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Doing the Same Thing but with Pretty Colors: Teaching and Change in 1:1 Ipad Secondary Classrooms

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ABSTRACT

This yearlong, multi-case qualitative study examined four secondary teachers who taught in a Midwestern, suburban 1:1 iPad high school. Participants taught various subjects and ranged in years of experience. The purpose of this study was to understand how teaching in 1:1 iPad classrooms changed how participants thought about or enacted their teaching. Cross-case analysis demonstrated that teachers enacted different types of change. Created as a result of this study, these change types are identified in the ACR ["acer"] Framework and have implications for inservice teacher learning and professional development.

Keywords: *educational technology, one-to-one (1:1) technology, secondary education*

INTRODUCTION

Now more than ever before, there is growing interest and investment in K-12 school technology as a means of developing students to actively participate in a knowledge and technological-based society (International Society for Technology in Education, 2015; Lei, Conway, and Zhao, 2008). One type of K-12 technological integration focuses on one-to-one (1:1) digital device models, in which every student and teacher operates a mobile device such as a laptop or tablet computer. Lei, Conway, and Zhao (2008) suggest that 1:1 technology offers teachers and students sophisticated tools and provides additional resources and opportunities, including access to the Internet, 24/7 accessibility, and increased communication. According to Martin and Ertzberger (2013), 1:1 technology provides "here and now learning" in which students utilize mobile technology, often resulting in changes in their learning environments.

However, integrating technology in K-12 settings is complex and often challenging (Mishra & Koehler, 2006; Mishra, Koehler, & Kereluik, 2009) and many teachers still conceive of and utilize technology as an add-on to what they already do, rather than a means of changing their teaching (Bebell & Kay, 2012; Cuban, 2001; 2013). As a result, 1:1 devices are often used to support teacher-centered rather than student-centered pedagogy (Palak & Walls, 2009). To gain an in-depth understanding so that more substantial change efforts can be understood and supported, the present yearlong study examines four secondary teachers' thoughts about and experiences with teaching in 1:1 iPad classrooms during the second year of a bond-based initiative at Watertown High School (WHS), a suburban Midwest United States public school district.

REVIEW OF LITERATURE

Although analogue educational technologies are already embedded in almost all levels of the nation's public school system, the potential for digital educational technologies continues to expand (Borko, Whitcomb, & Liston, 2009; Zhao, Zhang, Lei, & Qiu, 2016). But, how and why teachers use digital educational technologies in their classrooms often depends on their contexts (Harper & Milman, 2016). Educators' uses also depend on teacher characteristics, such as educators' pedagogical stances toward constructivist teaching (O'Dwyer, Russell, & Bebell, 2004), levels of confidence regarding using technology (Hennessy, Ruthven, & Brindley, 2005; Palak & Walls, 2009), and the efficacy of incorporating technology in particular content areas (Hennessey, Olofson, Swallow, Downes, 2015).

One hope is that technology will shift teachers' pedagogy, making their teaching more student-centered (Hennessey, Ruthven, & Brindley, 2005). This hope, though, is not always realized. Gorder (2008) analyzed survey data from 174 United States K-12 teachers regarding their integration and use(s) of instructional technology. Teachers' responses indicated that although they used technology to deliver instruction, their uses remained teacher-centered.

Recently, Koh, Chail, and Tsai (2014) found that Singapore practicing teachers' confidence with regard to technology integration was directly tied to the level of their technological pedagogical content knowledge (TPACK). The less a participant understood about technology and its pedagogical implications, the less likely technology was used to support and extend student learning. Thus, when teachers use technology their uses often do not support a student-centered instructional model but, rather, still promote a more traditional, teacher-centered model in which teachers direct and facilitate instruction (Cuban, 2013). This has led some researchers to conclude that teachers who use technology within a traditional teacher-centered model classroom often conceive of and utilize technology as an add-on to what they already do, rather than a means of changing their teaching (Cuban, 2013; Gunn & Hollingsworth, 2013).

Now, often the ratio of educational technology to students and teachers is 1:1 (Johnson, Adams Becker, Estrada, & Freeman, 2015) and many teachers have hopes for ways 1:1 technology can support teaching and learning, despite findings which indicate that these hopes are often not realized (Harper & Milman, 2016; Kearney, Burden, & Rai, 2015). Some researchers argue that 1:1 technology will change teaching and learning for the better (Lei, Conway, & Zhao, 2008; Lei & Zhao, 2008). For example, Lehmann and Livingston (2011) claimed that in a 1:1 laptop classroom the teacher's role changes because in a 1:1 technology environment, students can obtain information in a myriad of ways (e.g., websites, videos, etc.). However, Cuban (2013) claims that most, if not all, changes teachers make in adopting a new technology, such as 1:1 laptops or tablets, often solidifies familiar and conventional teaching practices. Swallow's (2015) study of potential drawbacks of 1:1 technology programs indicates that desired teaching and learning outcomes were not necessarily achieved after implementing 1:1 technology in K-12 classrooms. Thus, the addition of 1:1 digital technology in a classroom does not add value. Rather, it is how 1:1 digital technology is applied (Lehmann & Livingston, 2011).

Harper and Milman's (2016) recent literature review of 1:1 technology in K-12 classrooms indicates that the presence of mobile devices in K-12 classrooms does not guarantee changes in teachers' practice, a finding supported by Ifenthaler and Schweinbenz's (2013) pilot study of German middle school teachers who used Tablet-PCs in their teaching. Lindsay's (2015) study of New Zealand teachers found that although 1:1 technology supported the potential for teachers' "pedagogical transformation," change was only partially realized because oftentimes teachers used 1:1 technology to support students' access to information and the completion of previously conceived of learning tasks. Thus, although 1:1 technology provides additional access, there exists little evidence that technology drives change in classroom practices to support students' learning needs (Daniels, Jacobsen, Varnhagen & Friesen, 2014; Gunn & Hollingsworth, 2013).

According to Inserra and Short's (2012) study of U.S. secondary content teachers' teaching practices in 1:1 technology classrooms, teachers must first understand the relationships between technology, teaching, and learning. If they understand these relationships, they are better equipped to use 1:1 technology to foster students' problem-solving skills and higher-order thinking. Zuber and Anderson's (2013) study of secondary mathematics teachers in a 1:1 laptop program also indicated that teachers' knowledge of and pedagogical beliefs about 1:1 technology's effectiveness with regard to mathematics instruction impacted ways teachers used 1:1 technology to teach mathematics. Hennessey, Olofson, Swallow and Downes' (2015) work with middle school mathematics teachers and the impact of 1:1 technology in their teaching further confirms this assertion.

THEORETICAL FRAMEWORK

This study is informed by work on teacher knowledge and teachers' responses to change. Teacher knowledge embodies aspects of what educators need to know and be able to do and forms the foundations for teachers' thinking and actions (Borko, 2004; Putnam & Borko, 2000). Teacher knowledge – and, by extension, teachers' actions – are rooted in particular contexts (Bruner, 1996), making contextual knowledge an important part of what teachers need to know and be able to do. Context informs teachers' understanding of the location and culture(s) in which they teach, their colleagues and students, as well as

the content they teach (Lave & Wenger, 1991).

Teacher knowledge also connects to Wenglinsky's (2005) idea related to "goodness of fit," a statistical term regarding the proportion of variance a model explains. Wenglinsky used "goodness of fit" to measure the degree to which teachers' reported uses of technology impacted their students' academic performance on the National Assessment of Educational Progress (NAEP). However, a non-statistical, broader definition of "goodness of fit" – namely a teacher's knowledge and assessment of a "goodness of fit" between their context, curriculum, and available technology – is applicable to this study. Teachers who successfully integrate and use technology in K-12 classrooms understand technology and pedagogy and, as a result, are able to use this knowledge to determine a "goodness of fit" between their context, curriculum, and available technology.

Technology integration also introduces change regarding ways teachers achieve instructional objectives and learning outcomes (Zhao, Zhang, Lei, & Qi, 2016). According to Cohen (1990), there are two important ways teachers experience and respond to change. In his case study of a teacher who experienced important curricular changes, Cohen used the metaphor of weaving in which "the practice of teaching comprises many different threads" (p. 314).

Connected to this metaphor, one response to change is when a new instructional thread is introduced (i.e., a change) and teachers relate it to their already established fabric of teaching. In this instance, the new thread is dropped onto their existing teaching fabric and everything else is left as is. Another response to change occurs when new threads are somehow woven into the fabric. In this instance, existing threads are adjusted in some way, sometimes moved and at other times pulled out and replaced. According to Cohen (1990), even when change occurs many parts of an educator's teaching fabric remain the same, resulting in what Cuban (2013) terms "an uneasy equilibrium of stability and change" (p. 170).

Lei and Zhao (2008) call for additional research to examine teacher uses and outcomes as well as teacher learning with regard to 1:1 technology initiatives. Part of this research, they suggested, should focus on ascertaining how, when, and why teachers choose to integrate 1:1 technology into their content area(s) and particular factors that contribute to teachers' perceptions and usage. Intended as a response to this call, the present study seeks to connect the concepts of goodness of fit, Cohen's (1990) metaphor of weaving, and Cuban's (2013) "uneasy equilibrium of stability and change" (p. 170) to address the following question. In what ways, if any, does teaching with 1:1 iPads change how secondary teachers think about and enact teaching?

METHODS

Watertown Public Schools (WPS) (all names/locations are pseudonyms) is a suburban U.S. Midwestern school district that implemented 1:1 technology as part of a bond-based technology initiative. The bond provided all secondary teachers and students (grades 6-12) with school-owned iPad 2s to use on and off site during the school year. During the school year in which this study took place, WPS was in its second year of their bond-based initiative and Watertown High School (WHS) enrolled approximately 1,900 students and employed 97 full and part-time faculty. For this study, I employed a descriptive, multiple case study design (Yin, 2009).

Although not used for generalizability, case study method is important when studying complex phenomena in real-life contexts (Yin, 2009). Through observations and interviews, I focused on four secondary teachers and their teaching within the real-life contexts of their classrooms and the school in which they taught. Including multiple teachers afforded opportunities to collect and examine evidence across more than one case (i.e., teacher), making the study and its findings more robust (Yin, 2009).

WHS teachers with at least one year of teaching experience at WHS were invited to join the study (n = 87). They were recruited via an individual email sent to each faculty member during the first month of school. Eleven volunteered. Thus, I utilized purposeful sampling (Creswell, 2013) to identify those with six or more years of teaching experience, based on Russell, Bebell, O'Dwyer and O'Connor's (2003) finding that after six or more years "teachers have become comfortable with curriculums, schools, and other aspects of teaching, [so] they have the time and energy to invest in exploring ways to use technology in their classrooms" (p. 308). This left eight teachers. I then used stratified, purposeful sampling (Cohen, Manion, & Morrison, 2007) to obtain a cross-section of teachers who taught different content areas, increasing the diversity of participants' backgrounds, experiences, and perspectives. As a result, four participants were selected with teaching experience ranging from eight to thirty years and included chemistry teacher Ralph, a 30-year teaching veteran; Tim,

a Spanish teacher with 17 years' experience; Josh, an Advanced Placement (AP) psychology teacher with 16 years' teaching experience; and, Brian, a second-career English Language Arts (ELA) teacher who finished his ninth year teaching during this study. Although all participants were males, issues of gender were not explored (beyond the scope of this study).

The primary sources for this study include multiple un-structured, descriptive classroom observations of participants throughout the school year (10-15 per participant) and four semi- structured interviews at various points during the school year with each participant (45-90 minutes each). Secondary sources include: 1.) participants' responses to an initial online survey; 2.) participant-generated artifacts (e.g., website content, assignments, lesson plans, syllabi, etc.); and, 4.) researcher's field notes and analytic memos (Miles, Huberman, & Saldaña, 2014) captured before, during, and after data collection. During data analysis I utilized descriptive coding (Miles, Huberman, & Saldaña, 2014), generating descriptive case reports for each participant. Then, I re-examined primary data sources and applied interpretive codes centered on evidence of change. Throughout data analysis, I looked for and examined patterns and uniqueness in participants' perspectives, uses, and course content related to teaching in 1:1 iPad classrooms (Creswell, 2013).

RESULTS

Ralph

During this study, Ralph was in his 29th year of teaching at Watertown High School (WHS) and certified to teach math and science. He taught four sections of Honors Chemistry (sophomores and juniors) and one section of Advanced Chemistry (juniors and seniors).

According to Ralph, many of his students were interested in pursuing science, technology, engineering, and mathematics (STEM) related fields in college. When Ralph talked about the purposes he had for using 1:1 iPads in his classroom, Ralph's unequivocal response was to prepare his students for college chemistry.

Throughout the school year, Ralph and his students used a free online chemistry textbook and its supplemental materials as the basis for learning. Students accessed this resource via a web browser on their iPads. Ralph also encouraged his students to utilize graphing calculator iPad apps to solve chemical equations. In the middle of the year he worked with a district technology coach to use Google Forms to collect and grade students' answers for the laboratory portion of their semester exam. Ralph also allowed students to use their iPads during class to access PowerPoint presentations that corresponded to his in-class lectures, Ralph also allowed students to use their iPads during class to access PowerPoint presentations that corresponded to his in-class lectures.

Ralph talked about the ways he added content to his class website and shared digitized materials electronically with his students, which they accessed via a web browser on their iPads. During one interview, Ralph observed that in order to share his knowledge and enthusiasm with his students, his classroom remained teacher-centered most of the time. "I'm the one conveying knowledge to the kids. That's probably the classic definition of what goes on here. That's how I was taught and that's generally how I've taught all these years." This instructional model was further corroborated by classroom observations.

Although Ralph indicated that he liked using the 1:1 iPads, one of Ralph's frustrations with the iPad was its inability to load and play Adobe Flash-based content. As a result, one reason he did not often use the iPad related to his perceived incompatibility between Flash-based content and the iPad. Ralph explained that he had to "find stuff that fits the technology we have. There's not a lot of iPad compatible apps. There's a ton of stuff online for computers, but it's all Flash-based." At another point during the study, Ralph shared, "most of the simulation stuff for chemistry isn't Flash compatible. Science is one of the early adopters of computer technology so there's a rich bank of stuff that is Flash based out there. It just doesn't work for us." For Ralph, the lack of Flash was a consistent theme throughout the study and influenced how he thought about the iPad and, to some degree, why and when he chose to use it.

Josh

At the time of this study, Josh had been teaching for 16 years. During this study, he taught five sections of AP Psychology, a course he has taught for ten years. Central to Josh's teaching is his commitment to helping students prepare for and pass the College Board's Advanced Placement (AP) Psychology test. As a result, he looked for ways to help his students learn and study AP content, including exploring an online flashcard and test review website and using an online student response system for in-class AP test preparation.

His goal with these e-resources was aimed at

helping his students learn and retain information to pass the AP test. Josh believed he was a successful teacher because many students scored well on the AP exam. For instance, the previous year's approximately 200 WHS students earned an average score of 3.7 (out of 5.0) on the AP Psychology exam, and the approximately 200 students who took the AP test during the school year in which this study took place produced an average AP test score of 3.8 (out of 5.0). In Josh's experience, 1:1 iPads had not yet proven to improve students' achievement on the AP test, which was why he used 1:1 iPads on a limited basis. When asked how he structured his classroom and teaching, he responded, "teacher-centered. Very teacher-centered [because] I just don't trust the motivation of the students to learn on their own [with the iPad]."

As evidenced by his interview responses and corroborated by in-class observations, Josh's experiences as a student and as a veteran AP teacher influenced the model of teaching he believed worked best to prepare students for the AP test. During the third interview he explained, "I think for some teachers [with the iPad], it's become more of they 'flip it' [their instruction], they move around, they do less lecturing." He continued, "I don't feel comfortable doing less….I'm still not to the point where I'll let them learn from this thing [the iPad]. So that hasn't changed." He also noted that this teacher-centered instructional model was not uncommon among AP Psychology colleagues, whom he interacted with via online AP discussion forums and at AP trainings and conferences. "Even the [AP teachers at the] schools that have the 1:1 capability are still lecturing. It's the only way to get through the amount of material."

Josh utilized technology to update lecture materials, such as PowerPoint presentations and videos. During the second interview, in response to a question regarding the role technology played in his classroom, Josh explained,

> I think I would say that it [the iPad] is like a supplement, like a textbook. With the idea that it's there for them to review. It's there for them as an aid to the lectures. It's there for them to go back to on their own time, rather than it teaching them. I don't use it a ton, I know.

Following this response, he shared that he did not know of a lot of apps and websites students could use on their iPads to learn what they needed to know to pass the AP psychology test, which appeared to reinforce Josh's skepticism regarding students using iPads to learn course content.

Tim

A 20-year veteran teacher, Tim taught in multiple states before being hired to teach Spanish and history at WHS. During the year this study took place, he taught four sections of required honors Spanish Two (freshmen and sophomores) and one elective, Spanish Three (sophomores, juniors, and a few seniors). During this study, Tim learned about and employed some new apps, websites, and assignments. One app allowed students to use "spaceships" during a test review activity and another enabled students to post and read peers' responses to Spanish music. Tim employed websites that permitted students to search for and view Spanish video- based content, and during this study he and his Spanish Two colleagues created and implemented a video-based assignment focused on legends and heroes. Tim viewed himself as a facilitator of his students' learning and he directed students to various websites and applications they should use to complete their work.

Many of Tim's iPad uses enabled him to teach as he had done before but with a 1:1 device or, in Tim's words, "a different tool." During the last interview, Tim concluded that even though he taught in a 1:1 iPad classroom, his teaching had not really changed.

> I don't think there's much difference in what I teach, the pacing in which I teach, the expectations that I have for the outcomes….So now, we're using the iPad to present, using the iPad to research, we're using it to write – before it was pen and paper and making a poster or a PowerPoint to present the ideas. But the process, I think, is pretty much the same. It's just a different tool.

Tim's idea of a "different tool" was evident throughout the study. For example, he no longer used his classroom desktop or home computer to send and receive emails or access the Internet; now he used his iPad to perform these tasks. Tim also created and utilized electronic versions of his hardcopy worksheets. With fingers or stylus pens, students completed these worksheets on their iPads and when required to submit their work, they most often sent Tim attachments via email. Sometimes Tim used his iPad to project images on a pull-down screen in his classroom. For example, he used a photo app to show students pictures corresponding to vocabulary words, providing students with a visual of each word as they said the word aloud in class (e.g., "mostaza" =

mustard, represented by a picture of mustard on a hotdog). According to Tim, in previous years before the implementation of 1:1 iPads, students created hand-drawn pictures or cut pictures out of magazines to create vocabulary flashcards.

Thanks to the embedded camera in the iPads he and his students used, Tim's students sometimes used their iPads to take digital pictures of course-related information during class. Tim also assigned a video-based project, requiring the use of a movie-making app to create a Spanish-language video to be shared in class. This was a change from previous assignments in which students wrote and performed Spanish-scripted narrations, skits, or short stories during class. Tim still implemented some live student performances because he believed students needed real-time, peer-to-peer practice using their Spanish language skills. However, students also used their iPads to create, record, edit, and share their language skills. Tim described his teaching as "interactive" and stated that the iPad did not always do a good job facilitating the types of interactivity he wanted to promote. During one interview, he explained that world language acquisition is really a "face-to-face experience, so 80% to 90% of the time I'm going to opt to not have the technology because I just don't want it to get in the way."

Brian

During this study, Brian was in his 9th year of teaching at WHS and taught five sections of sophomore English Language Arts (ELA). Two of his courses were English 10 "Foundations" courses which enrolled struggling students. Beyond his role as a teacher, he also functioned as a WHS peer "technology coach," a paid, extra-duty position created to support teachers during the first two years of the WHS 1:1 iPad integration. He reported that he enjoyed being a technology coach because it enabled him to learn from and work with his peers as they identified ways to integrate 1:1 technology in their classrooms. As a teacher, Brian committed himself to building relationships with students, being a positive role model, and providing students opportunities to use language and literature to learn about themselves, others, and the world in which they lived. Of the four participants, he most often modeled, promoted, and integrated 1:1 iPads to support and extend students' learning.

Brian's ELA course content centered on grammar instruction, literature, reading, writing, and speaking. Since the implementation of 1:1 iPads, Brian explained how he moved around his classroom all the time, a fact corroborated by classroom observations. Rarely did Brian instruct from the front of his classroom for more than the first five-ten minutes. Most of the time in his three English 10 classes, students accessed Brian's app-based classroom management system on their iPads, retrieved course materials, and worked independently or in small groups. While students worked, Brian moved around his classroom, checking in and talking with students. In his English 10 Foundations classes, although these students had different needs and required additional scaffolding, he used a web-based learning management system to post and share daily checklists to remind students of work they needed to complete. In all five of his classes, he spent the majority of his time working one-on-one or in small groups with his students. In connection with this change, Brian shared how he believed that his students benefited from using their iPads and having Brian available in class to explain things which further scaffolded and supported their learning.

Although Brian reported that he experienced "profound change" when he used 1:1 iPads in his classroom, he recognized that this change was not just the switch to a 1:1 digital device model, nor was it the result of consistent access to and use of the Internet and apps. Having the opportunity to teach in a 1:1 iPad classroom also provided Brian with opportunities to change some of his own thinking and understanding about how he could meet his students' needs and create an environment that supported project-based, hands-on learning. During the second interview Brian stated,

> I think in some ways people limit themselves with the one-to-one technology. Oh, we need to find an app to do this? I would say if that app is going to help generate more interest in the activity, then great. If you're just seeking out apps for the sake of doing the same thing but just with pretty colors, then why bother?

Using the 1:1 iPads, Brian created opportunities for collaboration between students in his classroom and between students and the world in which they lived. For example, he required students to tweet or email questions to experts in various fields during a group-based research project and he expected them to regularly contribute to a classroom blog, sharing their ideas and writing. He utilized a free classroom blog website to facilitate peer-review of students' work across three English 10 sections.

Brian also modeled how to use the iPad to

connect to the outside world. For example, he introduced and required his students to use a relatively new school-friendly, research-centered website to conduct research for a class project. Seeing the large number of users from one location (i.e., Watertown, USA) the website creators reached out to Brian via email. As a result, Brian ended up video-conferencing with these individuals and he talked to his students about these conversations. He also provided these developers with feedback generated as a result of using their site and this collaboration netted Brian and his students an opportunity the following school year to beta-test the website's new iPad app.

DISCUSSION

Findings suggest that the teachers in this study enacted change in various ways. Moreover, what these teachers know and believe about the whole enterprise of schooling, namely its purpose and its ends, including benefits for students and society(s), seemed to be the critical driver of change. Their knowledge and beliefs also appeared to serve as an important filter regarding their technological implementation and integration of 1:1 technology. Generated from the results of this study, three categories serve to broadly identify the ways these secondary teachers thought about and enacted change in their 1:1 iPad classrooms. These categories comprise the ACR ["acer"] Framework, in which the three types of change, "Adding On," "Combining," and "Remaking," offer descriptions regarding the type of change teachers enact when teaching with 1:1 technology. These change types function as extensions of Cohen's (1990) work, regarding what teachers metaphorically do to their teaching fabric when required to implement a change, such as teaching with 1:1 iPads. To distinguish between the three types, definitions and indicators as well as examples from this study's data are included (Table 1).

Table1. *ACR Framework: Three Types of Teacher Change in 1:1 iPad Classrooms*

Type	Indicators	Examples
Adding On: Supplement old with new	Teachers employ 1:1 technology to support pre-existing pedagogy, practices, and course content.	Convert hard copy worksheets and handouts to electronic versions (Ralph; Josh) Provide in-class lecture materials electronically (Ralph; Josh)
Combining: Blend old with new	Teachers use 1:1 technology to accompany and extend established pedagogy, teaching practices, and course content.	Adjust previous assignments to include multimedia elements (Tim; Josh) Utilize apps and websites to further students' exploration and understanding of course content (Ralph; Tim)
Remaking: Remove old and replace with new	Teachers utilize 1:1 technology to generate and implement new ways of teaching, communicating, and assessing students.	Use apps and websites to broaden students' audience and increase the ways they may demonstrate knowledge and understanding (Tim; Brian) Employ social media and electronic resources to expand access to and connection with "out-of-school" peers and experts (Brian)

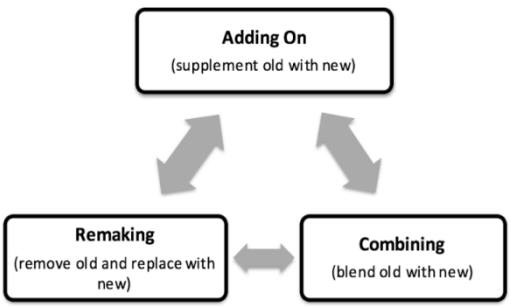

Figure1. *ACR Framework: Three Types of Teacher Change in 1:1 iPad Classrooms*

The examples included in the ACR Framework for each change type are by no means exhaustive. Instead, they are intended to illustrate some of the ways teachers enact change when teaching in 1:1 iPad classrooms. Moreover, although the table represents these change types in a hierarchical, ordered format, the ACR Framework should be understood as reflecting the recursive, ongoing process of teaching (Figure1).

Adding On

In the ACR Framework, "Adding On" occurs when a teacher supplements something old with something new. In this study, when enacting "Adding On," what teachers did previously remained central to their teaching and planning. As indicated in Figure1, when teachers enacted "Adding On" relative to 1:1 iPads, they used 1:1 technology to further support their existing pedagogy and practice. Results indicate that Ralph and Josh most often enacted "Adding On" when they made changes in their planning and teaching. Both teachers understood and viewed 1:1 iPads as an "Add-On" to their content and how they taught, reporting that even with 1:1 iPads they continued to teach in similar ways as before 1:1 iPad implementation. This type of change connected to their perceived roles as teachers and the expectations they held for themselves, including what they believed to be the central tenets of their work and teaching.

These examples highlight the ways in which Ralph and Josh viewed the iPad as a means of supporting their pre-existing pedagogy, practice, and course content. The connection between their understanding and their enactment of "Adding On" aligns with Ertmer and Ottenbreit-Lefwich's (2010) review of literature focused on the characteristics and types of understanding teachers need for effective technology implementation and integration. Teachers like Ralph and Josh, who maintain a teacher-centered view of teaching and learning even when they integrate 1:1 technology, demonstrate how closely teachers' technology integration practices align with instructional beliefs and philosophies (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Zhao, Zhang, Lei, & Qi, 2016).

Another reason these two teachers most often experienced and enacted "Adding On" connects to the broader concept of "goodness of fit." Specifically, teachers' perceptions and assessments of a "goodness of fit" between technology, their context, and students' required tasks – informs the choices and connections they make between their curriculum and the technology available. Neither Ralph nor Josh saw a clear "goodness of fit" between the 1:1 iPads and their curriculum or end goals. In Ralph's case, the iPad's lack of Flash compatibility provided a rationale for limiting the ways he planned and taught with 1:1 iPads. Josh did not believe his students could effectively and independently access and learn AP course material using 1:1 iPads. Josh's stated goal was to prepare students to take and pass the AP Psychology test and he did not view the 1:1 iPads as fundamental to achieving that goal. As a result of their perceptions regarding a "goodness of fit," Ralph and Josh enacted "Adding On" when integrating 1:1 iPads in their classrooms.

Combining

When teachers enact "Combining," they blend old with new. In a 1:1 iPad classroom, they use technology to accompany and extend established pedagogy, teaching practices, and course content. Results suggest that in addition to enacting "Adding On," Tim also enacted "Combining". For example, Tim's pedagogy and practice appeared to shift when he was introduced to and explored various online tools. When Tim understood how to use these websites to provide web-based opportunities for students to practice and share their writing (in Spanish), he integrated these tools into his teaching. The more he perceived a "goodness of fit" between his curriculum, student learning goals, and iPad technology, the more willing he was to explore and integrate 1:1 iPads.

As a result of "Combining" old with new, Tim often utilized his additional understanding and willingness to integrate 1:1 iPad technology to extend his teaching and students' learning.

This type of change highlights Inserra and Short's (2012) finding that for incremental changes to occur when teachers use technology in their classrooms, teachers must first understand the relationships between technology, teaching, and learning. In Tim's case, when he understood the affordances of particular tools available via the iPad he was better equipped to enact "Combining" and when doing so he was careful to align sites, apps, and tools with his existing curriculum.

When Tim enacted "Combining," he went through an "adaptive process" negotiating, reworking, rethinking, and integrating of 1:1 iPads within his teaching and classroom (Lei, Conway, & Zhao, 2008). Tim's enactment of "Combining" was based on his perceptions regarding the "goodness of fit" between his curriculum and 1:1 iPads. This "goodness of fit" was also reflected in the pedagogical beliefs he articulated about what was "best for students" when it came to teaching and learning a new language. When Tim chose to "blend old with new," his understanding of and practices with the 1:1 iPads evolved in ways that resulted in additional uses and changes in his planning and practice (Hicks, Young, Kajder, & Hunt, 2012).

Remaking

When teachers like Brian enact "Remaking," they "remove old and replace with new." Lehmann and Livingston (2011) claimed that 1:1 technology creates classrooms where "teachers are facilitators and mentors, guiding students through learning and creation…[and] it stops being about the technology and becomes about the work" (p. 77). In choosing to enact "Remaking," Brian was "not afraid to build learning experiences that don't always go exactly according to plan, but instead involve[d] some element of flexibility while striving for innovation" (Hicks, Young, Kajder, & Hunt, p. 73). Brian's perceived "goodness of fit" between his curriculum, students' learning, and the affordances of 1:1 iPads is reflected in his enactment of "Remaking" and use of 1:1 iPads to "generate and implement new ways of teaching, communicating, and assessing students" (p. 73).

Similar to Tim, Brian also saw direct connections between 1:1 iPads and his English Language Arts (ELA) curriculum. However, the connections Brian made extended beyond "Combining" because when he taught and planned, Brian often used 1:1 iPads to "remove old and replace with new". The ways in which Brian understood and used 1:1 iPads provided new opportunities for his students to be challenged, actively engaged, and part of the learning process. When Brian enacted "Remaking," he generated new ways of teaching, which included teaching his students how to use the 1:1 technology, which extended beyond troubleshooting technical difficulties. During class and via self-made or web-based videos, Brian often modeled how and why to use particular apps, websites, and iPad functions. Additionally, he was explicit with students about how and why to practice responsible digital citizenship, including citation of sources and considerations regarding social media and interacting with others online – something he reported doing only after teaching in a 1:1 iPad classroom.

Throughout this study, Brian often engaged in "Remaking," which included adding new teaching practices, such as those centered on understanding and teaching students how and why to use technology responsibly. This, it seems, was because he saw a "goodness of fit" between his instructional beliefs and philosophies with his understanding of how to use 1:1 iPads to promote student learning (Boling & Beatty, 2012; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). These connections Brian reported (also corroborated through additional data sources) aligns with the broader definition of "goodness of fit" used to describe participants' change types.

When examining and looking across the three types of change using the ACR Framework, it is likely that most, if not all teachers will enact "Adding On" at various points if they teach in 1:1 iPad classrooms. Given that all four participants engaged in "Adding On", there are clearly times when this change type makes the most sense, such as when teachers digitize and electronically share course content. However, 1:1 iPads may also be used to extend teachers' pedagogy and practice (i.e., "Combining") as well as generate and implement new ways of teaching, communicating, and assessing students ("Remaking"). Thus, the teacher's goal should be to understand the technology they use well enough so that when possible and applicable, they will recognize and connect a "goodness of fit" related to each change type. In doing so, teachers may be better equipped to embrace the dynamic and fluid nature of teaching and learning with technology (Zhao, Zhang, Lei, Qi, 2016).

Contrary to the notion that educational technology and teachers' use(s) of technology is hierarchical in nature (e.g., Puentedura's (2006) Substitution, Augmentation, Modification, and Redefinition (SAMR) model), technology integration alone is not sufficient to enhance learning outcomes (Russell, Sorge, & Brickner, 1994; Zhao, Zhang, Lie, Qi, 2016). Rather, teaching and learning with technology is a process. The goal of technology integration within educational settings is not to achieve a particular change type for the sake of "achieving" change. Instead, teachers should be integrating and using technology in ways that reflect the purposeful, recursive, and systematic process of instructional design (Reiser, 2012).

To be equipped to understand when and what type of change is necessary to best support and extend student learning, teachers must continue to enhance their understanding so they are readily equipped to enact change, all the while keeping forefront context, content, and student needs. The potential value of the ACR Framework – including the articulation and use of these change types, as evidenced in the examples generated through this study – is that it has potential to be used descriptively, offering common vocabulary for researchers and practitioners to understand the type(s) of change teachers choose (and, perhaps, need) to enact when teaching in 1:1 technology classrooms.

LIMITATIONS

By design a comparative case study aims to provide thick description of the variables and individuals in question (Yin, 2009; Geertz, 1973) and although much may be learned from these four teachers and their experiences teaching in 1:1 iPad classrooms, this study's sample size and scope are limited. Therefore, results are not generalizable. A more diverse sampling frame may provide a broader range of perspectives and experiences. For example, this study does not include any elementary or middle school educators. It also does not include teachers from other content areas such as math, English as a Second Language (ESL), Special Education, or electives. Future case studies should include participants from this broader frame to construct additional insights about the ways teachers understand and experience changes with regard to pedagogy and practice in 1:1 classrooms.

IMPLICATIONS

Teaching occurs within and between humans operating in various contexts. As a result, students, teachers, classrooms, schools, and districts are all different. Teaching is a complex endeavour in an ill-structured domain (Koehler & Mishra, 2009). Even in the same school, no two teachers teach exactly the same. These four educators reported that they cared about students and sought to teach them particular college and career-readiness content and skills. Findings from this study lend further support for the fact that the ways K-12 teachers adopt and use different types of technology, particularly 1:1 technology, differ (Aldunate & Nussbaum, 2013; Harper & Milman, 2016). This study's results also support the fact that teachers moving toward or already teaching in 1:1 technology classrooms need numerous opportunities to learn about 1:1 technology as well as how to use it within their specific content and context (Ifenthaler & Schweinbenz, 2013; Levin & Schrum, 2012; Zhao, Zhang, Lie, Qi, 2016). Thus, learning about and engaging in discussions of theory and practice guided by the ACR framework (i.e., "Adding On," "Combining," and "Remaking") may be an important addition to teachers and administrators seeking to understand types of change that may occur in 1:1 technology classrooms.

This study also has implications for in-service teacher professional development centered on the changes that occur when schools begin 1:1 technology integration. When designing and implementing professional development focused on 1:1 technology integration, for example, providers and participants should consider ascertaining information regarding teachers' perceptions of "goodness of fit" connected to their curriculum and available technology. Providing teachers with the ACR framework could prove useful for giving teachers and administrators vocabulary by which to think and talk about teaching and learning in 1:1 technology classrooms. Doing so may help us avoid what Brian cautions teachers against, namely "doing the same thing but with pretty colors". With additional understanding and awareness of these three change types, including multiple models and explicit conversations focused on types of change possible in our current digital age, teachers may be better equipped to enact changes that are purposeful, informed, and contextually situated.

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