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When Technology Works: A Case Study Using Instructional Rounds and the SAMR Model

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Billions of dollars are spent each year in the United States on technology for schools, and researchers in this case study wanted to determine the degree to which individual computing devices (ICDs) enhance the learning experience of students in grades six to twelve. The leadership practice of instructional rounds (City, Elmore, Fiarmen & Teitel, 2011) combined with the SAMR model (substitution, augmentation, modification and redefinition) (Puentadura, 2014) of technology integration was utilized in this case study to capture how ICDs are being used and the impact this use is having on learning. This method detected use rates far above what had been documented in the literature. By observing 27 randomly sampled classrooms and over 500 students in the case study district, researchers observed how ICDs were being used at the middle and high school level. Observational data analyzed using the SAMR model revealed that 84% of students were using the ICDs and of those, 86% were using them at higher levels of the model (i.e. modification or redefinition). Researchers also interviewed 45 students across eight focus groups. Focus group responses were culled for common themes, some of which included student reports of several learning enhancements as well as some problematic issues.

Keywords: one-to-one device, case study, focus groups, technology

With advances in technology, educators must ask how (or if) a given advancement can benefit teaching and learning. Schools and districts have considered the use of individual computing devices (ICDs) for their students. Responses to this technology range from not using ICDs at all, having students bring their own device, to districts purchasing an ICD for each student. Many districts have chosen this third strategy, and some estimated six years ago that the annual cost for that decision would rise to as much as \$19 billion across the United States (Nagel, 2014). That estimate was a bit high, the cost has probably approached \$11 billion in 2019, and few are successfully measuring its impact (Sadwick, 2019). That said, the use of ICDs is rising. In 2008, Abell (2008) and Borja (2006) found that 24% of districts in the US were implementing ICDs. By 2010, the implementation rate had increased to 37% (Nagel, 2010) and in 2015 the number of implementing districts had ballooned even further to more than 50% (Molnar, 2015). In 2019, 76% of district administrators report having ICD's for at least some of grade levels they serve (Mouhana, 2019).

What is driving these decisions to implement technology through the use of ICDs? According to Towndrow and Vallance (2013), three factors have recently influenced educational decision makers and administrators to purchase technical infrastructure to support ICDs in their institutions and schools: ubiquity (technology is everywhere in society), utility (ICD's are very useful for both teacher and student) and the prospect that technology can act as a change agent for the improvement of the organization (Towndrow & Vallance, 2013). All three factors were relevant especially when viewed as interrelated.

Despite districts' large investment in ICDs, controversy exists regarding what value the technology brings to the learning environment (Koba, 2015). For example, one study characterized teachers who integrated technology as also having a high sense of self efficacy, but also identified barriers for others such as lack of training and lack of time to implement well (Pi-sui, 2016). Another study cited the benefits of technology for students to research via the internet, access social media for learning purposes, and organize classes via Google classroom. In that study, however, others raised concerns about technology problems, students engaged in off task behavior, and faulty referencing (Laronde & Waller, 2017).

Financial investments of this magnitude as well as the professional learning, training, and coordination that may accompany it, demand evaluations that capture the impact of ICDs. District responses to evaluation of technology integration vary from seeking none at all to thoughtful and in-depth inquiries into practice. One moderately sized and ethnically diverse district in the Midwest falls into the latter category. They partnered with researchers to discover what effect, if any, ICDs have had on teaching and learning in their district? Following the purchase of ICDs for each sixth to twelfth grade student, researchers designed the present study to evaluate the impact of the ICDs on student learning. More specifically, researchers sought to answer two specific questions on behalf of the district and to add to contribute to knowledge base of the field:

1. Upon direct observation in classrooms, to what degree is the addition of an ICD enhancing student learning in grades six through twelve?
2. When asked directly, what do students report as the value or lack of value of having an ICD?

Literature Review

Influence of ICDs

Technology has certainly impacted current practice in education. Tierney (1988) was an early investigator in the research of the computer's influence on the development of students' intellectual capacities in a world where ICDs were becoming more common. The Apple Classrooms of Tomorrow (ACOT) study focused on the use of computers to support student thinking. The study measured student growth and development of academic writing skills over time. Using student interviews and observations of student writing while using the computers, the study found that students showed an "expanding repertoire of planning and revision behavior" (p. 1). Tierney (1988) also reported that students commented on an improved ability to make more revisions because the computer-generated text and skills were retained in the classroom setting. Subsequent to Tierney's pioneering research, others have conducted studies to capture the importance and adoption of ICDs in schools. For example, Groff (2013) gave insight about the reason for integrating technology by posing this question, "How can today's schools be transformed so as to become environments of teaching and learning that makes individuals lifelong learners and prepare them for the 21st Century?" (p. 1). Answering this question becomes imperative for educational leaders who ask their districts and communities to support ICDs financially. Additionally, however, Groff pointed out that educational leaders must also consider the "outer world" transformation, advances in the learning sciences and educational technology as additional events before fully responding to the question above.

Lessons Learned

Research can inform the use of ICDs in education. The Los Angeles Unified School District (LAUSD) adopted an ICD technology initiative in 2014. The lessons learned for this district's adoption and implementation were threefold: (1) Urgency is no excuse for poor planning; (2) Be wary of one size fits all solutions; and (3) Don't play favorites with vendors (Education week, 2014). Other initiatives captured additional lessons. For example, the Maine Learning Technology Initiative (MLTI) launched in 2002 put an Apple iBook in every seventh and eighth grade student's hands to prepare students for the 21st century (as cited in McLester, 2011). Texas and Michigan followed with their own initiatives. The impact on the students however, has remained inconclusive. Standardized test scores in the state of Maine revealed an elusive connection between achievement and the use of ICDs (McLester, 2011). Yet Wilson, from the One to One Institute, pointed out that these pioneering initiatives were important even though they were largely a hit and miss access to technology for students (as cited in McLester, 2011).

The One to One Institute (2015), in cooperation with the Greaves Group and the Hayes Connection launched Project Red in 2010. The project's purpose was to improve student achievement while evaluating the total financial impact of technology on state budgets. They recommended the following when adopting and implementing ICDs to increase student achievement and/or return on investment (ROI):

- Incorporate change leadership consistently throughout the entire process.
- Make professional learning and effective use of technology high priorities for administrators and teachers.

- Use technologies such as social media, games and simulations to engage students and encourage collaboration.
- Personalize learning for all students through frequent, appropriate use of technology integrated with curriculum and instruction in all classrooms and other learning places.
- Use ongoing online (formative) assessments to gauge student learning and then tailor instruction for personalized learning experiences (Hanowald, n.d.).

Recommendations from projects like Project RED provided important steps to take so that ICDs can impact student learning. Groff (2013) wisely advised districts, however, that the trajectory of any organization needs to be planned and customized for the distinctive milieu, goals and vision of the district, school or system.

Teacher and Student Voice

As the use of ICDs in schools continued to proliferate throughout the country, interest in student and teacher voice regarding the effects intensified. According to Storz and Hoffman (2013), teachers were greatly impacted by ICDs. They found that ICDs influenced teaching while presenting many new opportunities and challenges. Responses from students and teachers revealed changes in teaching style with less whole class instruction and increased small group/individualized instruction. Yet some students suggested that their teachers were doing less teaching and resorted to “mostly projects, the packet.... what you got to do, when it is due, what it is about. You teach yourself” (Storz and Hoffman, p. 8). Students agreed, however, that availability of ICDs provided easy access to the resources needed for class and that because of the ICDs, they had more creative ways and opportunities to demonstrate their learning (Storz & Hoffman 2013).

More recently, Varier et al. (2017) found support for the benefits of ICDs in elementary, middle and high school settings. Themes that emerged included opportunities to enhance 21st century learning, transition to a learner-centered instructional environment, opportunities for immediate formative feedback, and increased efficiency and student self-direction. Varier et al. (2017) also found that some devices are more suitable for different academic environments or levels of schooling and that internet connectivity was an important consideration. These two factors have become more important with the nearly ubiquitous use of ICDs in academic activity as Google Docs and other collaboration applications becoming practically universal in schools. In fact, Varier et al. found that a district’s decision to use applications such as these led to increased use of the device. Further, as students became more self-directed, independent and collaborative in the learning process, teachers could direct instructional time to assess student understanding while students were engaging in tasks. Teachers indicated a greater ability to provide immediate, constructive feedback closely linked with possible student achievement (Varier et al., 2017). Students and teachers overwhelmingly recommended ICDs, and the authors suggested that “continued innovations in technology devices and infrastructure can potentially meet both practical and 21st century learning needs” (Varier et al. p. 985).

Impact on Student Learning

While causality between ICDs and student achievement is rare in the literature, recent studies like those conducted by the one to one initiative (One to one institute, 2020) and Varier et al. (2017) indicate a greater amount of evidence demonstrating ICD’s positive impact on student learning.

Claro's results (2013) in Chile showed some promise for ICD use and technology integration. In this work, teachers with technical assistance during classroom instruction were able to support student learning objectives, while those classrooms without the technical assistance did not. Additional research shows that ICDs had the potential to impact multiple dimensions of learning – specific or alternate experiences, distant communication, connection, collaboration, mobility, access, personalization, flexibility, and alignment with the digital world (Varier et al., 2017; Lowther et al., 2012). ICDs and other technology related purchases by districts and schools correlated with student competence with technology (Lei & Zhou, 2008) and tolerance for risk taking (Pautz & Sadera, 2017).

Qualitative case studies examining the use of ICDs through classroom observation and student focus groups are a rare but do exist. In addition to Varier et al. (2017), Kirkpatrick et al. (2017) did an extensive questionnaire-based study in Canada in which a main finding was the positive impact of iPad on inclusion of students with special needs. In addition, Maich, Fanshawe and van Rhijn (2017) examined elementary classrooms through a focus group of educators and found that the ICDs were in use 31% of the time observed. Teachers also reported positive attitudes towards the devices by students. In another case study of iPad use, Kaufman and Kumar (2018) discovered that high school juniors and seniors reported “changes in communication, collaboration, learning strategies, as well as accountability and independence when learning with iPads” (p. 454). Finally, Higgins and BuShell (2017) interviewed teachers and observed classrooms and found that teacher and student relationships were positively affected by the introduction of ICDs. This present study extends and contributes to the research as it delves deeply into the teaching and learning process through qualitative inquiry using a specific classroom observation protocol and student focus groups.

Conceptual Framework

This study examined how students experience the introduction and integration of ICDs as part of their learning at the middle and high school level in the case district. To capture this, researchers combined two conceptual frames: instructional rounds protocols (City, Elmore, Fiarman & Tietel, 2011) and the SAMR model (Puentadura, 2014). Authors here used the former to develop a classroom observation protocol and the latter to analyze those observations as well as responses from student focus groups (see Appendix A).

City, Elmore, Fiarman & Tietel, (2011) described the concept of the instructional core which posits that in order to alter the level of student learning, change will only occur if there are improvements in three critical, interdependent realms: the level of content, the teacher's knowledge and skill, and student engagement. They expand on the work of philosopher David Hawkins who described the core as “the ‘I’ (the teacher), the ‘thou’ (the student) and the ‘it’ (the content)” (as cited in City et al, 2011 p. 23). These three pieces interact to form the instructional core. Instructional rounds protocols establish procedures for observing classroom instruction, specifically the instructional core. In this work, therefore, if adoption of an ICD initiative is coupled with the proper conditions and prerequisites involving preparation, planning and pedagogical support then we can expect that teachers will use the technology in ways that impact student learning.

City et al. (2011) also delineate seven principles of the instructional core as follows:

1. Increases in student learning occur only as a consequence of improvement in the level of content, teacher's knowledge and skill, and student engagement.

2. If you change any single element of the instructional core, you have to change the other two.
3. If you can't see it in the core, it's not there.
4. Task predicts performance.
5. The real accountability system is in the tasks that students are asked to do.
6. We learn to do the work by doing the work, not by telling other people to do the work, not by having done the work at some time in the past, and not by hiring experts who can act as proxies for our knowledge about how to do the work.
7. Description before analysis, analysis before prediction, prediction before evaluation (p. 23).

It should be noted that this study focused primarily on the third, fourth, fifth and seventh principles. Principles three, four and five are applied in the classroom observation protocol which captured teacher actions, student actions, content and task (see Appendix A). Principle seven was applied in the data analysis along with the SAMR model (see Data Analysis below).

In addition to the instructional rounds, researchers also analyzed classroom observations and focus group responses through the lens of the SAMR model (Puentadura, 2014). This model classifies technology integration into four progressive levels of integration: substitution, augmentation, modification and redefinition.

At the substitution level, technology acts as a direct tool substitute, with no functional change. For example, using a fillable PDF as opposed to a traditional worksheet is using the ICD as a substitute for more traditional pedagogy. At the augmentation level, technology acts as a direct tool substitute with functional improvement. The spelling and grammar check features of word processing programs represent augmentations when compared to pen and paper composition. To experience modification, the technology allows for significant task redesign. Google docs which can be shared with other collaborators, allowing for real time co-construction of a document modifies the task of collaborative writing. Coauthors of a text can work on a piece at the same time but in different locations or not at the same time, but the document is truly shared. Finally, at the level of redefinition, the technology allows for the creation of new tasks, previously inconceivable. Well beyond a traditional hard copy term paper, composition with ICDs can incorporate hypertext and video links, accessible by the click of a mouse for the reader. These compositions can also be published in the form of blogs or in online chat rooms. These kinds of tasks were inconceivable 30 years ago and would not be possible without student access to ICDs. (Puentadura, 2014; see also Appendix A).

The SAMR analysis allowed for the evaluation of differentiated gradations of technology integration as opposed to merely observing if the ICDs were in use or not. Using these two conceptual frames, instructional rounds and the SAMR model, in concert is a unique contribution of this research in terms of both data collection and analysis.

Research Methods

The overall method employed in this work is a qualitative case study evaluation (Yin, 2009). Researchers used this method to produce findings for the two middle schools and a high school in the case district through classroom observation and student focus groups. The larger phenomenon taking place across the country is the inclusion of ICDs and the impact of that decision on the teaching and learning process. Marshall and Rossman (2006) argue that the qualitative researcher

must make this connection to a larger phenomenon to build rationale for their work. What is not common in the literature is taking an evaluative look at the decision to implement ICDs and its impact in a specific setting through a qualitative lens. In fact, using of the instructional rounds protocol (City, Elmore, Fiarmen and Teitel, 2011) in conjunction with the SAMR model (Puentadura, 2014) to produce evaluative results is a unique methodological contribution of this study.

Study Context

The case district, located in the state of Michigan in the United States, spent \$22 million on instructional technology to provide an ICD for every sixth through twelfth grade student. Central to the messaging from the leadership involved this metaphor: “devices were not to be \$1,000 pencils.” Put another way, ICDs could not merely replace traditional instructional methods that added little value to teaching and learning. Instead, the district sought to use the technology in ways that enhanced instruction. The purpose of this case study evaluation, therefore, is to collect and analyze data related to this initiative to determine the extent to which that vision was realized.

Moderately sized with just under 7,000 students and ethnically diverse, this district presents an excellent opportunity for a case study evaluation. In fact, its diversity resembles that of the United States: 9.3% Asian, 2.1% African American, 36% Hispanic, 3.5% from two or more races, and 49% Caucasian. The district’s free and reduced lunch rate is 55% (State of Michigan, 2019).

Data Collection and Participant Selection

Data collection on the first research question, (to what degree is the addition of ICDs enhancing student learning) involved direct classroom observation using the instructional rounds protocol. Researchers felt it important to directly observe the teaching and learning process and did so by entering 27 randomly selected classrooms in grades six through twelve. School buildings were made aware of the study and knew the dates of researcher visits but did not know which of the 200 classrooms would be visited. With an average class size of 19 students, this involved direct observation of 27 teachers and over 500 students (State of Michigan Database, 2019).

The observation process took two researchers into each classroom for 15-minute intervals. During that time, each researcher independently recorded observations using a specific protocol (see Appendix A) focusing on the following questions derived from the third, fourth and fifth principles of the instructional core:

1. What is the teacher doing? Saying? With whom?
2. What are the students doing? Saying? How are the students interacting?
3. In what content are students being exposed/engaged? What is the nature of the content?
4. What is the activity students are asked to complete/accomplish to learn the content?

Researchers derived and adapted these questions using the conceptual frame from the instructional rounds protocol developed by City et al. (2011).

Researchers collected data on the second research question (what do students report as the value or lack of value of having individual computing devices) by engaging students in focus groups. A random selection of 45 students distributed into eight focus groups across the middle and high school levels met with researchers. Parent permissions were first obtained per the research plan approved by the University’s Institutional Review Board before any students were contacted. Students also had the opportunity to assent or not to assent to the study (see Appendix B & C for

consent forms). Student responses to pre-determined questions in a semi structured interview (see Appendix D) were audio recorded and transcribed for later analysis. Researchers limited follow up questions and kept them related to topic so that each group had a similar experience.

Data Analysis

This qualitative study investigated the phenomenon of introducing ICDs into the classrooms of sixth to twelfth grade students. Specifically, two research questions served as focal points: Upon direct observation in classrooms, to what degree is the addition of ICDs enhancing student learning in grades six through twelve? When asked directly, what do students report as the value or lack of value of having individual computing devices? Having collected these data sets, both researchers analyzed individual data collections separately. Researchers met later to compare and synthesize individual findings into their final form.

Classroom Observation. As indicated, the classroom observation data used an instructional rounds protocol which focused on the instructional core: the interaction between teacher behavior, student behavior, content and instructional tasks (City et al., 2011). Additionally, the data were then analyzed using the SAMR model: substitution, augmentation, modification and redefinition (Puentadura, 2014). In the highest two levels, modification and redefinition, the student is involved in higher-level learning and critical thinking indicative of transformational learning. These levels have also been connected to the higher-order thinking levels of Bloom's taxonomy (Netolicka & Simonova, 2017). One area of analysis sought to determine how frequently students engaged in modification or redefinition when observed.

To check each other's work, the two researchers intentionally did not discuss the classroom observation data until each had an opportunity to examine the data individually based on individual notations. This process included an examination of all notes taken to look for important data points or pieces of evidence. Researchers also looked for the SAMR levels independently before discussing findings together, tracking the highest level of SAMR in each classroom observed.

Once that had been completed, researchers engaged in the following collaborative steps grounded in the instructional rounds process (a protocol in which each researcher had been trained and had facilitated in the field):

1. Collaborative analysis: researchers compared individual notes and shared individual insights with each other. Researchers also interrogated the data, looking for patterns and evidence to support these insights.
2. Collaborative prediction: researchers clustered the data points to make predictions about the students, the school and the district related to ICD use. For example, what percentage of the time were students be expected to use their ICD during the day?
3. Collaborative evaluation: this formed the summary of our findings overall, making sure each statement could be backed with observed data.

These three steps, following the data collection above, applied the seventh principle of the instructional core, "Description before analysis, analysis before prediction, prediction before evaluation" (City et al, 2011 p. 23):

Student Focus Groups. Responses to the semi structured interview questions in student focus groups were audio recorded and transcribed. Analysis was guided by the work of Marshall and Rossman (2006), and began with reading participant responses and placing them into two large categories: comments that indicated ICDs were supportive and enhancing of the learning process, and comments indicating that ICDs were detrimental to the learning process. A second reading of

the responses yielded an additional category: comments indicating that ICDs have little to no impact on learning (see Table 1). Within each of these three categories, researchers gleaned common themes (Marshal & Rossman, 2006), described in greater detail below.

Findings

Classroom Observation

Classroom observations revealed high rates of ICD use at the higher levels of the SAMR model. Researchers observed ICD use in 84% of the classrooms for instructional purposes. Furthermore, of those classrooms that employed ICDs, 86% used them for instructional tasks involving modification or redefinition, the highest two levels of the SAMR model. This far exceeds the 31% level of use in the Maich et al. (2017) study cited above.

Examples of redefinition or technology that allows for the creation of new tasks that were previously inconceivable were of particular interest. For example, math students used a program entitled “ALEKS” that adaptively moved each student individually to problem sets in their zone of proximal development (Liudmila & Solomonovich, 2017). Each math student engaged in a personally customized practice set of problems, complete with links to learning supports that would not be possible without ICDs. Another notable example was in technology education. Sixth grade students worked with both the ICD and a desktop computer simultaneously to build unique applications, using designing and coding skills. Students in social studies collaborated with each other on digital presentations in class or from home to create a fictional nation based on natural resources and production possibilities.

Examples of modification, or technology that allows for significant task redesign, were also present, particularly in the area of assessment. Teachers obtained real-time, formative assessment data to drive instructional decisions; students could access this data as well. During writing instruction, students collaborated via Google Docs while also using Easy Bib to document their work, all while getting feedback from the instructor. Substitution and augmentation examples, while perhaps not as interesting, did serve to make learning more efficient, for example, by storing all handouts in Google Classroom for easy and continual access at student convenience.

Within the instructional rounds’ analysis protocol (City et al., 2011), researchers attempted to predict the student experience. The prompt, “if you were a middle or high school student in this district, what would you experience?” created an opportunity for prediction. Researchers made the following predictions based on data gleaned from classroom observations:

1. Almost every student will have an ICD every day. In fact, researchers did not observe a student without an ICD during visits to the buildings.
2. The rate of instructional technology use will likely be 80% or higher in the secondary schools of this district.
3. Google Classroom, Google Docs, and other applications will be part of daily teaching and learning.
4. Teacher and student acumen with ICDs will likely improve with continued use and support.

Based on collective observation and analysis, researchers feel confident that these predictions will be evident in secondary classrooms across the district.

Student Focus Groups

As indicated above, researchers classified student comments about ICD use in the categories of supportive, detrimental or having no impact. Table 1 below shows the overall summary by middle school (MS) and high school (HS):

Table 1

Classification of Student Comments

	Supportive	Detrimental	No impact
Middle School	60.3%	21.6%	17.9%
High School	67.2%	20.3%	12.5%

The overall comparison of supportive to detrimental comments shows students reporting the former at a ratio of three-to-one. Thus, a majority of students made comments supporting the inclusion of the ICD into their learning experience, reinforcing other findings in the research (Maich et al., 2017; Kaufman & Kumar, 2018; Kirkpatrick et al., 2017).

Supportive Themes. A majority of student comments revealed themes supportive of ICD use such as increased efficiency, creative engagement and learning supports. For example, the theme of efficiency came through from a middle school student who stated: “Homework is easier to do because you just have to open your computer, click on classroom and you would see if you have any homework.” Another middle school student noted the ease of organization when stating, “I’m not losing work because everything is in the same place, and I don’t lose track of anything.”

Creative engagement also surfaced as an important theme, especially with competitive review games, as one high school student indicated, “With everyone having an (ICD) it’s just easier to review that way. And it’s competitive too so it makes people want to engage more.” A middle school student noted how engaging and accessible ICDs made certain projects: “In the past few weeks in history we’ve been doing a video project, and all of us being able to go on (ICDs) allowed us to work on different stuff and find information and do it all individually.” The ICDs created engagement by encouraging a future perspective as well, as noted by another middle school student: “I think it’s helped our learning a lot because in our future careers were going to be using technology a lot, so it’s good to get used to it now.”

Finally, using ICDs as a learning support was also a prevalent theme, as noted by a middle school student: “It’s easier because if you’re absent from the class. . . the teacher can post last week’s videos and you can watch it on your own time.” A high school student commented that watching videos at one’s own pace and taking notes made learning more accessible. Moreover, another high school student expressed how access to ICDs for all students addressed equity issues: “I think that also for some people at least there’s definitely a socioeconomic factor that goes into it. I know a lot of people with lower incomes don’t have access to technology at home; certainly, I think that chrome books enabled them to.” Since focus groups were conducted after ICDs had been in place for five semesters, researchers anticipate that these themes will continue, if not improve over time.

Detrimental Themes. While the majority of student comments were supportive of ICD use, some students noted issues such as distractibility and perceived loss of instruction. One high school student described the distractibility issue this way, “You just can’t help yourself but go on

like a game website when you're supposed be doing something that you know you're supposed to do." Closely related to distraction was also the issue of procrastination as noted by a high school student: "There's more procrastination. . . you can do it at home if you did not get to where you need to be in class."

Other students noted their perception that instruction was being lost. One student stated, "They (teachers) give us no direction on what we need to do online and so it's just a bunch of assignments, and you're just like what am I supposed to do you're giving me no direction. You end up not learning." As indicated, detrimental themes represent the minority of comments, but also reinforce research reviewed (Kirkpatrick et al, 2017).

No Impact Themes. Closely related to this loss of instruction for those comments noted as detrimental, students also noticed when teachers merely used the ICD as a substitute for something they could have done traditionally. As one student noted: "I have a class every day that we could do stuff on paper and she could actually teach but everything is online. Seems like busy work." Similarly, another middle school student noted: "They have us do it in Excel when we could just do it on paper." Though comments such as these were far less frequent than supportive comments, they may illustrate the metaphor of the ICD being used as a \$1,000 pencil.

Discussion

Based on the conceptual framework, researchers used the instructional rounds protocol to examine the instructional core: the interaction between teacher, student and content (City et al., 2011). The addition to the instructional core in this study was the introduction of an ICD for each student. This phenomenon changed the behavior of teachers and students and impacted teaching and learning. Classifying classroom observations using the SAMR model (Puentadura, 2014) enabled researchers to capture the degree of that change.

From classroom observation and student reports in focus groups, ICD's are being used at high rates and in the upper levels of the SAMR model in this district. Since research has linked the SAMR model with Bloom's Taxonomy (Netolicka & Simonova, 2017), this implies students are likely learning at higher levels. Furthermore, students can identify the benefits of these devices on their learning with most of their comments depicting ICDs as supporting instruction. This serves as important evidence directly from the student that ICDs supported their learning.

Classroom observations also gave researchers an opportunity to view what kind of instruction was taking place when ICDs were not in use, and it was generally of high quality, revealing two insights. First, teachers did not necessarily feel compelled to use the ICDs even on a day when they knew researchers would be in the building. Second, and closely related, teachers appear to be using the ICDs strategically, meaning that if another instructional strategy made more sense given the context and progression of the lesson sequence, then that strategy was used.

Implications

Researchers believe that based on the literature, this case represents a relatively high degree of technology integration, especially after two years of implementation. Others in the field have pointed out concerns about potential waste of resources that have been dedicated to these kinds of initiatives (Koba, 2015). With an 80% or greater ICD use rate observed during instructional rounds and over 60% of student comments indicating that ICDs supported their learning, resources earmarked for this initiative have been well invested. Furthermore, students have acclimated to

ICDs as part of their learning experience. Very few were unprepared to use it in class (e.g. ICD not charged), and none were observed without the ICD. With continued professional learning supports and reflective practice, teacher and student acumen with the technology will likely grow.

Researchers also noticed a tentacle effect with the implementation of ICDs into the instructional program: (i.e. other positive consequences that resulted from ICD integration). For example, ICDs facilitated collaboration between students and with their teachers. A shared Google Document can be a platform for collaboration at any time of day or evening, for example. Teachers also shifted more of the instruction to a student-centered model knowing that each student has access to the ICD. And, as observed with the ALEKS program described above in high school math, this technology enabled profound differentiated instruction, certainly because of the adaptive nature of that particular program, but also because of the individual and continuous access afforded by the ICD.

Conclusion

This study, like most, comes with limitations. The case was limited to one district and three schools (two middle schools and one high school), and therefore extrapolating findings beyond these schools would be inappropriate. Also, though a random selection of secondary students within the district were observed, researchers did not survey all students within the district. Finally, The ICD in this case was a Chromebook which had been chosen by the case district. We did not study the use of other kinds of ICDs to make any comparisons.

Although case study insights are by design limited to the case under review, the researchers posit the use of instructional rounds (City et al., 2011) along with the SAMR model (Puentadura, 2014) as a method of evaluation for technology integration. The review of the literature did not reveal this model being employed, and given the robust findings obtained, researchers believe that it can serve as a useful model of evaluation for districts as they integrate technology.

The next logical step for a potential follow-up study would be to talk to the adults in the district through semi-structured interviews of teachers and administrators. Also of note, when gaining permission to speak with students, some parents wondered if their opinions would be sought. Given that the community financed the initiative through a tax supported bond, one could argue that discovering their perceptions of its success or failure could have value. And of course, it would be worthwhile to question school and district leaders on the leadership and/or change model employed during this implementation process. When something is effectively implemented, it bears asking how this took place.

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