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Effective implementation of 1:1 computing : benefits and teacher readiness

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One-to-one (1:1) computing initiatives have become widespread in K-12 schools today. The benefits of 1:1 computing are tremendous, but schools must take careful consideration when planning for such initiatives. The purpose of this literature review is to examine effective methods for 1:1 implementation. Thirty peer-reviewed studies on 1:1 computing programs in K-12 schools were purposefully selected, the majority being from 2010 to present. Special attention was given to benefits of 1:1 computing and several key elements leading to teachers' readiness for successful 1:1 program implementation: overcoming teacher fears, changing teacher beliefs and attitudes, and strengthening professional development in order to shift pedagogy. The implications of these findings are especially beneficial for any school in the beginning stages of 1:1 implementation.

EFFECTIVE IMPLEMENTATION OF 1:1 COMPUTING: BENEFITS AND TEACHER READINESS

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Abstract

One-to-one (1:1) computing initiatives have become widespread in K-12 schools today. The benefits of 1:1 computing are tremendous, but schools must take careful consideration when planning for such initiatives. The purpose of this literature review is to examine effective methods for 1:1 implementation. Thirty peer-reviewed studies on 1:1 computing programs in K-12 schools were purposefully selected, the majority being from 2010 to present. Special attention was given to benefits of 1:1 computing and several key elements leading to teachers' readiness for successful 1:1 program implementation: overcoming teacher fears, changing teacher beliefs and attitudes, and strengthening professional development in order to shift pedagogy. The implications of these findings are especially beneficial for any school in the beginning stages of 1:1 implementation.

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Introduction

One-to-one computing (1:1) initiatives, which involve providing every student with a device, have become commonplace in many K-12 schools in recent years. If a school hasn't already "gone 1:1" it is probably in the process of doing so. Referred to as the "One-to-one Tsunami" by one researcher (Livingston, 2007, as cited in Klieger et al., 2009), it can be concluded this concept is taking the educational world by storm. It is agreed that the benefits of being able to place a device in the hands of every student are manifold. With our current generation of learners, technology is a part of everyday life. To best reach these students, we must embrace technology as one of our main teaching tools.

While the benefits of a 1:1 program are obvious, the task of successfully implementing these programs is not easy. There are many obstacles that can hinder a smooth transition to a 1:1 initiative, as will be further explored in this literature review. By analyzing studies of schools that have already implemented 1:1 programs, we can find the most valuable methods for effectively beginning a program.

Starting a 1:1 computing program is much more than just choosing a device and budgeting for it. By analyzing what has worked or not worked for various schools, we can learn better how to create a long-term vision for a 1:1 program including the best ways to prepare the teachers who will be on the front lines of delivery every day. Schools are spending a large amount of money on 1:1 initiatives, but without properly preparing teachers, devices will not be used to their fullest extent, teachers will get frustrated, and the program could eventually fail. Spires et al. (2011) summarize what most of the studies in this literature review showed: Schools must plan 1:1 initiatives by looking at professional development, what to budget for and purchase, and technical support. They stress that "failure to tend to any of these contextual

variables can subdue an entire laptop initiative" (p. 67). By being proactive and examining accounts of successful 1:1 programs, we can learn the best ways to help teachers feel ready for such initiatives, which will in turn lead to engaged students and a true transformation of teaching and learning.

This review synthesizes research evidence focusing 1:1 implementation techniques drawn from studies published in the past decade. A correlation between strong implementation plans and successful integration will be discussed. In particular, this literature review examines teacher training, teacher beliefs and their relation to 1:1 implementation. It focuses on the most effective methods for teacher training and explains how and why these will lead to a strong and successful 1:1 program in schools.

There is ample research to show why 1:1 programs are good, and much literature out there to help schools choose a particular device, but knowing how to prepare schools and teachers best for the program isn't always obvious. The findings of this literature review will be helpful to teacher and administration alike as they look for steps to take to help pave the way for their program. Teachers must be able to express to their administration why they need training and what for, and administrators must recognize the need to alleviate concerns and anxiety that will most definitely come forward on the part of the teachers. By looking at research and schools that have achieved 1:1 programs with research evidence all schools can move forward with purpose and success.

While there are many aspects to 1:1 implementation plans, this literature review focus on three main research questions.

1. What are the benefits of 1:1 implementation?
2. How can teachers be ready for 1:1 implementation?

3. How can teachers successfully implement 1:1 in the classroom?

Methodology

To locate sources for this literature review *Google Scholar and the Educational Resource Information Center (ERIC)* database were first used to locate the articles about 1:1 implementation for the preliminary search. Then the University of Northern Iowa Rod Library's *One Search system* was primarily used. By using such resources to retrieve articles, the quality could be assured based on the ability to narrow results to only peer-reviewed articles. Thus, only peer-reviewed articles were selected for this literature review to assure scholarly and pertinent research to the education field. A combination of the following descriptors was used to locate the final resources: *1:1 computing*, *secondary education, teacher beliefs, teacher attitudes, teacher perceptions, ubiquitous computing, technology, teacher training, professional development, laptop initiatives, student engagement, 21st century skills, 21st century teaching, pre-service teachers,* and *teacher preparation.*

Although 1:1 computing is a term that appears in articles throughout the last decade, peer-reviewed journal articles written within the last three to four years were first considered. The majority of the articles selected for the final bibliography are from 2010 or later with just a few dating earlier. With more recent studies we can be assured that more up-to-date technology is being described as well as better integration practices. Also, newer articles also provide reflection and analysis of schools that have had a 1:1 program for several years, which helps us better understand what impact implementation practices have on the overall success of a 1:1 program.

Twelve of the articles reviewed provided qualitative research evidence (interviews, narratives, teacher observations, and anecdotal evidence). Qualitative research methods work

well to gather in-depth information about school climate and teacher perspective regarding 1:1 programs. Eighteen articles contained quantitative research methods by using surveys and questionnaires to gather data on 1:1 computing initiatives or using path model analysis to test their hypotheses surrounding 1:1 integration. This sort of data gathering was especially useful to get a large number of teachers' responses on their beliefs and perceptions. Using such data to evaluate the effectiveness of 1:1 computing programs helps us understand the best implementation methods and see more clearly what the possible obstacles are. On the other hand, interviews and narratives are often equally useful as they provide more-in-depth understanding about what is going on "in the trenches."

Finally, all of the articles referenced were read thoroughly, taking note of key ideas surrounding successful 1:1 implementation and the data that backed up those claims. Special focus was on teacher preparation, teacher readiness, and best practices for professional development. Through focus on these main points, subtopics also came to light, including role of administration, pre-service teacher training, and the need for a pedagogical shift. Implications for schools looking to start a 1:1 program are discussed as well as recommendations for future research.

Analysis and Discussion

Schools have recognized for many years now that in order to keep up with technology advances, putting technology into the hands of all students is a dream worth pursuing. Today, the term 1:1 computing is commonplace and these initiatives abound. As explained by Spires, Oliver, and Corn (2011), "A computer in the hands of every child is no longer a farfetched idea. In fact, 1:1 laptop computing has emerged as a key context for educational innovation" (p. 63). Is this just another trend in education? Or is there true value in attempting to equip every student with his own device? The research is overwhelmingly positive in terms of the benefits of 1:1 computing.

Benefits of 1:1 Computing

Before analyzing *how* to best implement a 1:1 program, it is perhaps wise to examine the *whys*. If we don't understand why these programs are beneficial, it is hard to convince administration, staff, students, and parents as to why such a program is even being implemented.

Oliver and Corn (2008) conducted a two-year mixed methods study that gathered data before and after implementation of a 1:1 program in a middle school in the US. The researchers used surveys, observations, and interviews to record student technology use and skill, as well as their thoughts on the program. 300 middle school students (grades 6-8) participated in the study. This study shows that, with technology use, teachers are able to better "individualize instruction based on student needs" (p. 217). Students in all of the grade levels reported "significantly higher satisfaction with the school technology infrastructure and software on school computers" (p. 220). The 6th graders involved in the study showed a significant increase in technology skills between baseline and year one of the 1:1 program. (p. 224). Students reported using more

collaborative tools online than before, such as wikis to complete class projects (p. 225). This particular school saw many benefits with their 1:1 program, but the researchers also noted that some aspects did not change significantly, for example, direct instruction was still the main format used for teaching, and independent seat work was still occurring frequently (p. 225). It would also be interest to know what sort of pre-planning and teacher training occurred before the study, which is not discussed. To best understand how a school benefited from 1:1 implementation, it is important to know what their implementation plan was.

Gundy and Berger (2013) conducted a qualitative, descriptive study of 10 biology teachers in Ontario, Canada. A purposeful sample was chosen from teachers in 1:1 settings and who taught the final two years of high school. Data was gathered through a series of three one-hour interviews. From these interviews, four themes were analyzed: how the integration was accomplished, teacher perceptions, challenges faced, and how their perceptions diffused to other biology teachers. These biology teachers reported many positives with 1:1 integration into their biology courses. For example, "students liked the coursework more and were less stressed" (p. 39). They also noted more student output and "were encouraged by new ideas they could adapt for their courses" (p. 39). Finally, the teachers were able to deal better with the time constraints that lab work presents due to the 1:1 integration. This study outlined many benefits a 1:1 program can bring to a classroom, although it must be kept in mind that this study was limited to a very small number of participants (10) and was only related to one subject area (biology.)

In order to extend research findings by viewing the 1:1 program both from students and teachers, Shih, Chu, Hwang, and Kinshuk (2011) conducted a mixed-methods research study that followed 34 5th grade students and their teacher through a ubiquitous learning activity that consisted of students using PDAs to independently explore vegetation on their school campus

and record their data electronically. After the activity was completed, students were given a questionnaire based on a 5-point Likert scale to solicit their feedback on the experience. Ninety-seven percent of the students agreed that the activity was more "interesting than learning in the traditional way" (p. 386). This same group of students also said that they enjoyed the fact that they could "control their own learning speed" in a 1:1 setting (p. 386). Analysis of the questionnaires also showed that students believed that learning by using PDAs could "enhance their learning attitude" with a score of 4.5 (p. 384). They also expressed that they would be willing to spend more time outside of class learning about plants (score of 3.65) (p. 385). The three teachers interviewed after the project also expressed much satisfaction with the experience and what it provided for the students. For example, they thought that "the one-on-one approach could adapt to every student's learning progress and condition" (p. 389). They also believe such initiatives could "increase student's attention and motivation" (p. 389). While the outcomes of this study were positive, there are certain limitations, especially in light of the fact that this was a one-time ubiquitous learning activity, and no background information was given on the technology skill level of the teachers and students. Nonetheless, the findings are in line with the aforementioned studies in terms of the many positives for both students and teachers in 1:1 settings.

Students aren't the only ones who benefit in a 1:1 setting. Teachers also benefit from such initiatives. In a collective review of several studies on 1:1 programs, Holcomb (2009) synthesizes the many advantages these programs bring, including teacher benefits. For instance, teachers reported increased technology proficiency, more creative and collaborative lesson planning, student-centered lessons, and more effectively meeting curriculum goals (p. 51). One teacher explained: "Teachers have become empowered to enhance and improve their teaching

and instructional practices" (p. 51). Additionally, teachers in 1:1 programs tend to use a more constructivist approach and better meet individual student needs (p. 51).

It has also been found that teachers use the technology as a source of personal professional development. Mwalongo (2011) surveyed 74 teachers in Tanzania on their perceptions about using technology for teaching, and coded the answers in terms of percentages. This particular study found that the technology allows the teachers to communicate with other professionals, find updated information in regards to their specific subject area, and have instant access to resources and other professionals that would be burdensome to find without technology.

Though just a small sampling of the benefits of 1:1 computing and technology integration in educational settings, it is hopefully clear to all involved parties that pursuing such a program is indeed beneficial and worthwhile. However, simply putting one device into the hand of each child does not mean the 1:1 initiative is complete or anywhere near being a success. As the studies analyzed for this review reveal, there are several factors necessary for successful implementation.

How does a school bring about true change? One of the first steps is to move the focus away from the technology itself, and start by looking at teacher readiness and preparation. Too often schools start by focusing on *what* they are going to purchase, not how they are going to prepare for implementation. As echoed by several researchers, Kim, Lee, Spector, and DeMeester (2013) summarize this concept in their mix-methods study of 22 teachers and how their beliefs affect technology integration, by stating, "Technology integration goes beyond the use of any particular technology, and it can be tightly connected with teachers' beliefs about effective ways of teaching to support learning and instruction" (p. 78). One of the first steps for

effective technology integration and understanding teacher beliefs is to survey the school climate in terms of teacher readiness.

Teacher Readiness

The benefits of implementing 1:1 depend on whether teachers are ready to implement 1:1 in the classroom. Several key elements leading to teachers' readiness for successful 1:1 program implementation include: overcoming teacher fears, changing teacher beliefs and attitudes, and strengthening professional development.

Teachers' concerns. Teacher concern is one of major factors to influence teacher's readiness for 1:1 implementation. One simple method to help alleviate fears and misconceptions is to allow teachers plenty of time to "play" and become comfortable with the new technologies. Holcomb (2009) explains, "Before laptops are placed in the hands of the students, teachers need the opportunity and time to practice and become accustomed to the new technology" (p. 53). Abilock, Harada, and Fontichiaro (2013) present their findings in the form of narratives and interviews discussing successful professional development for technology. They describe this sort of teacher training as a "playground atmosphere" or a "tech playground." They found that schools that took this approach created a safe environment for teachers where they weren't afraid to experiment take risks, and in result, led to more positive attitudes towards the technology.

Holcomb (2009) also stresses that "how and when laptops are distributed can play a key role in determining the success of a 1:1 initiative" (p. 53). While somewhat common sense, many schools may not practice patience in this area and may be too eager to move ahead with the program full steam, not allowing teachers enough time to become comfortable with the technology. Cox and Hanson (2009) even recommend that teachers focus first on creating lessons that lend themselves well to technology integration, doing this even before the laptops

arrive. (as cited in Spires et al., 2012) Lei (2010) examined the relationship between technology use and student outcomes in their study of 237 seventh and eighth grade students in a north-western middle school in the US. Using 5-point Likert scale surveys and interviews, they examined the relationship between quantity and quality of technology use. They make a similar recommendation for teacher preparedness, stressing that it is "important to set clear educational goals even before technologies are purchased and installed" (p. 468). By starting with the familiar, the technology integration aspect would not be as intimidating.

Time after time, researchers show that teachers who are not comfortable with the technology do not implement it effectively. Donovan, Hartley, and Strudler (2007) investigated teacher concerns during the implementation phase of a 1:1 program in an urban middle school in the Southwestern United States. Seventeen seventh grade teachers from core subjects and two administrators were surveyed using the Concerns-Based Adoption Model of evaluation. The participants were given questionnaires using the 5-point Likert scale, answered open-ended questions, and participated in "one-legged interviews" (Informal, unobtrusive question and answer sessions). Their study also emphasizes the need for teacher buy-in as it will be crucial to the longevity and sustainability of the any 1:1 program (p. 278). They note that when asked to adopt change, "teachers must feel important and involved" (p. 279). Also, "by acknowledging teacher concerns, change facilitators can support teachers through the change process" (p. 279). Teacher readiness is much influenced by their beliefs and attitudes. In order to have a smooth 1:1 implementation, schools must be ready to help create positive attitudes towards the technology.

Teacher Beliefs and Attitudes. Recognizing and addressing teacher beliefs regarding technology is a must when planning for a 1:1 program. In 1992, a study by Pajares noted that

"teacher beliefs are considered even more influential than teacher knowledge" (as cited by Kim et al., 2012, p. 77). This concept proves to be especially relevant in terms of technology integration. When exploring factors influencing 1:1 implementation, Inan and Lowther (2010) used a path analytic approach to analyze the data collected. Their study shows that "teacher readiness and teacher beliefs were the most important factors with the highest direct effect on laptop integration in K-12 classrooms" (p. 941). Among the five variables affecting laptop integration, "teacher beliefs" was ranked as the highest, leading them to the conclusion that "teacher beliefs and readiness directly influence teachers' laptop integration" (p. 941).

A similar finding is observed from a study where Karaca, Can, and Yildrin (2013) surveyed several teachers to find the "frequencies of factors affecting technology integration" and the top factor, with a frequency value of 91, was indeed, "teacher attitudes and beliefs towards technology" (p. 92).

A similar finding is found from the study of Ertmer, Ottenbreit-Leftwich, Sadik, Sendurer, and Sendurer (2012), who focused their entire study on the correlation between teacher beliefs and technology integration practices. They purposefully chose teachers for their study who were very strong in technology use. When given a survey (1-5 Likert scale model) about barriers to technology integration, they rated their own beliefs and attitudes as the lowest (score of 1) and rated attitudes and beliefs of *other* teachers as the highest barrier (score of 3.17). These tech savvy teachers had positive beliefs about technology and saw the potential for collaboration and higher order thinking skills to be fostered. They regularly used technology in their classes. However, in many of their colleagues, they saw teachers who were intimidated, with a rather negative belief towards technology, and thus didn't want to take on one more thing to learn.

This, in turn, led to a lack of technology integration. Facing a 1:1 program makes many teachers feel uncomfortable and there is a certain anxiety in moving outside of the familiar.

In fact, Storz and Hoffman (2013) confirm this in their study: "Most of the teachers we spoke with felt unprepared, frustrated, and out of their comfort zone" (p. 6). Donovan, Harley, and Strudler (2007) interviewed several teachers about their concerns teaching in a 1:1 program. They find that many teachers did not feel proficient in the technology, and consequently were not using the technology in innovative ways. They were simply using the programs they felt comfortable with, usually just word processing and Internet research.

A study by Garthwait and Weller (2005) finds that for the teachers they looked at "their teaching with computers was affected by personal beliefs about teaching and learning and by pre-existing technical expertise" (as cited by Storz & Hoffman, 2013, p. 3). A school is not ready for a 1:1 program until its teachers are ready. Inan and Lowther (2010) find this particularly true in their data gathered from 379 K-12 teachers that examined factors affecting their integration of laptops. Using a research-based path model, they sought to explain the variance between teacher readiness (43%), beliefs (51%) and laptop integration (55%). They find that, "teacher readiness is a critical factor that explains teachers' laptop integration" (p. 941). While perhaps obvious, many studies back up the idea that "teachers who feel ready to integrate technology used computers more in the classroom" (p. 938).

Williams, Coles, Wilson, Richardson, and Tuson (2000) found similar results in their study of 352 primary and 329 secondary teachers in Scotland. Using a survey, teachers were asked to provide basic information on ways they were using technology in the classroom, how competent they felt, and their attitudes relating to the technology. They discuss the various factors affecting technology use, with a "significant correlation between levels of use of ICT and

teacher attitudes" (p. 311). Those who saw positive benefits used the technology regularly. Those who had many worries and concerns about the technology tended to rarely use it. Mama and Hennessy (2013) also report this finding in their 1:1 research and their discussion of factors hindering progress, find that "positive beliefs and attitudes towards ICT encouraged higher classroom ICT integration and negative attitudes discouraged it" (p. 381).

How do we then overcome this obvious obstacle of teacher beliefs and attitudes and its effect on 1:1 implementation? As was discussed in the section on teacher readiness, a survey of the teachers involved in the initiative is a quick and easy method of gathering information on teacher beliefs and attitudes. This is an important initial step in 1:1 preparation for any school. Kim, Kim, Lee, Spector, and DeMeester (2012) establish that "teachers' beliefs about the nature of knowledge and learning and beliefs about the effective ways of teaching were related to their technology integration practices" (p. 81). They thus suggest, "Teacher beliefs should be considered in order to facilitate technology integration" (p. 81). It is interesting here this idea goes beyond more than just understanding teachers' beliefs about the technology itself, but perhaps more importantly, about teaching and learning in general. Again, we can return to the repeated theme that the focus of technology integration is not only the technology itself, but the marriage of pedagogy and technology.

If teachers' beliefs play such an important role towards technology and successful implementation, can these beliefs be molded and changed? Many studies reviewed offer insight to this very question. First, the more time and experience teachers have with computers and technology, the more positive attitude they will have towards them. (Buabeng-Andoh & Totimeh, 2012). Additionally, teachers who show openness to professional change have a more positive attitude towards technology (Blau & Peled, 2012). Karaca, Can, and Yildirim (2013)

remind us that "teachers are likely to develop positive attitudes about technology integration when they have sufficient knowledge about its use" (p. 361). Thus, schools must plan professional development opportunities and experiences for their staff that promote positivity towards technology.

Teacher professional development. As aforementioned, addressing teacher concerns via professional development can help break down these barriers that attitude and beliefs bring. Using peer mentoring, coaching, co-teaching and co-planning will also help promote positive attitudes towards the technology. This will allow all teachers to feel comfortable and enjoy the success that a 1:1 program can bring in their classroom and school. Training opportunities that are "aligned with teachers' belief systems and current practices might be helpful to improve teachers' technology utilization" (Karaca et al., 2013, p. 362). This idea is further backed by Inan and Lowther's (2010) research as they suggest that "professional development opportunities should concentrate on both teacher beliefs and competencies" (p. 942). Also, the goals of the professional development should be to "improve teacher beliefs regarding the benefits of laptop integration" (p. 942). Schools must remember that professional development goes beyond technical skills; it can help promote an overall attitude shift and help break down certain barriers that preconceived notions bring. As one principal explained, "When teachers are successful, the morale of the entire school goes up" (McLester, 2011, p. 5). Doesn't every school want this? Once a school has seen success and positive attitudes towards technology, is this enough? What long-term goals should schools envision for their teachers?

While granting teachers time to experiment and play with the technology can help build confidence and willingness to implement it in the classroom, research also shows that school leadership can "make or break" the digital culture within a school. A common factor

contributing to successful 1:1 implementation was found to be the principals in the school and the support they offered. (Klieger, Ben-Hur, & Bar-Yossef, 2009, p. 187). Encouragement and active involvement by the administration in the 1:1 program from the beginning will help all staff see the value in it and in turn, be more invested in the idea themselves.

Spires et al. (2012) investigated the ways that 1:1 programs change our current teaching environment. Using the term "new learning ecology," they outline how 1:1 programs force us to look at the shifting dynamic in teaching and learning. Through their discussion, they hope to better explain how both teachers and students can be prepared to meet the new challenges of 1:1 programs. For example, they explain that school leaders must adapt to technology changes, and help their staff do the same. Communication must change between administration and teachers, and administrators must consider "involving the staff in decisions" and encouraging participation in professional development (p. 66). It is also noted that these administrators have responsibility of "encouraging teachers to adopt the innovation" (p. 66).

In this same vein, Karaca et al. (2013) examined the role of administrators for technology integration in Turkish elementary schools. Using a Sequential Mixed Method Design, they first interviewed 20 elementary teachers to determine major factors influencing technology use. From there, a survey was created around these factors that was administered to 1030 classroom teachers in eight school districts in Ankara, Turkey. They found that administrators hold the important role of being "facilitators of technological changes" (p. 354) and thus have the ability to influence the culture of the school. The researchers cite an earlier study by Fallon (2007) which indicates that "school principals have a crucial role in developing a collaborative culture in which teachers share evolving vision and strategies for effectively integrating technologies" (p. 354). Karaca et al. conclude that schools with a "collaborative culture" will, without a doubt,

know more successful technology implementation and will foster an atmosphere of sharing among teachers.

In align with these findings, Inan and Lowther (2010) also stress the importance of the role of administration in relation to 1:1 initiatives and when analyzing previous research found that "administrative encouragement to use technology was one of the strongest predictors of teachers' computer use" (p. 938). If the administration can keep open lines of communication with their staff, the results will be positive. If not, it can negatively impact the 1:1 program. As summarized by Spires et al. (2012), "Overall, when teacher-administration communication and collaboration is lacking, inefficient implementation of one-to-one computing can result" (p. 69).

Other hindrances to 1:1 implementation on the part of administrators were found to be micromanaging or too restrictive rules that left teachers frustrated (Spires et al., 2012). One school reported teachers less willing to adopt the 1:1 initiative because of tiresome accountability requirements put on them by the administration. According to the researchers, positive or negative, the role of school leaders is crucial to 1:1 implementation and must be considered an important variable.

School leaders are not the only ones within the school who can positively influence a 1:1 program, but peer mentors and coaches can prove instrumental in shaping technology beliefs as well. Kopcha (2012), in his study of the 18 elementary school teachers' perceptions to 1:1 integration, described the positive role of the technology mentors, observing that the mentor "played a role in promoting positive beliefs about technology" (p. 1110). In half of the teachers surveyed for his study, the researcher also find that these teachers reported that "their beliefs remained strong or grew stronger as a result of their mentoring" (p. 1109). One way for changing a in-service teacher's beliefs and practice is through peer modeling.

Inan and Lowther (2010) note that "by observing an exemplary teacher using laptops, a teacher can increase his/her beliefs while gaining evidence that laptop use can make lessons more interesting" (p. 942). Kim et al. (2012) also encourage teachers to observe other teachers' successful lessons that use technology. This will cause these teachers to reflect on their own technology use. Through a "collaborative environment" teachers will be given "more opportunities to see successful outcomes of innovative uses of technology and see different beliefs and technology integration practices in action" (Kim et al., 2012, p. 83). Inan and Lowther (2010) also find that a school environment that supports "technology and professional development" will "significantly influence teacher beliefs" (p. 940).

Changing the digital culture of the school and ultimately teacher beliefs and attitudes is not a quick task. Teachers who feel pressured to do too much too quickly will be overwhelmed, and a negative attitude will result. If "slow and steady wins the race" this idea should be applied to technology integration as well. The biology teachers aforementioned in Gundy and Berger's (2013) 1:1 qualitative descriptive study of laptop integration, reported that it took at least two or three years to actually incorporate the computers well into the curriculum. This same group of teachers recommended that new teachers in the program should "plan to integrate the laptops only to their personal comfortable level and they should continue to use the teaching approaches, techniques and teaching materials that worked for them in the past as they begin the process of integrating laptops into their instruction" (p. 33). By acknowledging that it is ok to continue with "traditional" methods as these new teachers learn technology integration methods from their colleagues, there would be less intimidation about embracing the new learning tools.

By recognizing teacher desires and concerns through a relatively simple needs assessment, a school can then plan professional development accordingly. A Midwestern middle

school beginning their 1:1 program used the staff needs assessment to plan professional development days and the types of training offered (Storz, 2013). It was stressed that "meaningful professional development needed to be aligned with teacher concerns" (p. 13). In their previously mentioned study, Donovan et al.(2007) made the recommendation that professional development is not one-size-fits-all but must be "differentiated based on teacher needs and concerns" (p. 265). Planning professional development is a key factor in any 1:1 program. The difficulty comes in planning *meaningful* and *differentiated* experiences for teachers that leave them prepared to transform learning via technology.

There are a variety of methods to tackle professional development and teacher training for 1:1 programs. Tech savvy students can make great mentors for teachers who are not so comfortable with technology (Ertermer et al., 2012; Gundy & Berger, 2013; Kopcha, 2012). Ertmer et al. (2012) explain "one way to reduce fear is to provide teachers with ideas about how their students can assist them with technology" (p. 425). Most of the teachers in their study discovered that their students were very adept at helping them troubleshoot and provided good ideas for ways to integrate technology in the classroom.

According to the Generation YES program, over 50,000 teachers have had student help when planning technology use in their lessons (as cited in Ertmer et al., 2012). The 1:1 biology teachers in Gundy and Berger's study (2013) reported "learning from their students as they integrated the laptops into their instruction" (p. 39). The school district studied by Kopcha (2012) even included training student helpers are part of their 1:1 professional development plan. Along with training the teachers, "students were trained to assist teachers with troubleshooting and maintaining the computers during the school day" (p. 1112). When thinking about possible

resources for training and help, teachers and administrators should not overlook the ability of their own students to aid with technology use and troubleshooting.

However, simply relying on students to help is obviously not enough to provide teachers with the tools they need to teach effectively in a 1:1 program. Schools must rethink and revamp professional development. If not, a 1:1 program will not thrive. As quoted in Ertmer et al, (2012) "The most cited reason for lack of implementation of new technology is lack of professional development" (p. 430). William Penuel (2007) conducted an in-depth synthesis of several 1:1 programs and also found that "formal staff development has been a crucial component of many large-scale and smaller 1:1 programs" (p. 338). This same study also stressed that the teacher training must focus not just on the technology itself, but helping teachers "integrate technology into their instruction" (p. 338). Kopcha (2012) also notes that, "Training can be a barrier to technology integration when it lacks connection to actual classroom practice" (p. 1109).

In an older study on early ICT being used in the classroom, the researchers found that teachers desired training that was "appropriate to classroom use, had a hands-on element, and provided opportunities to work and share ideas with other teachers." (Williams et al., 2000, p. 317). The same holds true yet today. Donovan et al. (2007) also explain that professional development must be meaningful and relevant to be effective. They also propose that as the 1:1 initiative continues that teacher concerns be reevaluated and training aligned accordingly. Dunleavy (2007) designed a qualitative case study of two middle schools and their 1:1 computing programs, using interviews and observations to analyze what added value the laptops gave to the curriculum. These case studies sum up these ideas on professional development well with this thought: "Without a congruent professional development programme and clear

definition in programme objectives, certain uses of the technology for effective teaching may be ignored or overlooked" (p. 451). Schools must acknowledge the importance of professional development and must include this in their 1:1 budget planning.

Dunleavy's (2007) study, as cited above, also states that schools cannot just budget for the devices, hardware, and software, but they also have to budget for well-thought-out professional development. He explains, "If teachers and the technology specialists do not have opportunities to learn about and plan for meaningful and well-managed 1:1 uses, it is less likely that the laptop programme's goals will be reached, and the related investments warranted" (p. 451). With all of this being said, where does a school begin to plan meaningful professional development? The review of the literature shows many avenues a school might consider helpful in designing learning experiences for their teachers.

When thinking about professional development, many schools might first assume to look *outside* of the school in terms of consultants, trainers, and guest speakers. While these types of sources may be well-versed in new technologies, many schools have found greater success using an "in-house" approach to professional development and collaboration (Abilock et al., 2013; Kopcha, 2012; Spires et al., 2012). One of a school's greatest resources for professional development is indeed its own teachers, as several of the studies reviewed indicate. As cited by Klieger et al. (2009) Tubin and Chen (2002) point out that "the best form of training takes place inside the school and while working, thus enabling implementation" (p. 189).

Many studies (Abilock et al., 2013; Kopcha, 2012; Spires et al., 2012) since Tubin and Chen have continued to reiterate the idea that indeed the very best training can come from right inside the school. It has been found that the best professional development, in the eyes of teachers, comes in the form of mentors, peer coaches, or less formally, "tech buddies." (Abilock

et al., 2013; Kopcha, 2012; Spires et al., 2012) Spires et al. (2012) also inform us that "Administrators in 1:1 schools we have visited note that peer-to-peer sharing is one of the most effective sources of teacher ideas" (p. 70). A study by Drayton et al. (2010) found that "teachers desired professional development that included interaction with other teachers" (as cited in Spires et al., 2012, p. 68).

The literature reviewed also shows that this sort of training is much more than just a preference among teachers, it shows success. Kopcha (2012) in his analysis of several 1:1 programs finds that "mentored teachers integrate technology more frequently over time than teachers who do not learn with a mentor" (p. 1110). They are also "more confident with technology and more frequently employed student-centered uses of technology than non-mentored teachers" (p. 1110). In a study of six exemplary 1:1 schools (Spires et al., 2012), it is found that these schools had built professional communities within their school that consisted of trained technology peer coaches working with teachers to co-plan lessons. Consequently, successful technology integration ensues

Peer mentoring and coaching creates a safe environment for teachers to practice and experiment with the technology, but with support. Abilock et al. (2013) outline best practices for professional development in their article, "Growing Schools: Effective Professional Development." In their discussion with educators regarding successful professional development, they describe one school that worked to create "informal, customized learning" for their teachers. All technology questions and concerns were addressed with equal care, regardless of level of technology expertise. No question was deemed silly or too simplistic. Through "nonjudgmental support" and "informal and nonthreatening interactions" the participants felt safe and comfortable. The professional development planning team observed that the

participants "learned to trust us because we were coaches and partners; our goal was their achievement" (p. 11). The power of peer mentoring and coaching should be taken as a very legitimate form of professional development within a school.

As Gundy and Berger (2013) note, a "bottom-up implementation" has proved valid, as teachers work together in small groups, often by subject area, to help each other with individual technology needs. Administrators should not be afraid to let teachers take control of their own technology training and should allow sufficient time for teachers to work as a team, sharing with and teaching each other.

Despite the high success of peer mentoring and coaching as a form of professional development, more formal training should not be discounted. However, as schools look to plan formal training, they must make sure they are taking into account the needs of the teachers and assuring quality and meaningful presentations. The workshop approach may seem logical, but often fails to leave teachers with long-lasting resources and skills. Livingston (2006) states "the worst workshops were those in which skills were taught step by step" (as cited in Klieger et al., 2009, p. 190). This same report explains, "The effective workshops are those that gave the participants plenty of time to work in groups, laugh about common problems and share success stories, as well as failures, from the classroom" (p. 190). This idea shows a personal, and yet effective side to professional development. One group of teachers surveyed by Klieger et al. (2009) about professional development expressed the need for individualized training opportunities. They stated that it would be better to have fewer training sessions if it meant more "personal sessions in accordance with our needs" (p. 191). Here the teachers would have been satisfied with lesson training if it was more focused and relevant.

Holcomb (2009) summarizes well the characteristics of strong professional development based on several studies analyzed in her article, including: job-embedded, student-centered, collegial, ongoing, provided on a regular basis, anchored in the context of teaching and learning, and aligned with curriculum and standards. When schools plan for professional development, they must keep these sorts of qualities in mind, otherwise time and money will be lost. As one teacher keenly observed after a professional development session, "The professional trainer was more business-focused and didn't catch the educational angle" (Oliver & Corn, 2008, p. 227). The researchers noted that when training has the wrong focus (the product) the faculty is not shown how they might "leverage a 1:1 computing environment to change their teaching or engage in more student-centered learning." Schools must take into account the various facets of professional development and will find that with careful care and planning, training will have long-lasting results, and the technology will truly be used in transformative ways.

A Pedagogical Shift

Changing the digital culture of the school and ultimately teacher beliefs and attitudes is not a quick task. Teachers who feel pressured to do too much too quickly will be overwhelmed, and a negative attitude will result. If "slow and steady wins the race" this idea should be applied to technology integration as well. The biology teachers aforementioned in Gundy and Berger's (2013) 1:1 qualitative descriptive study of laptop integration, reported that it took at least two or three years to actually incorporate the computers well into the curriculum. This same group of teachers recommended that new teachers in the program should "plan to integrate the laptops only to their personal comfortable level and they should continue to use the teaching approaches, techniques and teaching materials that worked for them in the past as they begin the process of integrating laptops into their instruction" (p. 33). By acknowledging that it is ok to continue

with "traditional" methods as these new teachers learn technology integration methods from their colleagues, there would be less intimidation about embracing the new learning tools.

Kim et al. (2012) summarized the findings of several 1:1 studies explaining it has "been criticized that teachers have not been provided with adequate support that goes beyond learning specific technology skills, such as a particular tool or software" (p. 76). Oliver and Corn (2008) share that the technology director in the school they observed noted that "teacher-centered instruction was still the norm after implementing tablets" (p. 225). In data gathered by Mwalongo (2011) the most common uses of technology after the school's 1:1 implementation was note and exam preparation. In reality, the technology was simply being used for word processing. Mwalongo observes, "Such level of ICT use does not enable teachers to radically change their pedagogical practices. There is a need to go beyond such simple use by involving students in the use of ICT in order to transform students' learning" (p. 42). Kim et al. (2012) point out the fact that "using an interactive whiteboard just to present information without any interaction has no real pedagogical advantages over traditional whiteboards" (p. 78). Thus, it becomes necessary to really examine the technology use in terms of a pedagogical shift. Are we taking full advantage of what the technology has to offer, or are we simply "doing what we've always been doing, but with computers?" One principal in Maine leaves us with this thought: "Dropping a laptop into a classroom doesn't change learning for students. It takes a lot of professional development to change how technology is being used" (McLester, 2011, p. 7).

Creating an atmosphere where technology is embraced and helping teachers shift their attitudes and beliefs towards technology is a necessary preliminary step in implementing a 1:1 program. But far beyond this lies the need to help teachers shift their entire mentality surrounding learning and their role in the education process. Uredi (2013) expounds on this

notion, explaining that "rapidly developing science and technology has necessitated fundamental changes on educational approaches and has affected every field of education" (p. 50). He continues by suggesting that traditional educational methods are no longer appropriate and in a technology age are "inadequate." He emphasizes the need for 21st century teachers to take a constructivist approach to teaching. Constructivism requires teachers to allow for students to take control of their own learning, build on previous knowledge, and discover on their own. Teachers must provide real-life, authentic learning situations that allow for problem solving and collaboration skills. The 21st century teacher is no longer a "sage on the stage." Technology has played a large part in requiring teachers to rethink their place in the classroom.

Spires et al. (2012) described the change in dynamics that takes place in a 1:1 setting. Naming this the "new learning ecology" they note that teachers must be aware of the change in their role, which they define as, "content expert, facilitator, consultant, mentor, and improvisationist" (p. 68). They envision this concept evolving and changing as "one-to-one environments become more pervasive and as they continuously adapt with emerging technologies." Thus, return once again to the idea that the true focus of 1:1 implementation is not so much the technology itself, but the way it will be used and integrated.

Long after the 1:1 implementation plan has been achieved, the pedagogical implementation will continue. Klieger et al. (2009) explain, "pedagogical implementation becomes extremely significant, and the process where by innovation is implemented in the school is a gradual, long and complex one" (p. 188). "Complex" is without a doubt a word that comes to mind when discussing 1:1 implementation, technology integration, teacher preparation, and the long-term goal of transforming learning. However, with proper research and a careful and well-planned approach, schools will be more than able to reap all of the benefits of a 1:1

program. Ultimately the device itself will fade to the background and teachers will find themselves teaching in a whole new light, providing innovative and exciting learning experiences where technology is simply the tool, and transformed pedagogy is the result.

Conclusions and Recommendations

The focus of this literature review is to examine effective 1:1 implementation methods, relating specifically to three main questions: 1. What are the benefits of 1:1 implementation? 2. How can teachers be ready for 1:1 implementation? 3. How can teachers successfully implement 1:1 in the classroom?

The benefits of a school "going 1:1" are many, and it is agreed that as technology becomes an integral part of education, it is vital that students and teachers alike have easy access to new technologies. Students in 1:1 programs experience more engaging lessons, a student-centered approach to teaching and learning, collaborative opportunities, and even an increase in grades and higher attendance rates (Mama & Hennessy, 2013; Oliver & Corn, 2008; Shih et al., 2011). Teacher also benefit, becoming more technologically proficient, creators of more student-centered lessons, and all around stronger educators (Gundy & Berger, 2013; Holcomb, 2009; Oliver & Corn, 2008). One principal found that the 1:1 program in his school "brought staff to a new level of learning and creativity" (McLester, 2011, p. 4). Despite the many undisputed benefits of a 1:1 program, implementation and integration is often weak, and leads to unsuccessful use of the technology. What is often overlooked is the necessity for careful planning and implementation plans. If schools fail to properly prepare teachers for such initiatives, the technology will not be used in ways that will enhance and deepen learning.

Many 1:1 programs have known success by first determining teacher readiness. While not complicated, this is an important step. Many researchers found that a simple questionnaire or survey, using the Likert scale model can be very effective. (Donovan, Hartley, & Studler, 2007; Donovan & Green, 2010; Ertmer et al., 2012, Storz, 2013, & Williams et al., 2000) Such

surveys can reveal teacher concerns, perceptions, and areas of expertise or weakness. The reviewer of this literature would also highly recommend that all schools would consider such a survey before starting their 1:1 program. The results of the survey should be taken seriously and analyzed to recognize determine the particular needs of the school and teachers. Concerns should not be dismissed, but genuinely acknowledged and addressed. By giving the teachers a voice, and a means of expressing their concerns, this will help all involved feel that their needs are going to be met, and that they will not be left alone to navigate the tricky waters of 1:1 computing.

School administration and leaders must not take their role lightly in positively promoting a 1:1 program. Several of the studies reviewed stressed the huge impact school administrators can have on their staff and their perceived value of the 1:1 initiative (Karaca et al., 2013; Klieger et al., 2009; Piert & Hasso, 2011; Spires et al., 2012). A principal from one of Maine's 1:1 schools was interviewed explained, "I have seen some laptops be paperweights. It takes a lot of professional development and pushing by the principal to change how the technology is being used" (McLester, 2011, p. 38). Principals should not be afraid to "push" but must do so in an informed and inspirational manner that helps their staff see that they are aware of the benefits of 1:1 and are dedicated to providing their staff with the necessary support feel successful. If this does not happen, the laptops could very well prove to be expensive paperweights! It is recommended that administrators be involved in the 1:1 planning from the very beginning and must be able to explain the benefits and positive aspects of such initiatives to their staff. They should attend training with their staff to show their desire to learn alongside their teachers. When the staff sees an administration dedicated to the program, this will lead to teacher buy-in

and ultimately a smoother and more successful 1:1 implementation (Karaca et al., 2013; Klieger et al., 2009)

A needs assessment and survey of teacher attitudes will also play a big role in planning the needed professional development. Good professional development can make or break a 1:1 program. Several studies reviewed find that professional development is a crucial component to successful 1:1 implementation. (Dunleavy et al., 2007; Ertmer et al., 2012; Klieger, 2009; Kopcha, 2012; Penuel, 2006) The literature reviewed makes it clear that professional development must be relevant, hands-on, and based on teacher needs (Donovan et al,.2007; Holcomb, 2009; Williams et al., 2000).

Teachers have also found that students make great helpers when it comes to technology integration and can be instrumental in helping discover innovative ways to use the new devices. (Ertmer et al., 2012; Gundy & Berger, 2013, Kopcha, 2012) Schools should not overlook the untapped potential in their students to help with a 1:1 program and the integration of devices. Schools might consider student trainers, a student-run help desk, students doing presentations on Web 2.0 tools for teachers, or giving students a voice on the school's technology committee. Teacher buy-in is essential in a 1:1 program, but there must be student buy-in as well! If students are invited to be a part of the implementation process, this will not only help teachers be comfortable with the technology, but would help students feel more invested in the project as well.

For any 1:1 program, schools cannot ignore professional development. Included in any technology budget must be money for on-going professional development. While formal professional development is a must, the literature review revealed that in-house, peer-based professional development was the preferred method by teachers and also the most successful.

(Abilock et al., 2013; Klieger et al., 2009; Kopcha, 2012; Spires et al., 2012) When teachers are coached and mentored by their peers, they are able to experiment with the technology in a safe, and even fun, environment. It is highly recommended, based on the literature reviewed here, that schools seeking to start a 1:1 program consider training a group of their own staff who are more comfortable with technology to be these peer mentors and coaches. Even the most resistant teacher would probably warm up to the idea of a "tech buddy!" In another of McLester's (2011) interviews with principals in 1:1 programs, one principal stressed the need of "developing a school culture of learning, and of building leadership capacity among staff members in order to take full advantage of a laptop program" (p. 38). A culture of learning and collaborating will encourage technology use and will inspire all teachers, tech savvy or not, to try implementing technology.

Schools must also realize that even with new technology, and good training, it can come down to teacher beliefs and attitudes affecting 1:1 success. Many researchers discover that teachers who did not feel comfortable with the technology consequently did not have a positive attitude towards it, and ultimately failed to use it or only used it in very shallow ways (Ertmer et al, 2012; Mama & Hennessy, 2013; Storz & Hoffman, 2013; Williams et al., 2000). It is a must that schools take the time to analyze teacher attitudes and beliefs in their own building and work to find ways to help all teachers overcome certain fears relating to the technology. In doing this, a huge obstacle to effective implementation can be overcome, and the program will definitely know more success for all teachers and students.

As 1:1 computing becomes more mainstream and widespread, more research will continue to be gathered to help us understand even better the implications for a well-thought-out implementation methods. Currently much of the research concerning professional development

and teacher attitudes is based on interviews, observations, and some surveys/questionnaires. However, many studies did use quantitative methods show a direct relationship between teacher attitudes and technology use. Also, teachers in schools with successful 1:1 programs were asked to share their concerns, and in turn, professional development was planned accordingly. It will be interesting if further research can show a correlation between student achievement in a 1:1 program and the implementation methods and teacher training of the school. As 1:1 programs also become more commonplace it would be valuable to also study the shift in pedagogy and educational theory. Will "teacher as facilitator" become common practice? Will "constructivism" become a familiar term to all teachers? Will these ideas relate directly to technology and 1:1 programs?

Technology has had a powerful impact on society, and this cannot go overlooked in the education field. A 1:1 program can provide students with the access to technology that they need to learn skills necessary to face future demands. This being said, if teachers are not prepared to best use this technology in their classrooms, it will do no good. Schools can make the best out of both the technology and their teachers by assessing teacher needs, assuring teacher readiness through engaging professional development, and working together to break down beliefs and perceptions that might hinder technology integration. In doing so, we can face the future of technology in the classroom with a positive outlook, creating an atmosphere of excitement and innovation for our students.

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