starting from the highest cognitive level, eg., 1. Create/Synthesis, to the lowest thinking level, eg., 6. Remember. Descriptors for each level in terms of what a teacher would do to facilitate that level of thinking and what students would exhibit as evidence for that level of thinking were developed inductively from the data. Example teacher descriptors for 1. Create/Synthesis include: Facilitates learning by asking students questions, observing what students are doing and offering guiding advice; involved in analysing and evaluating students' work; and promotes learning through providing additional comments to students' responses or questions. Example student descriptors for 1. Create/Synthesis include: creates plans to solve problems, actively participate in classroom activities; puts forward ideas; and participates in making, designing and creating. Each of these descriptors was allocated a letter from the alphabet. For example, observational data of the teacher when providing students with support was coded as 'Promotes learning through providing additional comments to students' responses or questions' (1C).

B. Results

Both Higher Order Thinking and Lower Order Thinking was demonstrated by students in the lessons and HOT was evident in most lessons. Three themes surfaced as to how HOT was evident: student autonomy to complete laptop-based tasks facilitated HOT, classroom discussions facilitated HOT, and using the laptops in themselves facilitated HOT. Each of these themes is elaborated as follows.

Student autonomy to complete laptop-based tasks facilitated HOT

All but one of the laptop-based activities, were designed such that students could decide on how they would complete them. For example, whilst the teacher did provide some support and guidance, students had to select the program available on their laptop best suited to the task they had to complete. By giving students the freedom of choice in selecting programs, the teacher promoted student engagement in thinking deeply about the task. The teacher reported that the laptops facilitated HOT because they provided students with access to the Internet and through Internet-based research tasks invited students to decide what information was accurate and important to use and include in their work:

For the poster they definitely did [use laptops effectively] because they were learning how to research… and pick points that stood out to them …and put it into …a different… format…they wanted to display …so they were able to explore technology a bit in that way and how they wanted to… spruce up the poster and make it a bit more fancy...(interview, pre-service teacher).

The decisions made by students when completing their work samples, and the discussions they had with one another, showed evidence of HOT. The laptops facilitated HOT as the students had to think about how they could modify their work samples, e.g., the design of an advertisement to better position their product: "There was heaps of pictures but some of them were not that clear … so we wanted something big enough so it wouldn't be blurry and those looked good." (student focus group)

Classroom discussions facilitated HOT

The class discussions facilitated by the teacher, which involved probing for deeper understandings through the use of questioning when completing the laptop-based tasks, engaged

the students in HOT. For example, the teacher would often respond to student answers with a question: "What do you say to describe someone who lives in the outback?" (observation, student); "What work would a typical Aussie do?" (observation, teacher response). If students gave limited responses to questions, the teacher rephrased the question or asked another question.

The use of technology facilitated HOT

The use of the laptops themselves promoted HOT because although the pre-service teacher's limited knowledge about certain software applications limited the assistance she could provide her students, this enabled HOT as the students worked together to solve technical issues as illustrated in these comments from the interviews:

"I'm still not quite familiar with how everything works on the whiteboard and just finding things on the Mac and that sort of thing, so I might need my technology assistant to help me, one of the students…"

"Some students…might not be proficient with the use of …Photobooth…we have the technology helpers in the class."

"Was good because they were exploring the different types of programs and how to use them and some of them that didn't know how to use them other students nearby helping them and telling them how to transfer a photo onto the program and that sort of thing."

C. Discussion

Both Higher Order and Lower Order Thinking (LOT) was evident during the laptop-based activities in this case study. Laptops are tools for learning, however unless they are combined with effective pedagogical practices (such as thinking about how students will use laptops in classroom activities, and how students will achieve curriculum expectations) it is argued that they will only promote the development of LOT skills [32]. Two pedagogical strategies evident in this study as effective laptop-based tasks, were 'student autonomy' and 'active learning'. When students were encouraged to make their own decisions and thus given some autonomy that consequently enabled them to be more active in their learning. The findings of this study suggest that students should be given 'ownership' of their work to allow engagement in HOT [33]. Through allowing students to take ownership of their work they are able to engage in HOT, as they must understand the task they have been allocated, think about the applications on their laptops and devise plans to complete the laptop-based tasks set by the teacher.

Teachers' skills, understandings and knowledge of technology can influence their abilities to assist students with technical issues when they arise during learning experiences. The pre-service teacher had limited experience with Macintosh computers and thus experienced difficulties in using this technology during classroom learning experiences. Although this could have been considered as hindering the learning experience for students, instead it had a positive impact on the students' abilities to engage in HOT when using the laptops. This was because the students were actively involved in solving problems. They had to investigate or identify the issues and then work individually or collaboratively with their peers to put forward ideas that would assist the teacher in using her laptop. Furthermore, when the students were using their laptops, if they encountered any difficulties and the teacher was unable to assist them, their peers would help them solve the problems they encountered.

To encourage effective implementation of 1:1 laptop programs in future classrooms, 'technology partnerships' between teachers and students should be fostered. By working together through technical problems, teachers can improve their technical skills and students are empowered to be more active in their learning. By inviting students to take a more active role in the learning process, where they take responsibility for their education, the development of HOT skills can be fostered [33]. This is because students are engaged in problem solving and critical thinking, to solve technical issues that arise with laptops in the classroom. This can contribute to their sense of worth and value in the classroom environment, as well as enable them to develop the computer skills necessary to participate in our current and future digital society. The ability to engage in HOT is deemed an imperative quality for a "successful learner" as students "are able to think deeply" [34].

It is important to note several limitations of this study, which include timeframe, the bias of the researcher and number of participants involved in the study. The main limitation was that the study had to be completed within a tight timeframe (several months) and the researcher was only able to collect data on a single case. If more time was allocated to this study, data could have been collected on multiple cases to ensure the validity and reliability of the findings. Another limitation of this research was the fact that the researcher was the main instrument for data collection. As a result, the observations may reflect the researcher's beliefs and bias [35]. Overall, this research was conducted in a single upper Australian primary school classroom, involving twenty-eight participants: two teachers and twenty-six students. The scope of this study was limited, as a small number of participants were investigated. Additional research needs to be conducted to support the findings of this study and to inform the implementation of future 1:1 computer classroom practices.

III. Conclusion

This study has provided some insight into how higher order thinking was facilitated in a primary classroom through the completion of laptop-based tasks. Given that 1:1 computer initiatives are yet to become mainstream in primary schools, research of this kind is important to inform future 1:1 computer implementation in primary classrooms. Overall the research found that HOT was evident in laptop tasks that allowed students to take an active role in the learning process and make decisions about how they would present their work. The three main findings of this study were that student autonomy facilitated HOT, class discussions facilitated by the teacher promoted HOT, and the use of technology itself through some technical difficulties experienced enabled HOT This study, was limited in terms of scope, as the case comprised one primary school classroom and data was

collected based on nine classroom lessons. This study to our knowledge, however, is one of the first of its kind to closely examine teacher and student interactions to determine if higher order thinking was evident from students. A suggestion for future research is to replicate this study on a larger scale to further investigate whether 1:1 computer initiatives allow students to engage in HOT.

REFERENCES

[1] W. Harris and L. Smith, *Laptop use by seventh grade students with disabilities: Perceptions of special education teachers*, Maine Education Policy Research Institute, University of Maine Office, 2004.

[2] D. Silvernail and D. Lane, *The impact of Maine's One to One Laptop Program on Middle School Teachers and Students: Phase One Summary Evidence*, 2004. Available*:* http://mainegovimages.informe.org/mlte/articles/research/MLTIPhaseOneEvaluationReport2004.pdf#search= 22David%20Silvernail%22>

[3] D. Bebell and R. Kay, "One-to-one computing: A summary of quantitative results from the Berkshire wireless learning initiative," *Journal of Technology, Learning and Assessment*, vol. *9*, no. 2, pp.1-60, 2010.

[4] D. Bebell, and L. O'Dwyer, "Educational outcomes and research from 1:1 computing settings," *The Journal of Technology, Learning and Assessment, vol. 9, no.* 1, pp.1-16, 2010.

[5] L. Donovan, T. Green, and K. Hartley, "An examination of One-to-One Computing in the Middle School: Does Increased Access Bring About Increased Student Engagement?." *Journal of Educational Computing Research*, vol.42, no.4, pp.423-441, 2010.

[6] M. Dunleavy, and W. Heinecke, "The impact of 1:1 Laptop Use on Middle School Math and Science Standardised Test Scores", *Computers in Schools*, vol.23, no.4, pp.4-20, 2008.

[7] D. Grimes, and M. Warschauer, "Learning with laptops: A multi-method case study," *Educational Computing Research*, vol.38, no. 3, pp. 305-332, 2008.

[8] J. C. Gulek, and H. Demirtas, "Learning with technology: the impact of laptop use on student achievement," *Journal of Technology, Learning and Assessment*, vol.3, no.2, pp.1-39, 2005.

[9] L. Holcomb, "Results and lesson learned from 1:1 laptop initiatives: A collective review," *TechTrends*, vol.53, no.6, pp.49-55, 2009.

[10] J. Lei and Y. Zhao, "One to one computing: What does /it bring to schools?" *Educational Computing Research*, vol.39, no.2, pp.97-122, 2008.

[11] J. Lei, "Conditions for Ubiquitous Computing: What can be Learned from a Longitudinal Study," *Computers in Schools*, vol.27, no.1, pp.35-53, 2010.

[12] D. Lowther, S. Ross and G. Morrison, "When each has one: the influences on teaching strategies and student achievement on using laptops in the classroom," *Educational Technology, Research and Development*, vol.51, no.3, pp.23-44, 2003.

[13] W. Penuel, "Implementation and effects of one to one computing initiatives: A research synthesis", *Journal of Research on Technology in Education*, vol.38, pp.329-348, 2006.

[14] D.L. Silvernail, and A.K. Gritter, *Maine's Middle School Laptop Program: Creating Better Writers*, University of Southern Maine, Gorham, 2007.

[15] K.A. Suhr, D.A. Hernandez, D. Grimes, and M. Warschauer, "Laptops and Fourth-Grade Literacy: Assisting the Jump over the Fourth-Grade Slump," *The Journal of Technology, Learning, and Assessment*, vol.9, no.5, pp.1-46, 2010.

[16] D Walkowiak, "Excellence is Learning New Teaching Approaches," *Education Horizons*, vol.7, no.3, pp.19-21, 2002.

[17] M. Windschitl, and K. Sahl, Teachers learning to use technology within the context of a laptop learning initiative: the interplay of personal histories, social dynamics an institutional culture, paper presented at the annual meeting of the American Educatioanl Research Association, April 24-28, New Orleans, Louisiana, United States, 2000.

[18] Australian Government: Department of Education, Employment and Workplace relations 2011, *Digital Education Revolution*, Available: http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/Pages/default.aspx

[19] T. Broadley, "Digital Revolution or digital divide: will rural teachers get a piece of the professional development pie?," *Education in Rural Australia*, vol.20, no.2, pp.63-76, 2010.

[20] Commonwealth of Australia, 2011. *Digital Education Revolution program: National Secondary Schools Computer Fund*, Available: http://www.anao.gov.au/Publications/Audit-Reports/2010-2011/Digital-Education-Revolution-program----National-Secondary-Schools-Computer-Fund/Audit-brochure

[21] B. Houghton, "Netbooks, networks and internet safety: are you ready for the digital education revolution?," *Teacher*, no.207, pp. 40-42, 2009.

[22] D. Roddick, "No kidding: teachers are not to blame for slow take-up," *Teacher*, no.217, pp.38-39, 2010.

[23] J. Orlando, "Understanding changes in teachers' ICT practices: a longitudinal perspective," *Technology, Pedagogy and Education*, vol.18, no.1, pp.33-44, 2009.

[24] B. Head, "The laptop revolution," *Campus Review*, vol.19, no.13, pp.14, 2009.

[25] G. Milgate, "One Laptop Per Child in remote indigenous communities," *Research developments*, vol. 23, pp.1-3, 2010.

[26] J. Montgomerie, "One laptop per child," *Peace Magazine*, vol.23, no.4, pp. 15, 2007.

[27] D. Purington, D, "One laptop per child," *Computers and Society*, vol.40, no.1, pp.28-33, 2010.

[28] M. Warschauer, and M. Ames, "Can one laptop per child save the world's poor," *Journal of International Affairs*, vol.64, no.1, pp.33-51, 2010.

[29] M. Streicher-Porte, C. Marthaler, H. Boni, M. Schluep, A. Camacho and L. Hilty, "One laptop per child, local refurbishment or overseas donations? Sustainability assessment of computer supply scenarios for schools in Colombia," *Journal of Environmental Management*, vol.90, no.11, pp.3498-3511, 2009.

[30] C. Mouza, "Learning with Laptops: Implementation outcomes in an Urban, Underprivileged School," *Journal of Research on Technology in Education*, vol.40, no.4, pp.447-472, 2008.

[31] B. Bloom, *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*, David McKay Co Inc, New York, 1956.

[32] K.S. Shapley, D. Sheehan, C. Maloney and F. Caranikas-Walker, "Evaluating the Implementation Fidelity of Technology Immersion and its Relationship with Student Achievement," *The Journal of Technology, Learning and Assessment*, vol.9, no.4, pp.1-69, 2010.

[33] R. Herman, J. Tondeur, J, van Braak and M. Valcke, "The impact of primary school teachers' educational beliefs on the classroom use of computers," *Computers and Education*, vol.51, no.4, pp.1499-1509, 2008.

[34] MCEETYA, 2008. National Report On Schooling In Australia Information Framework Ministerial Council on Education, Employment, Training and Youth Affairs, p. 9. Available: www.**mceetya.edu.au**/verve/_resources/ANR2008_Information_Framework.pdf

[35] D. Mertens, *Research methods in education and psychology: integrating diversity with quantitative & qualitative approaches*, Sage Publications, Thousand Oaks, California, 1998.

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