1:1 Classrooms and Teaching with Technology: A Best Practices Review

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Integrated classrooms and 1:1 initiatives are growing in popularity *and* maturity. Each year, new school- and district-wide 1:1 initiatives launch. Even if schools are not yet a 1:1 environment, teachers and students likely incorporate and encounter more technology with each passing semester. While new initiatives launch each year, the first wave of initiatives in Maine and Vermont are nearly 20 years old. Not surprisingly, research and philosophy around integrated classrooms and 1:1 initiatives are vast and diverse, with notable increases in production by researchers and industry leaders in the last 10 years. This is good news, as teachers and administrators need varying research-based supports based on initiative goals, tenure, and history/context of the school/district to assist with implementation and development.

The purpose of this document is to highlight best practices for teachers in 1:1 classrooms. This means actual teaching practices, with examples, that are actionable and measurable, and supported by recent research on what makes for effective teaching with technology. We have identified and briefly explained 8 best practices, and provided further reading related to each. The document begins with a presentation of two prominent frameworks for effective teaching with technology: The Technological Pedagogical and Content Knowledge (TPACK) model and the Integrating Technology for Inquiry (NTeQ) model. We then present best practices that supersede these individual models.

Technology, Pedagogy, and Content Knowledge (TPACK)

Technological Pedagogical Content Knowledge (TPACK; Mishra & Koehler, 2006) is the intersection of three areas of teacher knowledge: content knowledge, pedagogical knowledge, and technological knowledge (see Figure 1).

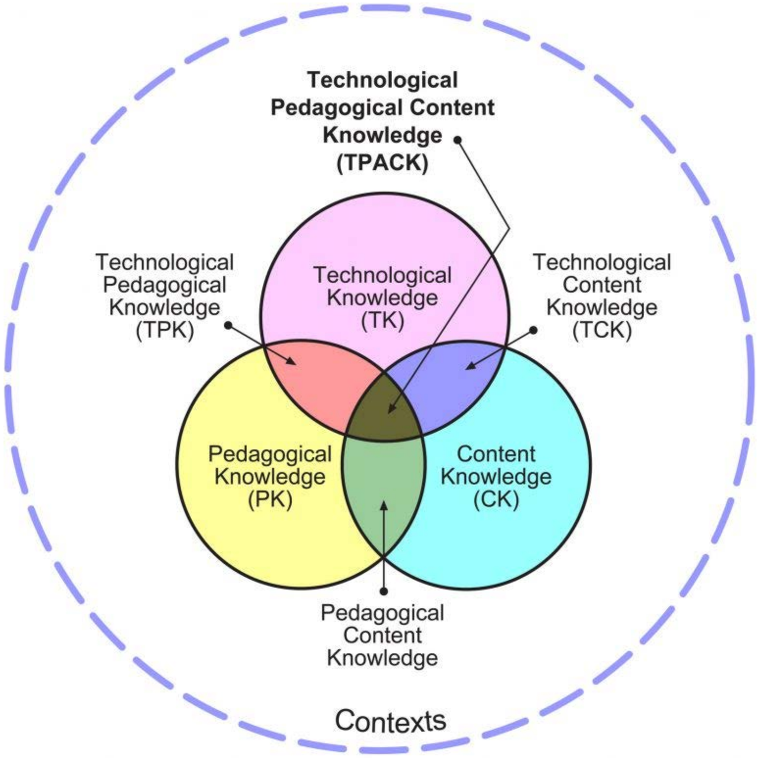

Figure 1. TPACK model from tpack.org.

Content knowledge is knowledge of the subject matter to be taught/learned (Koehler & Mishra, 2009). Content knowledge is both broad (e.g., middle school science or elementary English/language arts) and specific (e.g., physics or early literacy), and includes knowledge of concepts, organizational frameworks, and established practices and approaches to knowledge in a particular discipline. *Pedagogical knowledge* is knowledge about the processes and practices related to student learning including classroom management, instructional planning, student assessment, teaching methods, and identifying/adapting to learners' needs and preferences. Teachers with deep pedagogical knowledge understand cognitive, social, and developmental theories of learning and how they apply to students in the classroom. *Technological knowledge* refers to computer literacy—the ability to operate a computer efficiently—and knowledge of technological developments, programs, and tools. This is an overwhelming task for time-strapped teachers and lacks an end state, as technology is always evolving. Technological knowledge also includes a more essential understanding of information systems so that many different technological tools may be broadly applied productively at work for communication and problem solving.

TPACK proponents posit that instructional decisions that involve technology are pedagogically sound when teachers are strong in each individual knowledge area *and* understand the congruence of each knowledge area with another.

Pedagogical Content Knowledge

Pedagogical content knowledge is acquired when a “teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and students’ prior knowledge” (Mishra & Koehler, 2006). Pedagogical content knowledge is the “core business” of teaching and learning, meaning that it involves the merging area of expertise with professional practice to cultivate the conditions that promote learning in a certain subject (Shulman, 1987).

Technological Content Knowledge

Technological content knowledge includes “an understanding of the manner in which technology and content influence and constrain one another” (Koehler & Mishra, 2009). Mastering the subject matter taught must include understanding of how developments in technology change the way information is communicated and the ways students, as digital natives, experience content matter. For example, the discovery of x-rays changed the nature of knowledge in medicine; integrated data systems changed the nature of knowledge in sociology. Further, technological content knowledge involves a firm grasp on the impacts of different technologies on cognition, broadly. For example, the printing press, electricity, the automobile, and wireless Internet connection have each fundamentally altered the way we think and communicate. New technologies provide shifts in cognition on a smaller scale, when new developments occur in specific content areas, and should be understood as they are relevant to content areas.

Technological Pedagogical Knowledge

Technological pedagogical knowledge describes teachers’ knowledge of how technologies change and/or impact teaching and learning by introducing affordances and constraints in pedagogy. It is the convergence of professional practice and technology literacy, and results in understanding how and when technology tools can *or cannot* be appropriately integrated into lessons and assignments. Teachers with strong technological pedagogical knowledge understand how technology changes teaching and learning, and they make good choices as to when and how to use technology.

Technological Pedagogical Content Knowledge

Technological pedagogical and content knowledge is an emergent form of knowledge that is the basis of effective teaching with technology. It requires the following:

- Understanding of the representation of concepts using technologies;
- Pedagogical techniques that use technologies in constructive ways to teach content;

- Knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face;
- Knowledge of students' prior knowledge and theories of epistemology; and
- Knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Koehler, Mishra, & Cain, 2013).

Integrating technology, pedagogy, and content will not result in a single technological solution for a lesson. Rather, solutions emerge from teachers as they navigate the convergence of the knowledge areas with creativity and practice. One author warns that "ignoring the complexity inherent in each knowledge component or the complexities of the relationships among the components can lead to oversimplified solutions or failure" (Koehler, Mishra, & Cain, 2013).

To use technology effectively for instruction, teachers need to:

- Have a good understanding of content, pedagogy, and technology applications
- Be able to integrate these three domains so as to blend effectively the affordance of each
- Share practices and lessons with other teachers to create a community of TPACK practices

Additional Resources

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70.

Koehler, M., Mishra, P., & Cain, W. (2013). What Is Technological Pedagogical Content Knowledge (TPACK)? *The Journal of Education, 193*(3), 13-19. www.jstor.org/stable/24636917

Koehler, M. J., Mishra, P., & Zellner, A. L. (2015). Mind the gap: Why TPACK case studies? In M. Hofer, L. Bell, & G. Bull (Eds.), *Practitioner's guide to technology pedagogy and content knowledge (TPACK): Rich media cases of teacher knowledge* (pp. 2.1-2.8). Waynesville, NC: Association for the Advancement of Computing in Education (AACE).

Koehler, M.J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2014). The technological pedagogical content knowledge framework. In J.M. Spector et al. (eds.), *Handbook of Research on Educational Communications and Technology*. Springer: New York, NY

Harris, J. B., Grandgenett, N., & Hofer, M. (2010). "Testing a TPACK-Based Technology Integration Assessment Rubric" *Teacher Education Faculty Proceedings & Presentations*. 18. Retrieved from: https://digitalcommons.unomaha.edu/tedfacproc/18

Harris, J., Mishra, P. & Koehler, M. J. (2009). Technological Pedagogical Content Knowledge and Learning Activity Types. *Journal of Research on Technology in Education*, 41(4), 393-416, doi: 10.1080/15391523.2009.10782536

Mishra, P. & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017-1054.

Integrating Technology for Inquiry (NTeQ)

The integrating technology for inquiry (NTeQ) model "provides a framework for creating an environment for students to use computers as tools" (Lowther & Morrison, 1998). The philosophy underlying the NTeQ model encompasses five components: the teacher, the student, the computer, the lesson, and the classroom environment. During successful practice, the NTeQ model results in **teachers** who go beyond computer literacy to become technologically competent and they assume roles of designer, manager, and facilitator; **students** who are actively involved in the learning process and work as researchers while they gain the skills to become technologically competent; the **computer** is not what the students learn about, but is rather a tool they use to collect, investigate, and present their findings and solutions; **lessons** are authentic and problem based, and are dependent on the use of computers; and the **classroom environment** contains these features: access to multiple resources, simultaneous occurrence of multiple activities, and collaboration among students (Lowther & Morrison, 1998).

The planning process for an NTeQ lesson involves 10 steps (see Figure 2). Prior to using the model to plan a lesson, teachers should consider the attention span of students – how long in minutes, hours, or days can students at a specific age remain interested in solving a problem. The first step in planning is to specify the objectives for the entire unit or lesson, not just the information related to the computer component.

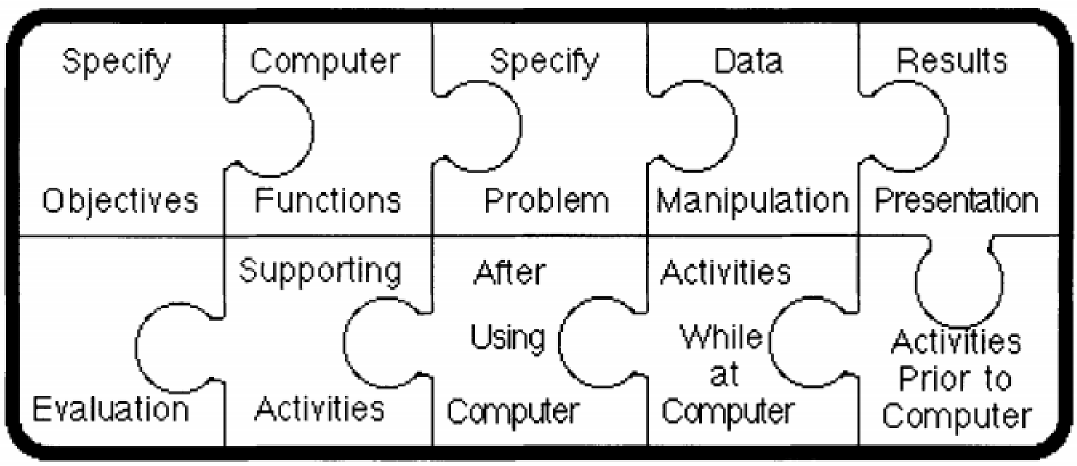

Figure 2. Planning Process for an NTeQ Lesson

To create a successful integrated computer lesson, you must find a match between your objective(s) and computer functions. Computer functions are the tasks that computers do – word processing, data analysis, calculation, simulation, and so on. The computer function is what the student will do on the computer. Once the objectives are identified and matched with a computer function, teachers should identify a realistic problem that provides the environment for students to develop thinking skills and knowledge associated with the objectives. For example, if the objective of a study is to learn the type of trees and leaves native to the region, a problem may be, “What are the trees available on school property or in my neighborhood?”

The fourth step is to plan how students will manipulate data or information. This aspect of the lesson relates to how students will use a computer function or functions to solve the problem. For example, students may gather facts and organize them into an essay; they may document, using Excel, observations; or they may take collaborative notes using a Hyperdoc. Once students have solved the problem or completed the task, they should be encouraged to present their results, whether as a presentation or a written report, or some other media or print-based product.

The next steps involve planning various activities, before, during and after computer use, that also support the objectives and the problem solving and presentation students ultimately conduct. An integrated lesson includes multiple ways of experiencing content—on the computer and off. Other instructional activities such as conducting hands-on experiments, discussion groups, or reading various print materials, will solidify learning objectives for students while diversifying modalities of learning. Activities prior to computer use should serve to prepare students for effective and efficient use of computer tools. For example, if students are to use a software program to design a map, they may benefit from sketching the map beforehand. Prior activities may include a brief lecture or collaborative brainstorming with their peers. Activities after computer use should focus on exploring the results of the computer activity and may include debriefing with peers, written reflections, exit tickets, or a discussion led by the teacher.

Planning supporting activities is integral to integrated lesson plans and are often the most difficult part of the planning process. This is because broadening the lesson beyond the main activity may lead teachers and students to busy work, or teachers to question if class time allows. However, supporting activities should challenge teachers to perhaps shorten the portion of the lesson that involved technology, or to expand the number of objectives that guide lessons.

The final step of the NTeQ model is the development of evaluation. Assessment of student learning from an integrated lesson may require multiple forms of data. Teachers are encouraged to create rubrics which reflect objectives and activities, and to embed assessment into student activities.

Best practices related to the NTeQ model:

- Effective technology integration involves identifying the roles and interactions of the teacher, student, computer, lessons, and classroom environment
- Systematic planning and implementation should revolve around instructional objectives
- Additional steps should address computer functions, problem definition, data manipulation, results presentation, evaluation, and supporting activities at different stages
- The guiding theme of NTeQ is using technology in deliberate, carefully planned ways that exploit its unique affordances relative to traditional, teacher-led instruction

Additional Resources

Flake, L. H. (2017). E-Learning and the iNtegrating Technology for inQuiry (NTeQ) Model Lesson Design. Retrieved from: https://files.eric.ed.gov/fulltext/EJ1154644.pdf

Lowther, D. L., & Morrison, G. R. (1998). The NTeQ model: A framework for technology integration. *TechTrends, 43*, 33-38.

Lowther, D. L., Ross, S. M., & Morrison, G. M. (2003). When each one has one: The influences on teaching strategies and student achievement of using laptops in the classroom. *Educational Technology, Research & Development, 51*(3), 23-44.

Best Teaching Practices in 1:1 Classrooms

Based on our broad review of literature related to teaching in integrated classrooms, we present the following best practices:

Best practice #1: Increase/ease differentiation and personalization.

The positive impact of differentiated instruction on student learning is established in education science (Chamberlin & Power, 2010; Firmender, Reis, & Sweeny, 2013; Tomlinson et al., 2003; Tulbure, 2011; Johnsen, 2003). Students benefit, in terms of engagement and achievement, from receiving content that is tailored to their skills, interests, and needs. Using technology to differentiate learning may involve adaptive and/or intelligent technology, in the form of adaptive drill/practice games or assessment tools. Supplemental educational programs are abundant, and many provide adaptive features and attempt to do the work of differentiation for the teacher. We provide more information on selecting software and applications that provide differentiated experiences through games and adaptive programs.

In addition to specific programs that adapt to students' performance, teachers are able to distribute differentiated content quickly and discreetly to students via technology. This may include differentiated problem sets, literature, or tasks, which are accessed by students in digital classroom spaces. Teachers may effectively teach students in small groups by preparing different content for students grouped by ability. Some example of strategies for providing differentiated learning experiences that apply to a 1:1 setting include:

- Grouping students and directing small groups to different content as they accomplish collaborative learning tasks
- Present different instructions and tasks for different learners, such that more support and feedback are given to struggling students and/or that high-achieving students encounter more difficult and more quantity of content
- Allow flexible timelines, including weekend and evening submissions, allocating more or less time for students to complete tasks
- Allow students to work alone instead of in group settings

Technology is a tool that students may use to explore their passions and personal interests while at school and home. Students who are interested in a task or activities engage longer and demonstrate more effort and more productive learning behaviors, including self-regulation and problem solving, and better learning outcomes (Lipstein & Renninger, 2006; Harackiewicz, Durik, Barron, Linnenbrink-Garcia, & Tauer, 2008; Mitchell, 1993; Renninger & Hidi, 2002; Renninger & Shumar, 2002).

Personalized learning experiences should work to cultivate balance between the characteristics and personality of the learner and the demands of the learning environment. Personalized learning may involve customized interfaces in learning management systems, adaptive applications, flexible boundaries from teachers around outputs and final products, and/or emphasis on self-directed learning tasks that allow content personalization. Content personalization (Walkington & Bernacki, 2014) means allowing students to adapt the content of learning tasks to reflect students' out-of-school interests. Prior research indicates that this type of personalized learning has a particularly positive effect on learning (Cordova & Lepper, 1996; Walkington, 2013). Creating space for authentic curiosity, exploration and research also helps to cultivate a mindset for lifelong learning (Keefe, 2007).

Best practice #2: Avoid technocentric approaches to lesson planning.

Perhaps the most fundamental conclusion from research studies is that technology, in and of itself, is not the driver of improvements in student learning. Rather, it is the *quality of digital instruction* that drives learning (Howell, 2001; Mayer, 2018). Though in many ways obvious, it can be easy for educators to lose sight of this concept during the transition to 1:1 learning. Digital learning initiatives can be expensive, and understandably, district leaders and school administrators can often be anxious to see a return on the investment. They want to see that the technology they purchased is used extensively – whether that be a new set of laptops for students, a new SMARTBoard, or a new educational technology mathematics or reading program. In these instances, it is understandable that teachers may feel pressure to 'jump in with both feet' even though they may not yet be fully comfortable with digital teaching. This said, however, research clearly demonstrates that what impacts student learning is not the technology itself, but rather *how it is used* (Howell, 2001; Mayer, 2018).

Through 1:1 initiatives, teachers can just as easily, if not more so, engage students in a wide variety of activities that are well-grounded in contemporary research on how people learn. For instance, research-based activities such involving students in summarizing information (Anderson & Hidi, 1988; Hidi & Anderson, 1986; Marzano, Pickering, & Pollack, 2001), performing elaborative encoding (Llewellyn, 2013; Staszemski, 1990), or using advanced-organizers or note-taking techniques (Beecher, 1988; Marzano, 2007) all foster active student engagement with digital content. These instructional activities along with many others that have been employed since long before laptops, are well within the teacher's toolbox. The important concept is that "learning is caused by instructional methods rather than instructional media" (Mayer, 2018, p. 152).

Best practice #3: Integrate computational thinking into regular curriculum.

In integrated classrooms, computational thinking (CT) emerges alongside other higher-order thinking skills as increasingly important to cultivate and evaluate in students. Computational thinking is understanding the capabilities of computers and how computers can be used to solve problems or accomplish tasks (Berry, 2014; Wing, 2014). More sophisticated CT involves designing, testing, and refining computational steps and algorithms to be executed by a computer. In an everyday classroom setting, age-appropriate CT is at the heart of appropriate and effective computer use. Increased computational thinking skills are associated with increased reasoning, cooperation and sharing, and problem solving (Grover & Pea, 2017; Roman-Gonzales, Perez-Gonzalez, & Jimenez-Fernandez, 2017). CT can be cultivated through student reflection on computer tasks, coding, designing computer games or multimedia projects, analyzing computer processes, and applying existing processes to new tasks.

Best practice #4: Incorporate collaborative learning opportunities.

A bevy of research supports the effectiveness of collaborative and cooperative learning strategies (Gillies, 2016; Slavin, 2009). Strategies that involve students discussing and sharing ideas, working together toward a common goal, or strategically socializing in ways that enhance learning are well supported in the research literature on how people learn (Dirksen, 2012; O'Connor, 1998; Okita, Bailenson, & Schwartz, 2008; Saloman & Perkins, 1998; Slavin, Hurley, & Chamberlain, 2003). Interestingly, research has found that the effectiveness of these strategies in particular translates well to digital learning environments (Means, Toyama, Murphy, Bakia, & Jones, 2010; Robertson & Riggs, 2018). With digital instruction, teachers can easily fall into the habit of relying too heavily on assigning independent work to students (Robertson & Riggs, 2018) which can be both isolating and disengaging for learners. Fortunately, nearly all Learning Management Systems (LMS) from Blackboard to Schoology, now include robust features that enable teachers to assign group work and foster student collaboration. Through the use of group assignments, student team competitions, jigsaws, group learning simulations, and class discussions through message boards and live chats, research suggests that not only does the online setting become less isolating for students, but that engagement and learning are enhanced as well (Hanover Research, 2015; Robertson & Riggs, 2018; Smith & Brame, 2018).

> The opportunity to work with other classmates closely on an assignment provides the chance to learn a great deal from others. It is important to always actively engage online learners in the course content. Team projects inherently bring a social aspect to the forefront. There will be opportunities for team meetings, sharing, and time to contribute to an overall project which will make learners feel more connected to others in the online course. (Budhai & Skipwith, 2017, p. 61).

Best practice #5: Promote inquiry-based learning.

In today's world, educators understand the need to prepare students with 21st century skills due to the ever-changing nature of work. Students need to be critical thinkers and problem solvers. Research suggests that more authentic learning –

activities that require them to use higher-thinking skills – can have a positive impact on their learning.

> Students need to take part in complex, meaningful projects that require sustained engagement, collaboration, research, a management of resources, and the development of an ambitious performance or product. (Barron & Darling-Hammond, 2008, p 1).

This belief has led many districts and schools to incorporate inquiry-based learning into their curriculum:

> Inquiry-based instruction refers to a multifaceted activity that involves making observations, posing questions, examining sources of information, planning investigations, reviewing evidence, using tools, proposing answers, explanations and predictions, and communicating results. Inquiry requires identification of assumptions, use of critical and logical thinking and the consideration of alternative explanations (National Research Council, 1996, p. 23).

Indeed, the model of pretest-teach-posttest is being replaced with a more challenging approach that engages students in meaningful work that they can apply to real-world situations. In today's classroom, inquiry-based learning uses technology to guide students toward content knowledge, and technology integration is essential to the practice of inquiry-based instruction. Another benefit to technology is that it can provide specific applications and virtual simulations particularly in the area of STEM education. As noted by Marshall and Smart (2013), one opportunity to improve STEM learning is to adopt more inquiry-based approaches to instruction rather than traditional, teacher-centered approaches.

Best Practice #6: Choose games and supplemental programs wisely.

Games and gamification of learning has emerged as a promising avenue for effective teaching and learning (Budhai & Skipwith, 2017; Connelly et al., 2012; Hamari et al., 2016; Garland, 2015; Majuri, Koivisto, & Hamari, 2018). Games are fun. They have a different feel than a typical school setting. Gamified learning is associated with increased engagement in learning, problem-solving skills, concentration, motivation to learn, and achievement (Budhai & Skipwith, 2017; Buckley & Doyle, 2016; Majuri et al., 2018; Sailer & Homner, 2019). Strategically selecting and providing students with instructional games can be an effective means of leveraging online teaching in a way that enhances both engagement and learning.

Artificial intelligence and adaptive technologies are not currently advanced enough to fully replace human intervention to differentiate content, so the degree to which teachers are able to monitor and influence adaptive games should be central during program selection. Programs that allow teachers to modify skills and content by individual student may prove more useful than programs that do not. Additionally, teachers may consider selecting games with reward mechanisms, as rewards influence students to persist in games and solve problems independently, and that offer peer collaboration and competition between peers in the game (Sailer, Hense, Mayr, & Mandl, 2017; Sailer & Homner, 2019; Clark, Tanner-smith, & Killingsworth, 2016; Sun, Chen, & Chu, 2018).

Best Practice #7: Be strategic in leveraging the affordances that technology can provide.

In engaging in digital instruction, it is important that teachers thoughtfully consider the ways that technology can be used to do things that might not be feasible through more traditional methods alone. Though technology itself does not drive improvements in student learning (Howell, 2001; Mayer, 2018), when used thoughtfully, it can provide more personalized instruction for students and offer unique learning opportunities that might not be feasible otherwise (Clark, 2002; Dean, Hubbell, Pitler, & Stone, 2012; Sankey, Birch, & Gardiner, 2010). A growing body of research supports the importance of leveraging affordances unique to e-learning. For instance, research on differentiated instruction (Tomlinson et al., 2003), and Universal Design for Learning (Rappolt-Schlichtmann, Daley, & Rose, 2012; Rose, Meyer, & Hitchcock, 2005) has demonstrated the utility of using multimodal types of teaching that strategically target students' individual needs. Fortunately, the affordances of instructional technology can make flexible, individualized, multimodal forms of teaching such as these easier and more robust (Dean, Hubbell, Pitler, & Stone, 2012; Sankey, Birch, & Gardiner, 2010). Smart and creative use of technology can make student-centered instructional approaches more efficient and effective.

Beyond making instruction more individualized and multimodal, teachers should also consider the ways that they can leverage technology to provide learning experiences to students that they may not otherwise have. Use of experiential simulations, virtual field trips, and virtual problem-solving activities are all ways that technology can be leveraged to make learning more relevant, engaging, and authentic. As Mouza (2008) highlights:

> Use of computers can also change what students learn by providing exposure to ideas and experiences that otherwise would be inaccessible. Such opportunities are particularly useful in developing the higher-order skills of critical thinking, analysis, and inquiry that are necessary for success in the 21st century. (p. 449)

Research is beginning to uncover many of the benefits that these novel uses of instructional technology can provide. Multiple studies on learning simulations and 'virtual field trips' have found positive influences on student engagement and learning (Gredler, 2004; Henderson, Klemes, & Eshet, 2000; Poland, 1999). When designed well, these types of learning activities aim “to motivate the learner to engage in problem solving, hypothesis testing, experiential learning, schema construction, and development of mental models” (Lunce, 2006, p. 37). Whether it be exploring a tropical rainforest using virtual reality (Poland, 1999), uncovering and studying fossils through a computer simulation (Henderson, Klemes, & Eshet, 2000), or conducting virtual science-experiments in physics classes (Swaak & de Jong, 2001; van Joolingen & de Jong, 1996), research indicates well-designed simulated learning activities can be both engaging and effective (Gredler, 2004; Hattie, 2009; Lejeune, 2002; Lunce, 2006). In fact, some research suggests that problem-solving scenarios in simulations can be just as effective as real experience, particularly in science (Horowitz & Christie, 2000; Swaak & de Jong, 2001; van Joolingen & de Jong, 1996). Beckem and Watkins (2016), highlight the many benefits of these types of learning experiences:

> Simulations empower learners to acquire new knowledge and build upon existing competencies that are entirely driven by their experiences within the environment. Incorporating simulations in education supports the shift towards a student-centered approach where students are more in control of how and when they learn. These experiences enable students to move beyond merely remembering, understanding and applying concepts to a higher order process of analyzing, evaluating and synthesizing information to formulate new knowledge. Their ability to inspire intrinsic motivation makes simulations a tremendous asset to any blended learning program seeking to better engage and retain students. (p. 62)

Taken in combination, these research findings highlight some of the unique affordances of instructional technology. Not only can technology facilitate more individualized and flexible forms of instruction, but it can also help provide students with authentic learning opportunities that may otherwise be unattainable. ‘Smart’ use of technology leverages these unique affordances to create learning experiences that go beyond what might be feasible with traditional instruction alone.

Best Practice #8: Ensure teachers receive appropriate professional development.

Professional development is critical to the success of any intervention, whether technology is involved or not. As such, it is not surprising that a variety of research has demonstrated that robust professional development for teachers is often a crucial feature of successful district-wide instructional technology initiatives. Research has also sought to identify the practices, strategies, and approaches that are most important to incorporate in teacher professional development. This section provides an overview of the best practices that are most strongly supported by the research in this area and examines how FCPS seeks to incorporate such practices in their FCPSOn professional development approach[1].

Broadly, the research surrounding teacher professional development has converged around roughly half a dozen overarching “best practices” that appear to be consistently beneficial in enhancing the impact of teacher training. In no particular order, these include:

- Emphasizing instruction that is specific to the content or discipline teachers teach
- Tailoring training to the specific school contexts and needs of participating teachers
- Implementing professional development that is of a sustained duration as opposed to “one-time” trainings
- Incorporating active learning strategies
- Incorporating participant collaboration and cooperative forms of learning
- Providing teachers with illustrative models and examples of the practices being taught
- Use of coaching

When used thoughtfully, research suggests that incorporating these practices within a professional development program can enhance teacher learning and skill development, as well as increase the likelihood that teachers will change their instructional behavior. These practices are discussed in more detail below.

Content/discipline specificity. Research on teacher training has consistently reinforced the value of content or discipline-specific professional development over broader or less specified approaches (Darling-Hammond, Hyler, & Gardner, 2017; DeMonte, 2013; Guskey, 2003; Hixon & Buckenmeyer, 2009; Klein & Riordan, 2011; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Indeed, “Helping teachers to understand more deeply the content they teach and the ways students learn that content appears to be a vital dimension of effective professional development” (Guskey, 2003, p. 749). Professional development on instructional strategies primarily serves to increase teachers’ use of those techniques (Desimone, Porter, Garet, Yoon, & Birman, 2002), and as such, discipline-specific strategies that are situated within the context of teachers’ classrooms should be emphasized (Darling-Hammond, Hyler, & Gardner, 2017). Put simply, mathematics teachers need training oriented toward mathematics instruction, reading teachers need training oriented toward reading, and high school teachers need training specific to teaching adolescents. Clearly, by matching teachers’ content needs with the focus of a training, it can become more relevant and impactful for participants.

[1] Additions were made to this section by the JHU CRRE research team after consulting with FCPS. The goal of these additions is to provide more in-depth information concerning practices that may relate to and inform the FCPSOn professional development approach.

Addressing school and teacher context. Beyond making trainings discipline-specific, research has also demonstrated the importance of tailoring training to the specific *school contexts* and needs of participating teachers (Bayar, 2014; DeMonte, 2013; Guskey, 1994; 2003; Hixon & Buckenmeyer, 2009; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). To the extent possible, it is important that the professional development that teachers are provided aligns with other initiatives and instructional priorities that may be happening in their school simultaneously (Guskey, 2003). Trainings can also be enhanced by adapting to the differences among teachers with regard to instructional skill and familiarity with the topic being addressed. In the case of trainings on instructional technology, such as those being delivered through FCPSOn, research suggests that trainings should strive to be sensitive to and work to address differences between teachers in their beliefs, skill levels, and comfort with using technology (Hixon & Buckenmeyer, 2009). Focusing on incremental changes in practice, helping teachers to view technology as an instructional *tool*, and providing teachers with first-hand experiences where they can *use technology successfully*, can all be helpful in gradually altering teachers' beliefs and behaviors with technology (Ertmer, 2005; Hixon & Buckenmeyer, 2009). Guskey (1994) provides further insight into the facets that professional development providers should consider in adapting trainings to school contexts:

> Because of the variability between different educators' situations, it is difficult to know exactly what makes an effective professional development program. However, there are some guidelines. Change is both an individual and an organizational process. In planning and implementation, it is important to work for incremental change. Working in teams maintains support for change. It is necessary to include procedures for feedback on results. Continued follow-up, support, and pressure are necessary in professional development. Innovations presented in professional development must be integrated into existing educational frameworks. While professional development can be complex and difficult to measure in student achievement, it is possible to tailor programs to specific contexts. (p. 1)

Sustained duration. Next, research clearly highlights the importance of professional development being of a sustained duration (Bayar, 2014; Darling-Hammond, Hyler, & Gardner, 2017; DeMonte, 2013; Guskey, 1994; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Teachers need to be provided with adequate time to learn, practice, implement, and reflect upon new strategies – and this can seldom be accomplished through single "one-time" trainings alone (Darling-Hammond, Hyler, & Gardner, 2017). Professional development initiatives that provide multiple opportunities for teachers to engage in learning around a topic over the course of weeks, months, or even academic years, appear to be substantially more impactful than those offering only brief workshops (Darling-Hammond, Hyler, & Gardner, 2017). Given this context, it is particularly important that ongoing trainings maintain a sense of instructional coherence as they are implemented over time, and that teachers are provided with the necessary instructional materials (e.g., curriculum plans, instructional programs, etc.), planning time, and ongoing support necessary to implement the training's teachings (Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Though it is difficult to precisely identify the optimal duration and volume of instructional time for a training program, research seems to suggest that professional development programs should span a large portion of the school year:

> Researchers and practitioners note that when the traditional programs of professional development — usually single-event, so-called "drive-by" interventions — are replaced by longer-term designs, there is a greater chance that teachers will improve instruction. For example, in (a) survey of 1,300 studies of professional learning…the one study with the most power(ful) effect on raising student achievement had teachers participating in the activity for about 60 hours over six months. (DeMonte, 2013, p. 7)[2]

Active learning and teacher collaboration. Beyond a training's content and duration, research has found that the instructional strategies used by trainers can have a substantial impact on teachers' learning. Use of active learning strategies (Bayar, 2014; Darling-Hammond, Hyler, & Gardner, 2017; DeMonte, 2013; Desimone, Porter, Garet, Yoon, & Birman, 2002; Hixon & Buckenmeyer, 2009) as well as collaborative and cooperative learning techniques (DeMonte, 2013; Darling-Hammond, Hyler, & Gardner, 2017; Guskey, 2003; 2009) have been shown to noticeably enhance participant learning. Ideally, trainings should strive to incorporate active learning utilizing learning theory, recognize and leverage teachers' prior knowledge and experiences, provide teachers with choices based on interests and needs, and include ongoing opportunities for reflection and inquiry (Darling-Hammond, Hyler, & Gardner, 2017).

Providing teachers with opportunities to engage in cooperative learning and supporting teachers in collaborating as they implement new instructional techniques are also practices that appear to be distinctly beneficial for enhancing teacher buy-in (Ertmer, 2005; Hixon & Buckenmeyer, 2009) and enhancing a training's impact (DeMonte, 2013; Darling-Hammond, Hyler, & Gardner, 2017; Guskey, 2003; 2009). As a byproduct of incorporating these approaches, teachers not only gain hands-on experience designing and practicing new teaching strategies in a way that is highly job-embedded (Darling-Hammond, Hyler, & Gardner, 2017; DeMonte, 2013), but they also experience participating as learners in the same types of activities they may hope to use with their students (Darling-Hammond, Hyler, & Gardner, 2017).

Modeling and illustrative examples. Teachers can also benefit greatly from trainings that provide clear modeling and examples of the instructional techniques that

[2] For further information on this research, please see Yoon, Duncan, Lee, Scarloss, & Shapley (2007).

are being taught (DeMonte, 2013; Darling-Hammond, Hyler, & Gardner, 2017). The process of actually seeing what certain techniques look like in practice can be invaluable to teachers. Modeling may take the form of videos of accomplished teaching, demonstration lessons, sample lesson plans, unit plans, or exemplar student work (Darling-Hammond, Hyler, & Gardner, 2017). Furthermore, providing teachers with tangible materials that they can take with them from the trainings can also be of substantial value. Whether it be curriculum documents, process charts, or actual lesson plans or student activities that they could use the next day – providing teachers with something that they can physically use can greatly enhance the likelihood that they will implement the strategies being taught.

Coaching. Lastly, research suggests that coaching, particularly that which is delivered from a coach with expertise specific to working with teachers, can act as a highly valuable companion to ongoing professional development (DeMonte, 2013; Darling-Hammond, Hyler, & Gardner, 2017).

> Coaching is often part of professional-development programs and the research that does exist suggests that, like other features…it works in conjunction with other aspects of professional development. If coaching is longer in duration, if teachers collaborate around what they learn from coaching, if they get to observe instruction and then talk about the observation with a coach, then it is more likely to be effective. This feature hinges on the expertise of the coach to do this work. If the coach is not an expert in teaching teachers, then it is unlikely that coaching will be effective. (DeMonte, 2013, p. 8).

Indeed, when done well, ongoing coaching and expert support can enable teachers to gain expertise that is directly applicable to their individual needs. One-on-one coaching, coaching during group workshops, and even remote coaching done online can all be used effectively as part of professional development programs (Darling-Hammond, Hyler, & Gardner, 2017). Research suggests that, at least in part, the benefits of coaching are derived from the opportunities for feedback and reflection that it provides (Darling-Hammond, Hyler, & Gardner, 2017). Through incorporating coaching as part of a comprehensive professional development plan, these benefits can be cultivated along with numerous others:

> High-quality professional learning frequently provides built-in time for teachers to think about, receive input on, and make changes to their practice by facilitating reflection and soliciting feedback. Feedback may be offered as teachers analyze lesson plans, demonstration lessons, or videos of teacher instruction, which also provide opportunities for reflection about what might be refined or retained and reinforced. These activities are frequently undertaken in the context of a coaching session or

> workshop, but may also occur among peers. (Darling-Hammond, Hyler, & Gardner, 2017, p. 4)

Other Research on Best Practices

The practices discussed above – from making trainings discipline and content-specific, to incorporating active learning strategies and modeling – can all serve important roles in enhancing the impact of professional development for teachers. While these "best practices" mark those that research has arguably converged around most often, they are certainly not the only practices that research supports for enhancing the quality of teacher trainings. For instance, a variety of research has highlighted the importance of dynamic school leadership (Guskey, 2009), often in the form of teacher leaders, for helping build teacher buy-in and enhancing the impact of trainings (Bayar, 2014; Darling-Hammond, Hyler, & Gardner, 2017; Guskey, 1994). Research has found support for using blended learning techniques (DeMonte, 2013) and has also highlighted the importance of high-quality professional development instructors (Bayer, 2014). Incorporating formative evaluation activities and making ongoing adjustments to better match trainings to participant needs is also well-supported (DeMonte, 2013).

Indeed, though the best practices listed in this document should largely serve as the foundation of any well-designed professional learning program, they are by no means the only strategies worth considering, and school leaders should be open to strategic innovation in creating learning experiences that are worthwhile for teachers. One particularly creative avenue in this regard is the use of student shadowing activities. This approach involves teachers following a student or a group of students for a day or more in an effort to gain a more insightful understanding of a student's day-to-day school experience. While engaging in this exercise, teachers will often participate in all the activities that the student will – from riding the school bus, to completing word problems in math class, to eating lunch in the cafeteria. Using a "shadow, reflect, act" model of learning, teachers use the insights they gain through the exercise to design simple interventions to help improve the quality of students' everyday experiences at their school (Shadow a Student, 2020). A growing body of research suggests that these activities may indeed be useful in helping teachers better understand the lives of the students they teach (Ginsberg, 2012; 2016; Klein & Riordan, 2011). As Klein and Riordan (2011) argue:

> This strategy is based on the concept that skill building is most effective within a real context…and is an essential component of experiential professional development because it draws teachers into the experience of students and helps them envision how experiential learning can be transferred to a subject-specific classroom. (p. 49)

By considering innovative training activities such as these and strategically using them to complement the overarching best practices discussed in this section, school leaders can build learning experiences that more powerfully resonate with their teachers.

> Effective school leaders must begin all professional development endeavors by clearly focusing on learning and learners; recognize the vital importance of core elements such as time, collaboration, a school-based orientation, and leadership; and then work to find the most appropriate adaptation of those core elements to specific contexts. Careful planning, insight, and consideration of context characteristics will often help realize the sought after improvements in student learning. Occasionally, despite our best efforts, the adaptations will fail. But clear evidence of effectiveness based on student outcomes will suggest how to redirect efforts in more-promising directions. Success will come from finding the optimal mix of effective practices based on core elements that work well in a particular context or collection of contexts. (Guskey, 2009, p. 231)

FCPSOn Professional Development

To complement this best practices review, the JHU CRRE research team also reviewed planning documents produced by FCPS that described the district's professional development approach with regard to FCPSOn. In specific, the research team reviewed documents including the "Learning and Innovation Teams Framework" and the "Shadow a Student" resources. Upon review of these documents, it appears that the FCPSOn professional development program will incorporate many of the research-based best practices discussed above.

First, FCPS has professional development for teachers scheduled regularly over the course of the school year. Training includes a full week of sessions during teachers' pre-service time in August, and then two training days apiece in September, October, December, February, and March. Clearly, the district's approach encompasses a sustained duration of training and will offer teachers many opportunities over the course of the year to advance their skills with instructional technology.

The framework document also describes the role that school-specific "Learning and Innovation Teams" will play in supporting the PD approach. Among a variety of duties, members of these teams will lead professional learning at a school and will "develop and implement a plan with administration to connect FCPSOn and school priorities to promote student learning." This approach aligns with tailoring professional development to schools' specific contexts and needs – one of the key best practices discussed above (Bayar, 2014; DeMonte, 2013; Guskey, 1994; 2003; Hixon & Buckenmeyer, 2009; Penuel, Fishman, Yamaguchi, & Gallagher, 2007).

The framework also implies that FCPS plans to utilize a variety of important instructional strategies while delivering the FCPSOn trainings. The framework outlines that the Learning and Innovation Teams will “develop structures, such as learning walks, to observe and scale meaningful learning experiences within collaborative teams and throughout the school.” As discussed above, the use of modeling techniques that provide teachers with the opportunity to observe others can be highly valuable (DeMonte, 2013; Darling-Hammond, Hyler, & Gardner, 2017). The framework also lists “literacy” focused training and “horizontal and vertical collaboration” as part of its PD approach. As discussed, a variety of research has highlighted the importance of a content-specific approach, such as literacy, to teacher training (Darling-Hammond, Hyler, & Gardner, 2017; DeMonte, 2013; Guskey, 2003; Hixon & Buckenmeyer, 2009; Klein & Riordan, 2011; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Research has also demonstrated the value of including opportunities for teacher collaboration (DeMonte, 2013; Darling-Hammond, Hyler, & Gardner, 2017; Guskey, 2003; 2009). Other features listed as part of the framework including the use of blended learning (DeMonte, 2013), “Shadow a Student” activities (Ginsberg, 2012; 2016; Klein & Riordan, 2011), and modeling “growth mindset” for students (Dweck, 2006), also represent areas where the FCPSOn approach aligns with contemporary research.

Beyond these strategies, the FCPSOn framework also clearly includes an emphasis on ongoing evaluation and reflection to help schools make adjustments so that they can continually improve the relevance and quality of the trainings. Here, the “Essential Questions” that are used as part of the end of year professional development sessions include: “In what ways have we created meaningful learning experiences for students?” and “Where might we want to go next in our journey?” By building evaluation and reflection into the overarching PD framework, FCPS better positions itself to match the content of its trainings with the evolving needs of teachers.

Taken in combination, these features of the FCPSOn professional development plan suggest that the district’s overarching approach is situated appropriately in the contemporary research on high-quality teacher training. If executed with fidelity throughout the year, this approach is well-positioned to advance teachers’ expertise and skills with instructional technology and can serve an important role in enhancing learning outcomes for students across Fairfax County.

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