ONE-TO-ONE TECHNOLOGY IN MIDDLE SCHOOL SCIENCE

By

Jenny Anna Finnegan

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Committee Membership

Dr. Eric Van Duzer Committee Chair

Dr. Shannon Morago, Committee Member

Dr. Valarie Lynch Committee Member

Dr. Eric Van Duzer Program Graduate Coordinator

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ABSTRACT

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This paper reports on the ongoing digital implementation of one-to-one digital devices in the middle school science classroom, examining existing goals, the history and use, and offers a professional development course designed to engage teachers to improve their practices. This work examines teacher efficacy in the classroom and highlights teachers' views on the emerging push for one-to-one student centered learning. Results suggest the importance of methodologies that increase student achievement and reduce teacher driven curriculum. The combination of teacher engagement through professional development and practice promote both teacher and students' interest and learning goals with the use of one-to-one devices, the created professional development incorporates these ideas.

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INTRODUCTION

Over the past few decades research has demonstrated the potential of technology in the classroom to impact the manner in which teachers teach. In the past, a limited number of computers in the classroom have mitigated many potential benefits (Sandholtz et al., 1991; Winn, 2002). In classrooms where inexpensive web-based mobile-digital devices such as tablets, iPads, and Chromebooks, ("one-to-one" technology) are more available to all students, changes in the way teachers instruct and engage students are becoming more common. Classrooms using these devices have become more appealing and efficient to students than the analog version in a variety of subjects (Ertmer & Ottenbreit-Leftwich, 2010). In the field of science in particular, the opportunity to employ one-to-one devices has the potential to usher in transformational change in teaching.

The following literature review will first explore some of the many goals of technology in the classroom. It will then describe the current use of educational technology and shed light on recent technological advancements in the classroom. An analysis of a range of effective implementation practices of one-to-one technology with a focus on student engagement and teacher knowledge of the technology will follow. Finally, this review will conclude with a deconstruction of the Next Generation Science Standards and describe the emerging opportunities to meet the standards by teaching science using one-to-one technology.

LITERATURE REVIEW

Goals of Technology in the 21st Century Classroom

According to Steve Jones (2008) Senior Research Fellow at the Pew Internet & American Life Project, children aged six or younger currently spend as much time using screen media as they do playing outdoors. Twenty-first century learners have grown up with digital technology, were born around the time the personal computer (PC) was introduced, and typically began using computers by the age of five (Oblinger & Oblinger, 2005).

The launch of Sputnik, the first artificial Earth satellite by the Soviets in 1957, made science education a national priority sponsored by the newly formed National Science Foundation. Since then the nation's interest in science has waxed and waned (Duschl, 2008). In a Congressional research service report for Congress (2008) the authors observed that students in the U.S. are currently not prepared in the areas of science, technology, engineering, and mathematics (STEM). The report shares that as a world leader in scientific innovation there is a growing concern with the poor ranking of 15-year old students in math and science proficiencies. In response to this concern, President Obama in his 2010 State of the Union Address said:

> Instead of rewarding failure, we only reward success. Instead of funding the status quo, we only invest in reform -- reform that raises student achievement; inspires students to excel in math and science; and turns around failing schools that steal the future of too many young Americans, from rural communities to the inner

city. In the 21st century, the best anti-poverty program around is a world-class education (Obama, 2010, pp. 9-10).

Information Technology

The U.S. has sought to address the lack of student science skills with legislative actions. In one such action, the U.S. Department of Education engaged in a substantial initiative attempting to "facilitate the comprehensive and integrated use of educational technology into instruction and curricula to improve teaching and student achievement" as a way to capitalize on new teaching opportunities and help students master the use of technology in problem solving (U.S. Department of Education, 2004, Goal 8). The U.S. is attempting to produce a scientifically literate population to prepare for a global market of science, technology, engineering, and math practices.

The National Education Goals (1990) established the standard of information literacy for students to achieve. Information literacy is ability to access, evaluate, and use information from a variety of sources (Doyle, 1990). The student's struggle with evaluating information from various sources is evident in that their search for information typically ends with Google (Purcell et al., 2013). As Wallace et al., (2000) observed in evaluating science information gathering on the web, sixth grade students look for an obvious answer or seek to find a good website that can answer the question for them. Thus, past use of the internet in classrooms has conditioned students to search for immediate answers (Barnes et al., 2007). Students seek to reduce the task to finding the obvious answer instead of understanding content. Little progress has been made helping students negotiate the complex cognitive and meta-cognitive strategies required by the information seeking process, and it is not clear how to go about teaching these strategies to students (Wallace et al., 2000).

One-to-One Pedagogical Approaches

As a teaching tool, searching the web is not the primary tool for students to acquire knowledge and skills, what matters most is what students are asked to do, as well as the tools and techniques used to accomplish these tasks. Research shows that the tasks assigned when using one-to-one technology and the overall goals of their usage in the classroom varies between teachers. Often the ways the devices are used are limited by the technological abilities and experience of the teacher (Garthwait, 2005; Purcell et al., 2013). Teachers need access and training, Judy Buchanan, Deputy director of the National Writing project states, " the key to move forward is to ensure that all educators have equal access to the vast resources online, and the encouragement and training to use them in groundbreaking ways," (Targeted News Service, 2013).

Technology can affect all aspects of teaching. However, simply introducing new technology will not necessarily have a profound effect. Punya Mishra, the Associate Dean of Scholarship and Innovation and professor in Leadership & Innovation at Mary Lou Fulton Teacher's College at Arizona State University, along with Matthew Koehler, a professor of educational psychology and educational technology, focus on the design of technology-rich, innovative learning environments and the professional development of teachers. Mishra and Koeler (2006) argue that pedagogy, content knowledge and technology need be interwoven to reach the potential of the technology to support student learning. The implementation of these components cannot be isolated from each other. “To use technology to support meaningful student learning, teachers need additional knowledge of the content they are required to teach, the pedagogical methods that facilitate student learning, and the specific ways in which technology can support those methods” (Ertmer & Ottenbreit-Leftwich, 2010, p. 260). Creating technology based learning environment goes beyond bringing computers into the classroom.

Improving the strength and range of teacher qualifications and therefore student learning in science and mathematics are national goals. For example, funding available through the No Child Left Behind (NCLB) legislation support providing specific instructional technology to be provided to schools (No Child Left Behind, 2001). According to the current Race to the Top legislation, state plans need to implement technology to some extent. The U.S. Education Secretary Arne Duncan noted: "For the first time, state assessments will make widespread use of smart technology. They will provide students with realistic, complex performance tasks, immediate feedback, [and] computer adaptive testing, and incorporate accommodations for a range of students" (Fletecher, 2010). Teacher credentialing programs currently include classes on up-to-date technology integration. However, those who have been teaching in the classroom for the past ten years or more need to be provided equivalent training to meet the national goals as per Race to the Top legislation.

Educational Technology

The term educational technology should not be confused with technology in education. Technology in education is generally referred to as the hardware available to a classroom (Hooper & Reiber, 1995). However, educational technology includes many types of technology, from media based film, radio, and television to those that are simple in their design and application such as textbooks, chalkboards, and overhead projectors (Kent & McNergney, 1999). The growing use of small portable devices in a one-to-one ratio provides another powerful tool (Lianget al., 2005). New technologies can change the nature of the classroom, similarly as it has changed routines and practices in most arenas of human work, (Mishra & Koehler, 2006) despite a relatively poor record of doing so over the last 40 years. Several key impediments of the past are changing, technology has become more affordable and will soon become indispensible educational tools (Liang et al., 2005). Both students and teachers are more technologically savvy today (Purcell et al., 2013). The recent availability of sufficient number of devices for all students in a classroom overcomes many of the limitations previously found when there were only a limited number of computers available to a school to complete assignments.

For over one hundred years influential American leaders have advocated new technology in the classroom. Thomas Edison an early advocate of educational technology, was quoted in the Oamaru Mail Newspaper (1912, p. 2) for promoting educational films, he states, “Teach the children everything from mathematics to morality. . . . Sort o' swing the education in on them so attractively that they'll want to go to school. You'll have to lick 'em to keep 'em away.”

In more modern times, former President Bill Clinton, also advocated for more technology in schools. In his 10-point plan to improve education in his 1997 State of the Union Address, Clinton focused on extending internet access and use in the nation's schools:

> We must bring the power of the Information Age into all our schools.
> Last year I challenged America to connect every classroom and library to the Internet by the year 2000, so that for the first time in our history, children in the most isolated rural town, the most comfortable suburbs, the poorest inner-city schools will have the same access to the same universe of knowledge (Clinton, 1997, p. 140).

By 2009, 93% of all public school classrooms were wired for the internet (U.S. Department of Education 2010). In a recent survey of high school and middle school teachers, 92% say that the internet has a major impact on their ability to access content, resources, and materials for their teaching (Purcell et al., 2013).

The current explosion of resources and information available on the internet and global communications, both visual and audio, provide a particularly rich learning environment when students can individually access them (Borgeman, 2008). A wired classroom with Wi-Fi enabled one-to-one devices opens many opportunities beyond he curriculum content confined to books, filmstrips, and videos associated with direct instruction. Today's internet provides a rich learner-centered environment that has accessible data with interactive applications, animated graphics and 3D visualizations (Borgeman, 2008).

Teachers play a pivotal role in how effectively educational technology is used, and are the driving force for change. Instructional design that is technology-based can bring information to students that the teachers may not typically bring forward (Winn, 2002). Ertmer and Ottenbreit-Leftwich (2010) define good teaching as teaching that facilitates student learning by leveraging relevant information while using computer technology resources as meaningful pedagogical tools. A technology-based classroom allows teachers to introduce ideas from various sources to create a supportive learning environment, this means including the integration of new curriculum and revising goals to include the opportunities that technology in education may offer beyond those achievable with traditional modes of instruction (Hooper & Reiber, 1995).

In 2007, Hew and Brush examined the barriers affecting use of technology to help student learning. Lack of specific technology-supported-pedagogical knowledge and skills has been identified as a major barrier of technology integration. Other barriers faced when integrating technology into the curriculum for instructional purposes include lack of time, teachers experiencing "burn out" through spending long hours previewing websites or locating photos for multimedia projects, and teacher attitudes and beliefs about technology in the classroom where many are unconvinced that it will help in the classroom to benefit students. Suggested strategies to overcome these barriers include a school wide technology vision and plan, providing the necessary resources such as access to technology and technical support with collaborative time, providing ongoing professional development, and encouraging teachers use of technology for instruction.

Professionals in the 21st century work and act differently than those in previous centuries, due in part to the radical advancements in technology. The same change in work applies to the classroom, “effective teaching (with technology) requires effective technology use” (Ertmer & Ottenbreit-Leftwich, 2010, p. 256). Some technologies will emerge, change, and unquestionably disappear, however, the ability to learn and adapt to teaching with technology will still be important (Mishra & Koeler,2006).

Effective implementation

For a technology program to work in the classroom, teachers need meaningful training in how to best use the technology for their students (Wallace et al., 2000).

Research shows that teachers have various levels of concern with device use in the classroom, a range of comfort levels with technology, and different needs for professional development to successfully integrate one-to-one technology into the curriculum. One reason teaching has changed so little despite the availability of technological tools is that absence of training. Without training teachers do not effectively implement technology. Staff competence and implementation in instruction and learning is one of the most important supports for technology (Donovan et al., 2007; Venezky, 2004).

As explained by Wallace et al. (2000), despite the growing numbers of computers in schools, teacher practices are relatively unchanged. It is not the tools but the implementation that inhibits the benefits of educational technology. Notwithstanding the evidence that computers can greatly benefit teachers by making curriculum more meaningful for their students, many teachers have failed to incorporate it in a meaningful way.

In a technology curriculum integration study in Australia by Wallace et al. (2000), where curriculum is mandated at a nationwide level, technology implementation changes have only been successful when implemented by knowledgeable teachers. Effects at a national level are less clear given the wide range of knowledge and experience amongst Australian educators. The study suggests that teacher attitude towards the use of technology to support curricula is also significant in how much benefit students get from integrating technology-infused lessons.

Teacher development requires professional and personal growth with time for reflection and discovery of their own practices to build confidence (R. Barnes, 2005). Development of instructional practices requires varied training at many levels. Teachers want guidance and they want to use various technologies, so they rely on peers or they teach themselves when professional development is unavailable (Jaber, 1997). Although the number of professional development opportunities has increased, these are not always effective at changing practice. It is not simply availability, but the underlying philosophy and focus of professional development related to technology and instruction that is critical. Separation and contrast between professional development focused on the integration of technology in instruction rather than simply learning about types of software or applications seems to determine whether it impacts teachers' practice and student outcomes (Lawless & Pellegrino, 2007). The evidence suggests that when well-designed professional development with teacher support and assistance are incorporated in a school setting, teachers' use of technology can strengthen student engagement (Ertmer & Ottenbreit-Leftwich, 2010).

Mishra, P., & Koehler, M. J. (2006) focus on the design of technology-rich, innovative learning environments and the professional development of teachers. They argue the three main components of learning environments are content, pedagogy, and technology. The overlap of these three main components is referred to as Technological Pedagogical Content Knowledge (TPACK). Instead of treating these separate bodies of knowledge individually, the TPACK model emphasizes the interplay of the three. This approach recognizes that the usage of technology in education requires a complex form of knowledge different in some ways from that required in traditional classrooms. Traditional teacher workshops are ill-suited to give a deep understating of technology and do not help teachers become intelligent users of technology for pedagogy. Traditional technology workshops that focus on learning technology/skills highlight each feature giving participants time to practice with the technological features using provided examples of how the tools could be used in an instructional setting, however they are out of context with individualized classrooms (Figg & Jaipal, 2012). Generalized teacher technology trainings do not address the rapid rate of technology change, or how to repurpose software designed for business purposes to be used as pedagogical tools. Generic solutions to the problem of teaching technology do not tackle the content specific integration. Learning technology in ways that encourage integration (e.g., learning by design) provides teachers with real educational problems, which they solve with technology. Teachers take on the task of incorporating different technologies, PowerPoint, images, video into their course based on content and age appropriateness. This approach has shown some promise in sustained increases in the level of technology usage in teacher's own academic programs (Mishra, & Koehler, 2006).

Student Engagement

Student engagement has been defined in various ways. In one study engagement has been measured through the student's use of academic learning time as a measure of student persistence. In this quantitative study the longer one persists the more engaged they are (Kuh, 2009). Multi-dimensional models of framing student engagement have developed. Sandholtz et al. (1991) evaluated engagement and came to the conclusion that students are engaged when they recognize the significance of their work beyond its personal value, spend considerable time on a task, and are careful about the quality of their work. Regardless of the model or definition chosen, engagement is not easily recognized in the digital age. Research suggest that asking students how they would measure engagement and opening a dialogue with the teacher sharing conversations about how they are learning instead of dictated accountability measures promote meaningful learning experiences (Parsons & Taylor, 2011).

The world engages students differently today than it did when their teachers were their age. One of the emerging challenges in student engagement research is defining what appropriate engagement looks like in the digital age. It could be argued that the current generation of learners are not off-task while using an instant messaging app, listening to music, or viewing a video clip while working on academic assignments. “To the tech-enhanced student this behavior is completely natural and not at all an attempt to ‘turn their back’ on learning but rather a natural way to interact and construct their own learning” (Reddekopp, 2006, para. 14). In a large scale census that included both tweens (broadly defined as 8-12 year olds) and teens (13-18 year olds) it was found that the average young person uses digital media technology as part of their ambient reality: 51% say they “sometimes” or “often” watch TV while doing their homework, 50% use social media, 60% text, and 76% listen to music. They’re not only multitasking, nearly two-thirds are convinced it has “no effect on the quality of their work” (The Common Sense Report, 2015, p. 82).

Educators can motivate students and enhance engagement by modifying teaching methods and materials to meet the unique needs, characteristics and life experiences of today’s learners, by demonstrating relevant applications of the curriculum in school, community, and life generally (Gonzalez et al., 2006). The rapidly changing technology can make experienced teachers find their skill sets challenged, what works in one generation may not work in the next (Brown, 1997). . Evidence suggest that in general teachers are not changing their methodologies to keep pace with technology changes (Ertmer & Ottenbreit-Leftwich, 2010). This accelerated pace of change results in classrooms scattered along the continuum of technology implementation. Technology is already a part of what is happening in most classrooms and the ways of incorporating it into the curriculum need to be considered when planning. Teachers must also be engaged in their work to take on new pedagogy. When teachers make personal connections to the material in their professional development they, in turn, increase their efficacy in the technologically-infused classroom (Dawson, 2006).

In designing instruction for middle school students, who are quick to identify busy work, a motivational task that is realistic in nature is the most engaging. If the task is challenging and useful, it will result in higher levels of engagement (Lipscomb, 2003). Additionally, it should be noted that students enjoy playing games on devices that enhance learning. A number of educators are working on game-based instruction. However, if there is too much attention focused on academics, the game playing may become a chore and take away the curiosity and discovery inherent in play (Charsky & Ressler, 2011). Hence, both designing effective tasks and the way those tasks are presented have an effect on both student engagement and outcomes.

Student engagement with technology can also be related to the novelty effect. However, research has shown that typically the critical factor is not the novelty of the computer but rather the way that it is being used in the classroom. Students can become distracted with technology as easily as with traditional exercises with paper. The goal of improving engagement and therefore mastery in areas of the curriculum such as mathematics and science are ongoing. Current Reform efforts are moving towards interdisciplinary, student-centered and project-based education (Sandholtz et al., 1991) The Next Generation Science Standards (NGSS 2012) address these efforts. The goals are particularly well suited to technology-infused instruction and student centered learning.

Next Generation Science Standards

Children naturally enjoy observing and thinking about nature and because of their innate curiosity, they embrace scientific inquiry (Schweingruber et al., 2007). The most recent science curriculum reform, the Next Generation Science Standards (NGSS), include performance standards with expectations that describe what students should know and be able to do at the end of instruction (Workosky & Willard, 2002). The NGSS vision of science education is one that highlights the power of integrating the ideas of science, engineering and technology using the processes of scientists (Schweingruber et al., 2012). The NGSS curriculum is exploratory, learning is participatory and knowing depends on practice and participation (Oblinger & Oblinger, 2005).

The NGSS standards are broken into core disciplines: physical sciences, life sciences, earth and space sciences, engineering, technology and applications of sciences. Students in early grades are taught to recognize patterns and formulate answers to questions about the world around them. By the end of fifth grade students should be able to demonstrate gathering, describing, and using information about the world. The middle school student faces a blend of core ideas with scientific and engineering practices and crosscutting concepts with language arts and math to explain real world phenomena in the sciences. The ideas build upon students' science understanding of the earlier grades. The expectations of students include developing and using models, planning and conducting investigations, analyzing and interpreting data, mathematical and computational thinking, and constructing explanations. In addition, students are expected to demonstrate understanding of several engineering practices such as design and evaluation. By the time they reach high school, students should have numerous experiences in engineering design (NGSS, 2012).

Science Pedagogy

Science based activities that involve the learner, such as inquiry learning or problem-based learning are arguably more effective than traditional methods in promoting the construction of knowledge (Hmelo-Silver et al., 2006). Computer technology provides many opportunities for inquiry learning that were not available to teachers or students in the past (Edelson, 1999).

The word *inquiry* has been used multiple ways in the science literature Hofstein and Lunetta (2004, p.30) define inquiry as:

> Inquiry refers to diverse ways in which scientists study the natural world, propose ideas, and explain and justify assertions based upon evidence derived from scientific work. It also refers to more authentic ways in which learners can investigate the natural world, propose ideas, and explain and justify assertions based upon evidence and, in the process, sense the spirit of science.

A scientist's knowledge of concepts, tools, and inquiry skills are intertwined. Engaging in inquiry-based science helps students improve the same type of integrated understanding used by scientists. Investigative skills, as well as content and principles of science are common objectives in the science classroom (Edelson, 1999). However, when unleashed from the confines of the classroom, inquiry becomes richer and more accessible to the student. The web is a resource that goes beyond the boundaries of the science classroom and provides opportunities for students to pursue project-based learning of personal interest, thus increasing engagement and in turn retention (Garthwait, 2005).

Summary

The teaching and learning process is complicated. Confucius is reputed to have said: "Tell me and I will forget; show me and I may remember; involve me and I will understand." In 450BC how people learned and the technology available to support learning was dramatically different, but the idea of learning through involvement stays the same. In the current science classroom, technology must be used in particular ways to have an impact on engagement. Up to date technology-based professional development can help to create competent and confident teachers particularly when professional development is combined with implementation. Effective integration of technology into the science classroom engages students (Donovan et al., 2007; Ertmer & Ottenbreit-Leftwich, 2010;Venezky, 2004). A wired classroom with one-to-one devices provides opportunities for inquiry and challenges students to draw their own conclusions "the need to explore is implicit in our desire to learn" (Windam 2005, p 5.8).

The NGSS, NCLB Act, and Race to the Top reform designed to integrate technology and engineering to the classroom has brought sweeping change to how science is taught. The question remains, where do we go from here? The literature tells us that technology will play a role in classroom reform (Winn, 2002). This change may or may not be effective depending on the way it is used. Pedagogical changes, along with new science standards open a door for future research. With this in mind I attempt to answer the questions:

What are the variables that affect the use of computers by teachers in the classroom?

How can I help my fellow colleagues embrace the change?

METHOD

To investigate the variables affecting device usage in the classroom, a mixed method approach was used, utilizing interviews and survey instruments designed to gather information about science teachers' use of computers in the classroom. Four existing surveys were modified to use as a research instrument.

Sample

The survey involved science teachers, including special education teachers, working in middle schools in a School District, located in Southern California. All qualifying teachers were notified through district email, and invited to take the survey. A total of 27 teachers responded, representing a response rate of 54%, and completed the survey. The surveys were electronic, and a link to the Google survey was emailed to all fifty science teachers in the district. Subjects were offered a chance to win a $25 gift card to encourage participation.

The sample included 20 females and 7 males; the range of years teaching varied from less than 1 to 30, with an average of 14. All teachers in the district had one-to-one computer integration in the classroom with Chromebooks.

Interviews were conducted with two science teachers from the pool based on availability. The teachers chosen differed in their classroom experience and in technology use. One subject was a veteran teacher who rarely used one-to-one devices and the other subject had less experience in the classroom but frequently integrated the devices throughout the curriculum.

Instrument

Four established surveys were chosen to measure teachers beliefs in their on abilities in the classroom and their attitudes towards the use of computers in the classroom (See Appendix A). The measure of a teachers confidence and belief in one's ability's, or Teachers' Self-Efficacy (TSE), which may be more important than skills and knowledge among teachers that implement technology (Ertmer & Ottenbreit-Leftwich, 2010) was determined based on a modified version of the 'Ohio State teacher efficacy scale' (OSTES, Tschannen-Moran & Woolfolk Hoy, 2001). The survey contains 12 items, utilizing a 5-point Likert scale format. The teachers were asked to rate how much a teacher could do in a given situation (Likert scale 1-nothing to 5- a great deal, scored in reverse for data analysis to match other survey data). A Teacher Computer Efficacy scale (TCE) was used to investigate teachers' self-efficacy about computers. The 9 item survey was derived from The Microcomputer Utilization in Teaching Efficacy Beliefs Instrument (MUTEBI) (Enochs, Riggs, & Ellis, 1993), using a 5-point Likert scale format (scale 1- always to 5-never). An 8 item Attitudes toward Computers in Education Scale (ATE), designed by van Braak (2001) was used to measure teachers' attitudes toward the effects of computer adoption in the classroom, the scale uses 5-point Likert scale format (scale 1- always to 5-never). A Computer Use Scale (CU) was used to gauge educational computer use, it was derived from the 'Computer Use Scale' of van Braak et al. (2004), it also uses 5-point Likert scale format (scale 1- always to 5-never). The main objective of these surveys is to measure what effects of the teachers thinking processes influence their interests in implementation of computer devices in the classroom.

Interviews with 2 selected teachers used open-ended questions focused on teachers' instructional planning and use of technology. Interviews were completed informally at the teachers' venue of choice and provided a snapshot of how technology was used by both students and teachers. Questions asked about student access to technology, curriculum integration, and what needs, if any, for future technology integration.

RESULTS

The purpose of this study was gain a better understanding of the kinds of things that create difficulties for teachers in their school activities including use of technology in the classroom, determine how often computers are used in the classrooms and their attitudes about their usage. The following statistical analysis draws conclusions from the data about whether or not computers are being used successfully. Based on the results of the interviews and surveys, a professional development course was created to engage teachers to integrate various technologies into their curriculum with the focus on formative assessment.

Descriptive Statistics

The mean scores and standard deviations of TSE, TCE, ATE, and CU are summarize in Table 1. All mean scores are < 2.0, ranging from 1.0 to 3.0. Indicating an overall positive response.

Table 1 Descriptive statistics for each subscale (n=27), Teacher Self-Efficacy (TSE), Teacher Computer-Efficacy (TCE), Attitudes Towards Computers (ATE), and Computer Use (CU). 1-agree to 5-disagree (TSE, TCE, & ATE) 1-always to 5 never (CU)

Variable	Number of items	Mean	StDev
TSE	9	1.67	0.50
TCE	9	1.77	0.69
ACE	8	1.95	0.55
CSU	9	1.71	0.51

Correlation analysis.

The relationships between variables were examined using the results of bivariate Pearson Correlation analysis (Table 2). For this study the correlations with computer use are of primary interest.

Table 2. Correlations coefficients for variables (n=27), Teacher Self-Efficacy (TSE), Teacher Computer Efficacy (TCE), Attitudes Towards Computers (ATE), and Computer Use (CU). 1-agree to 5- disagree (TSE, TCE, & ATE) 1-always to 5 never (CU).

	CU	TCE	ATE	TSE
TCE	0.52*			
ATE	0.76*	0.37*		
TSE	0.42*	-0.03	0.49*	

*p<0.05

A picture of the nature of relationships between the variables can be derived from the correlation analysis. The results suggest that there is high interconnectedness among the computer use variable and teacher attitudes towards computers variable.

Interviews

The science teacher interviews indicated overall positive attitudes towards computers in the classroom, with teachers using the computer, on average, 2-3 hours per week, mainly with teacher generated work, including watching educational videos and supplemental work such as vocabulary flashcards. Both teachers talked about using interactive websites that reinforce the class concepts as filler for students who are done with their classwork early or for struggling students to access at home. Teachers described difficulties in monitoring student use of computers. Both teachers frequently redirected students who were off task, playing computer games or on social medial. On respondent stated “I would probably move towards complete technology if the students were fully dedicated to education and could not be distracted so easily, but I cannot monitor technology and get things done that need to be done.” Respondents indicated that the majority of students’ computer usage was for the introduction of new concepts, often to hook students on new ideas with access to videos of activities and experiments that were beyond the classroom limitations, noting “I am very hands on in science and want students to experience, rather than watch experiments. There are so many variables that can go wrong, and when students watch it done they cannot manipulate things, and students do not learn from their mistakes.” The teachers agreed with the importance of using computers to assist English learners and those with learning disabilities, by providing alternative explanations or translations of items to appropriate reading Lexiles, the numeric representation of an individuals reading ability. The teachers expressed an interest in integrating new technological tools in their classroom that match the current hardware available.

PROFESSIONAL DEVELOPMENT

After an examination of teacher views and current use of digital technology, a professional development (PD) presentation was created based on the best-practices literature and refined with the data collected through the survey and interviews (See Appendix B). The literature indicated that developing easy to follow learning guidance models is challenging, and have reported the effectiveness of applying formative assessment in technology-based learning activities (Hwang, & Chang, 2011). Creation of the presentation took in mind that attitudes toward computers was a major factor in their implementation in the classroom and the goal of the presentation was to engage teachers while introducing new classroom approaches involving students use of computer devices.

The goal of the interactive slide show presentation was to offer a variety ways to implement new one-to-one device strategies in the classroom that engage students while effectively using instructional and planning time. The PD was designed to employ teachers with interactive websites and applications for use in the classroom. These sites were made accessible to participants through Google Classroom, which also provided the related slide show presentation. The presentation highlighted various technological strategies for formative assessments, while pausing for teacher practice. Teachers were asked to participate as a student would with each application, as well as create their own sample lesson. Teachers were encouraged to leave feedback and reflections on the Google Classroom site. The site also offered links to tutorials for other sites and applications not covered in the PD. They were encouraged to add links for frequently used technological strategies to the page.

During professional development time set aside by the school district, teachers were offered a session titled, "Digital Applications for Formative Assessment." Twenty teachers participated in the training. Participants were all middle school teachers, grades 6-8, from all curricular subject areas. One segment of the training included participants share how they could use and how they would use particular apps within lessons to enhance the learning experience of students.

Description of the Professional Development

Six digital applications that facilitated formative assessment were chosen based on ease-of-use and student engagement. First, Animoto, a web-based video and photo editor that can create stylized presentations was introduced. It takes slide show presentations to a new level, giving students more creativity with their theme and music selections. Participants were introduced to the ease of the site and watched a short Animoto presentation pre-made that highlighted the information about a school club, showing pictures and slides put together by students. Second, Google Forms Quiz provided a way for teachers to give a quiz, offering instant feedback and grades. Participants were given a trivia quiz; the incorrect answers resulted in feedback and links to further information about the topic. Participants were then asked to create a simple quiz of their own with 2-3 questions, which they could share with others. Next, Playposit, a site that makes classroom videos interactive was introduced. With this site, online classroom videos (screencast, TED, Khan-Academy) are transformed from a passive activity to an active experience with time-embedded activities, during which, the teacher has the ability to monitor progress. Participants watched a 2-minute example, created by the publishers of the program that gave them a brief overview of the layout. The video paused and asked the viewer to respond to the video while modeling the tools of the application. The next application was Formative, an application used to turn existing worksheets into digital worksheets that can be graded/monitored in real time. Participants accessed a short worksheet that required them to answer multiple-choice, fill in the blank, and draw a diagram questions. Participant's answers were shown in real-time for the group to view the monitoring process. Next, Google Classroom was demonstrated, although this format has been widely used by the school, many of the utilities often go unnoticed. Participants were introduced to strategies to assist in formative assessments that utilize this program, such as classroom surveys and exit slips. Last, Quizziz, a fun way to take a quiz online was presented. Students start by putting in their name, and a cartoon avatar is assigned to them. They begin the quiz, upon answering a funny meme appears, either positive or negative depending on whether their answer is correct. Then they see their current score and status related to other students taking the quiz. Students get instant feedback and compete with each other. Participants completed a pop culture quiz and the navigation of the site was demonstrated. The conclusion of the PD involved a discussion about their engagement with the training and how teachers could see implementing such strategies into their classrooms.

DISCUSSION

This study provides empirical evidence from the surveys administered that shows teachers have strong teacher efficacy, strong computer efficacy and positive attitudes towards computer use. Among the teacher survey variables, attitudes towards computer use in the curriculum, was the strongest predictor of computer use in the classroom.

Teacher computer efficacy and teacher self-efficacy were also predictors of computer use. This implies that the more confident teachers are with their abilities to teach and use computers, the more interest they will have in using computers in their classroom. This finding is in line with previous research, showing that the tasks assigned when using one-to-one technology and the overall goals of their usage in the classroom varies between teachers; often the ways the devices are used are related to the technological abilities and experience of the teacher (Garthwait, 2005; Purcell et al., 2013).

The PD was created to positively impact teachers' attitude towards computer use in the classroom. Teachers that were reluctant to try new technology strategies became more comfortable with implementing them into their classrooms. As one teacher commented "I've now use the Chomebooks in my classroom for bell ringers, warm-ups, and to quickly assess progress on projects."

The PD was well received and all attendees participated as students in all assignments. Digital monitoring of progress was displayed during the activities for the participants to measure engagement from the teacher standpoint. Seasoned teachers were excited to use the applications and brainstormed how they could be used in their classes, both digitally on the Google Classroom application and verbally. New teachers, some with significant technological skills helped others and gave feedback. After completing the PD participants' reported at the following staff meeting that many of the applications were integrated into the classrooms within the week. One administrator later gave positive feedback about the level of engagement of the participants and the collaboration of the members.

CONCLUSION

Surveys indicate teacher self-efficacy, computer-efficacy, and attitudes towards computers are a determinant of computer use in the classroom. Studies show that confidence in one's ability to use available technology increase usage (Compeau et al. 1999; Sang, 2007). Teacher education and professional development workshops should provide a learning environment conducive to using computers for a variety of classroom work. Such implementation in teacher education can create confident teachers in the classroom who are willing to integrate more technology into their curriculum. The applications and the breath of their uses are unlimited, ongoing professional development including the introduction of new ideas has the capability to create confident teachers in their capacity to teach and use computers in the classroom.

Limitations

It should be noted that a convenience sample of a small size may limit the findings of this study. In addition, the sample was narrowed to one subject, science. More research could be carried out with a larger sample size in more subject areas. The survey was self-reported and could be strengthened with classroom observations.

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APPENDIX

Appendix A Teacher Self-Efficacy Survey

Teacher Self-Efficacy Survey

	Nothing	Very Little	Some Influence	Quite A Bit	A Great Deal
1. How much can you do to motivate students who show low interest in schoolwork?	1	2	3	4	5
2. How much can you do to control disruptive behavior in the classroom?	1	2	3	4	5
3. How much can you do to calm a student who is disruptive or noisy?	1	2	3	4	5
4. To what extent can you use a variety of assessment strategies?	1	2	3	4	5
5. To what extent can you craft good questions for your students?	1	2	3	4	5
6. How much can you do to get children to follow classroom rules?	1	2	3	4	5
7. How much can you do to get students to believe they can do well in schoolwork?	1	2	3	4	5
8. How well can you establish a classroom management system with each group of students?	1	2	3	4	5
9. How much can you assist families in helping their children do well in school?	1	2	3	4	5
10. How well can you implement alternative strategies in your classroom?	1	2	3	4	5
11. How much can you do to help your students value learning?	1	2	3	4	5
12. To what extent can you provide an alternative explanation or example when students are confused?	1	2	3	4	5

Teacher Computer Efficacy Survey

	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree
1. When students have difficulty with the computer, I am usually at a loss as to how to help them.	**1**	**2**	**3**	**4**	**5**
2. I wonder if I have the necessary skills to use the computer for instruction.	**1**	**2**	**3**	**4**	**5**
3. I generally employ the computer in my classroom ineffectively.	**1**	**2**	**3**	**4**	**5**
4. Whenever I can, I avoid using computers in my classroom.	**1**	**2**	**3**	**4**	**5**
5. I am not very effective in monitoring students' computer use in my classroom.	**1**	**2**	**3**	**4**	**5**
6. Even when I try very hard, I do not use the computer as well as I do other instructional resources.	**1**	**2**	**3**	**4**	**5**
7. I do not know what to do to turn students onto computers	**1**	**2**	**3**	**4**	**5**
8. I find it difficult to explain to students how to use the computer.	**1**	**2**	**3**	**4**	**5**
9. Given a choice, I would not invite the principal to evaluate my computer-based instruction.	**1**	**2**	**3**	**4**	**5**

Appendix C Attitudes Toward Computers Survey

Attitudes Toward Computers Survey

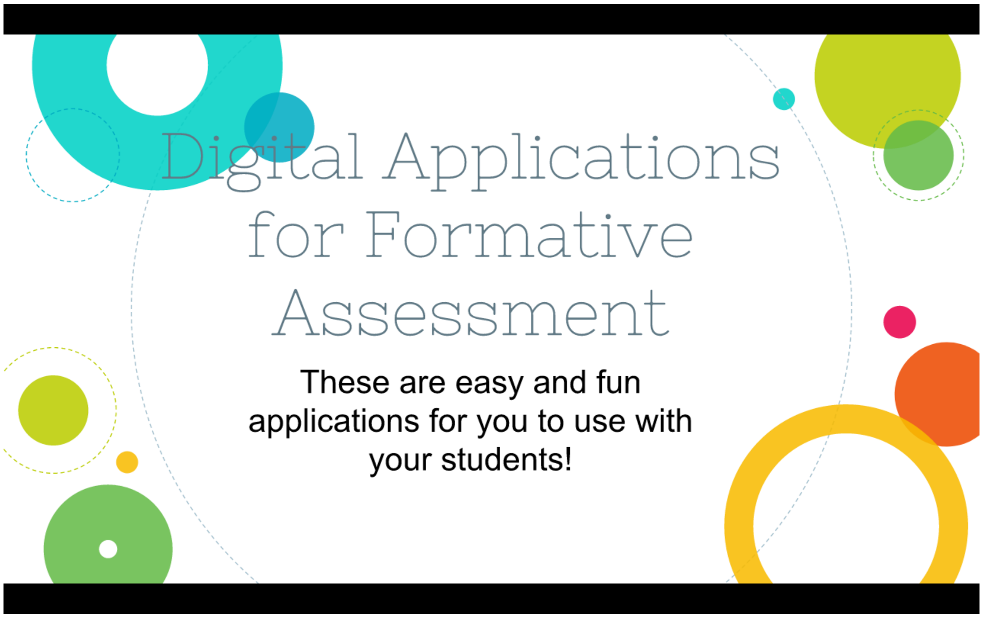
	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree
1. The computer provides opportunity for improving the learning performance.	**1**	**2**	**3**	**4**	**5**
2. The efficiency of the learning process is increased through the use of computers.	**1**	**2**	**3**	**4**	**5**
3. The computer used as a learning tool, increases student motivation	**1**	**2**	**3**	**4**	**5**
4. Students with learning difficulties can strongly benefit from the didactic possibilities which the use of computers entail	**1**	**2**	**3**	**4**	**5**
5. The computer increases the level of creativity of students	**1**	**2**	**3**	**4**	**5**
6. The use of computer helps students to achieve better text writing.	**1**	**2**	**3**	**4**	**5**
7. Computer knowledge and practical experience should be more integrated in the curriculum	**1**	**2**	**3**	**4**	**5**
8. Computers can help the teacher to apply differentiation among the students	**1**	**2**	**3**	**4**	**5**

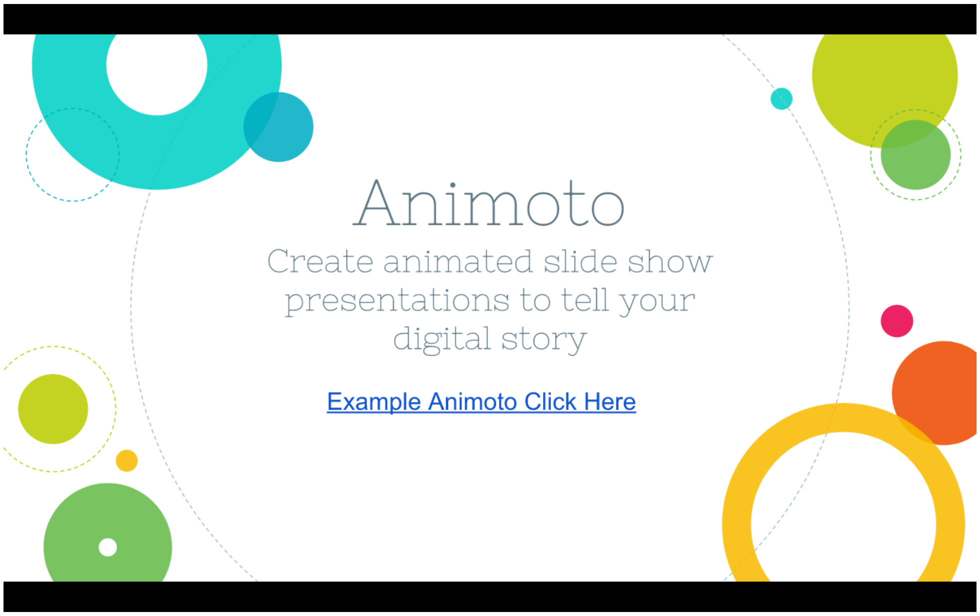
Appendix D Computer Use Survey

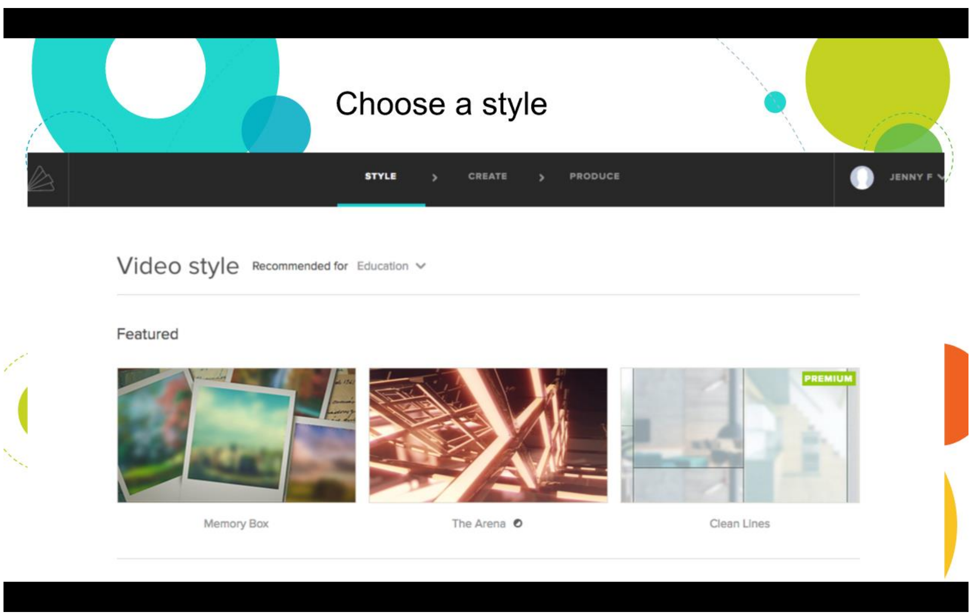
Computer Use Survey

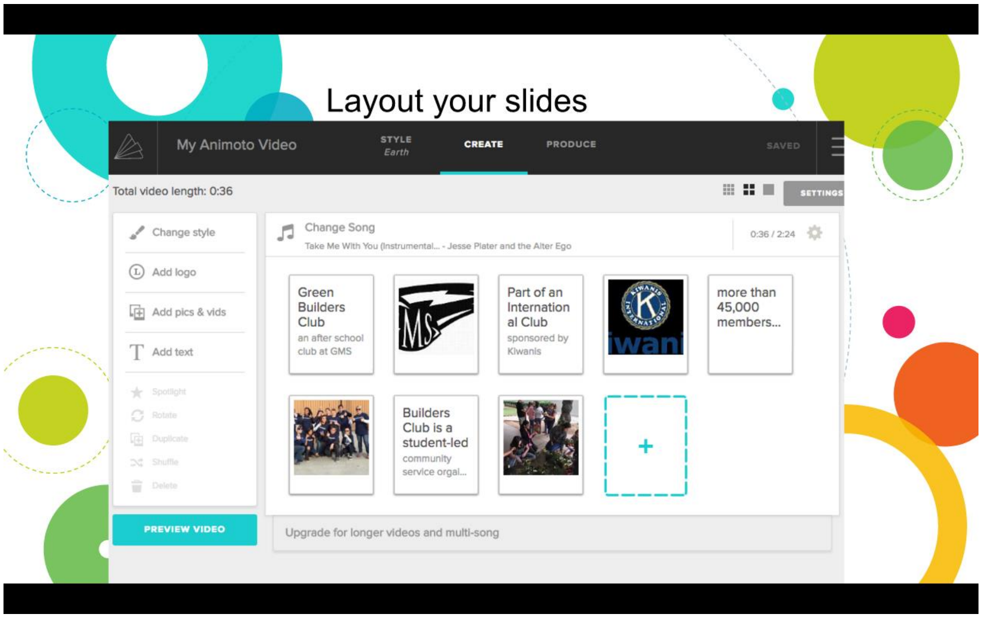
	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree
1. I use the computer as a tool for demonstration working with existing presentations, or those someone else has made for me	**1**	**2**	**3**	**4**	**5**
2. I use the computer as a tool to teach new subject knowledge, i.e. the pupils acquire knowledge directly from the computer	**1**	**2**	**3**	**4**	**5**
3. I encourage pupils in class to search for relevant information on the Internet	**1**	**2**	**3**	**4**	**5**
4. I use educational software with my pupils for learning subject knowledge through drill and practice I would teach pupils to consider the implications and opportunities of computer use .	**1**	**2**	**3**	**4**	**5**
5. I use the computer as a tool for demonstration working with presentations I have made myself (e.g., PowerPoint)	**1**	**2**	**3**	**4**	**5**
6. I ask pupils to undertake tasks or follow up classwork at home on the computer	**1**	**2**	**3**	**4**	**5**
7. I use the computer to assist with differentiation or implementing individual learning plans	**1**	**2**	**3**	**4**	**5**
8. I encourage pupils to work collaboratively when using a computer	**1**	**2**	**3**	**4**	**5**
9. I use e-mail to communicate with pupils out of school (or class time)	**1**	**2**	**3**	**4**	**5**

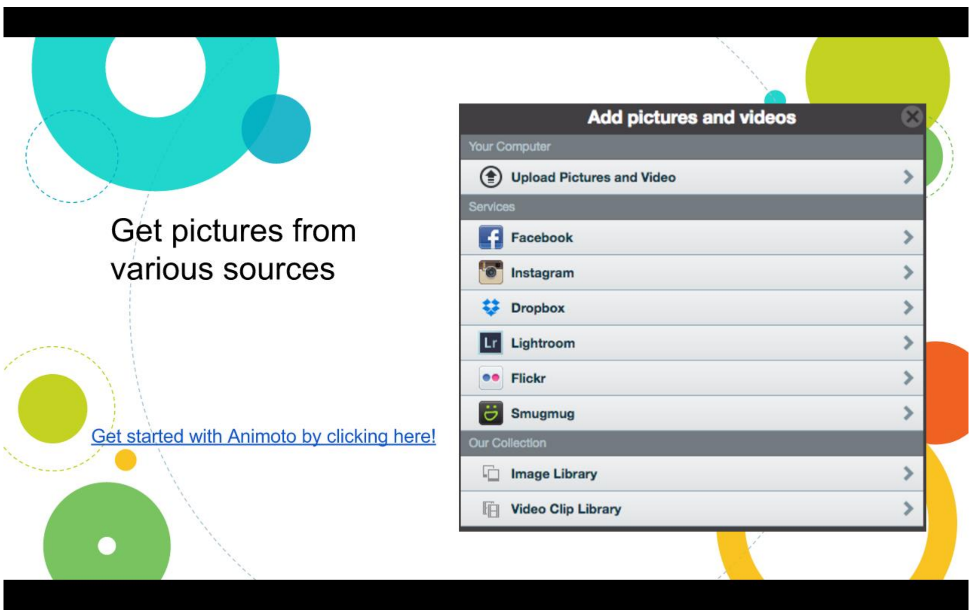
Appendix E Get to know Digital Applications Presentation Slides

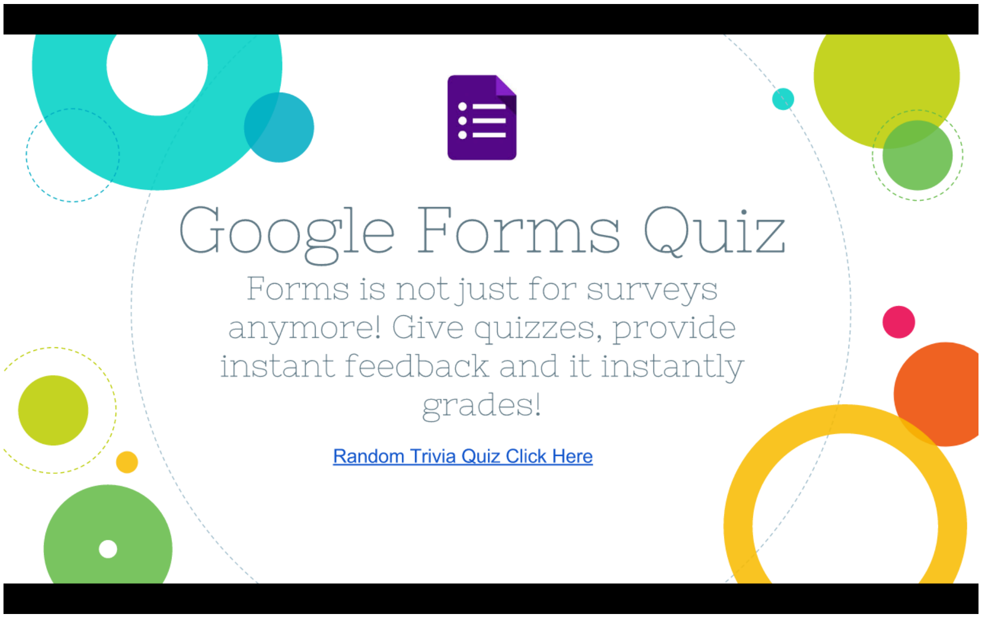


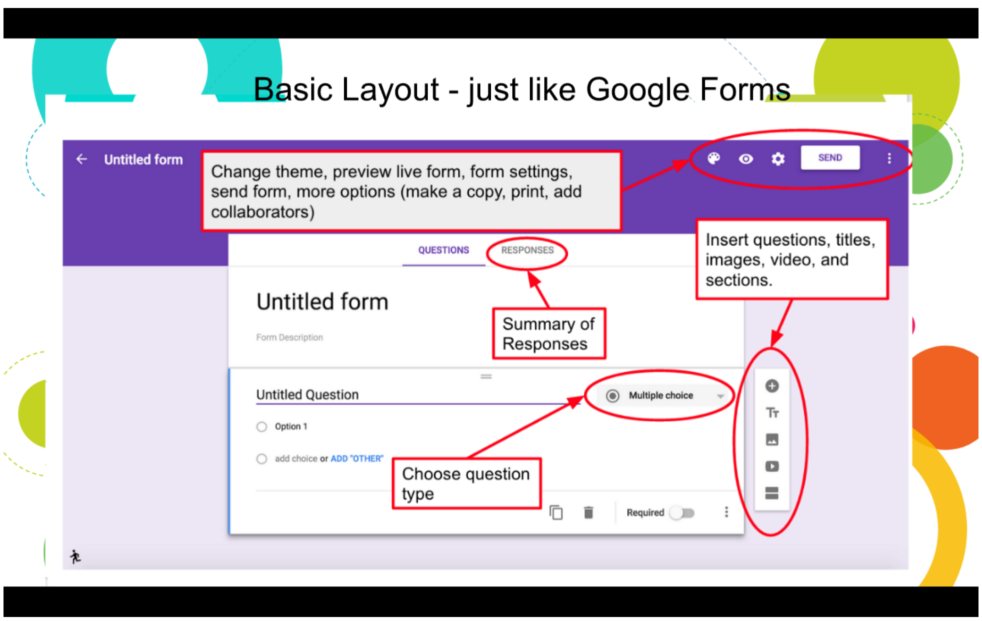

Animoto
Create animated slide show presentations to tell your digital story
Example Animoto Click Here

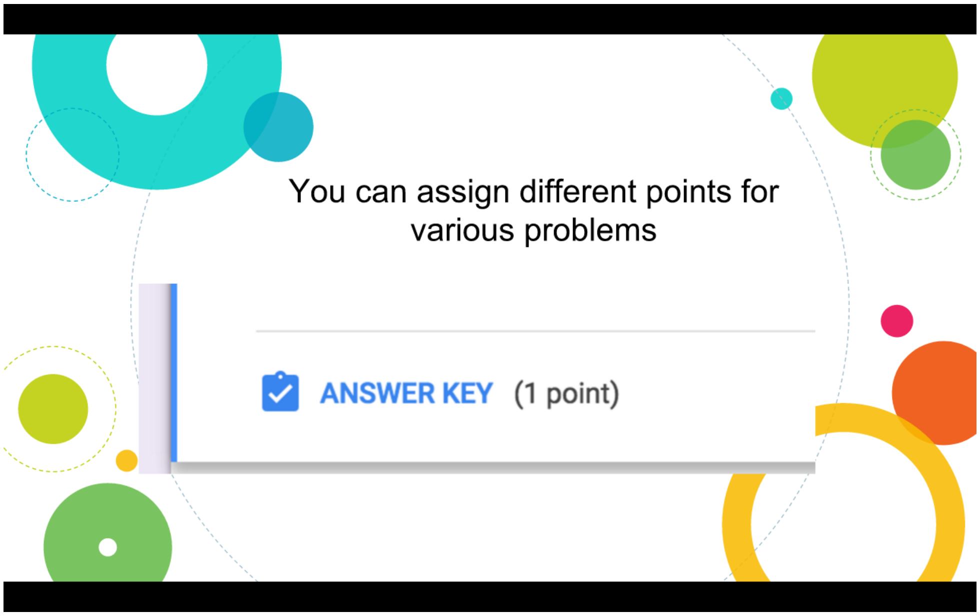

Choose a style
STYLE
CREATE
PRODUCE
JENNY F
Video style
Recommended for
Education
Featured
PREMIUM
Memory Box
The Arena
Clean Lines

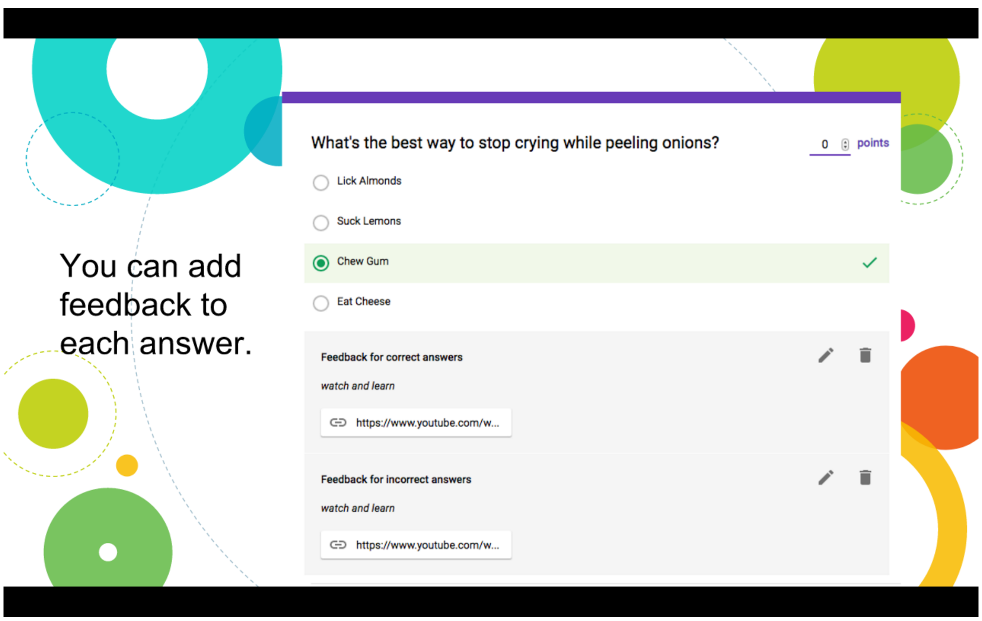

Layout your slides
My Animoto Video
STYLE
Earth
CREATE
PRODUCE
SAVED
Total video length: 0:36
SETTINGS
Change style
Add logo
Add pics & vids
Add text
Change Song
Take Me With You (Instrumental... - Jesse Plater and the Alter Ego
0:36 / 2:24
Green Builders Club
an after school club at GMS
Part of an International Club
sponsored by Kiwanis
more than 45,000 members...
Builders Club is a student-led
community service orgai...
PREVIEW VIDEO
Upgrade for longer videos and multi-song

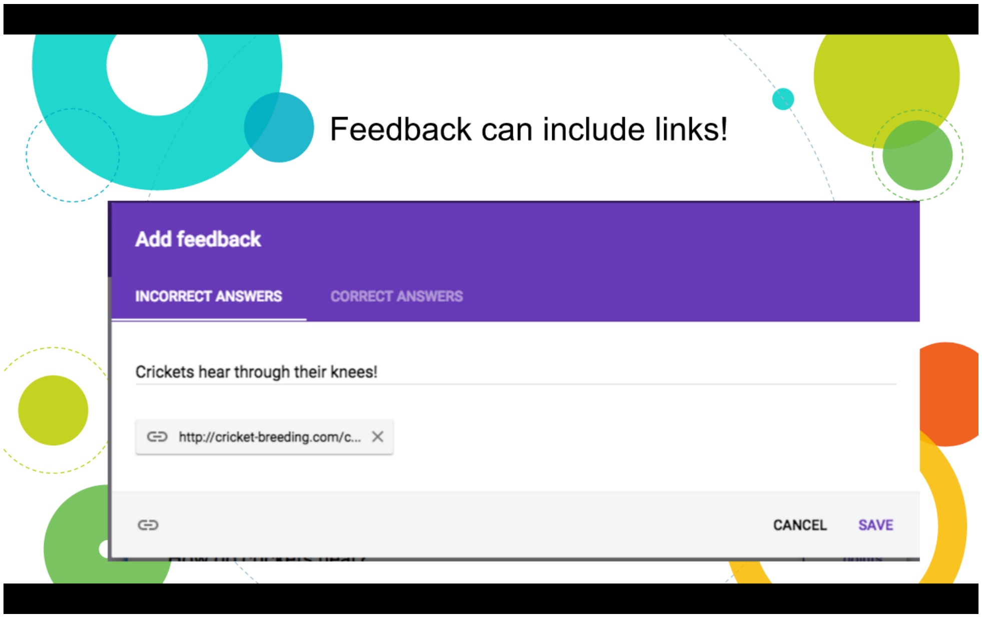

Get pictures from various sources
Get started with Animoto by clicking here!
Add pictures and videos
Your Computer
Upload Pictures and Video
Services
Facebook
Instagram
Dropbox
Lightroom
Flickr
Smugmug
Our Collection
Image Library
Video Clip Library


Google Forms Quiz
Forms is not just for surveys anymore! Give quizzes, provide instant feedback and it instantly grades!
Random Trivia Quiz Click Here


Basic Layout - just like Google Forms
Untitled form
Change theme, preview live form, form settings, send form, more options (make a copy, print, add collaborators)
SEND
QUESTIONS
RESPONSES
Insert questions, titles, images, video, and sections.
Untitled form
Form Description
Summary of Responses
Untitled Question
Multiple choice
Option 1
add choice or ADD "OTHER"
Choose question type
Required


You can assign different points for various problems
ANSWER KEY (1 point)


You can add feedback to each answer.
What's the best way to stop crying while peeling onions?
0 points
Lick Almonds
Suck Lemons
Chew Gum
Eat Cheese
Feedback for correct answers
watch and learn
https://www.youtube.com/w...
Feedback for incorrect answers
watch and learn
https://www.youtube.com/w...


Feedback can include links!
Add feedback
INCORRECT ANSWERS
CORRECT ANSWERS
Crickets hear through their knees!
http://cricket-breeding.com/c...
CANCEL
SAVE

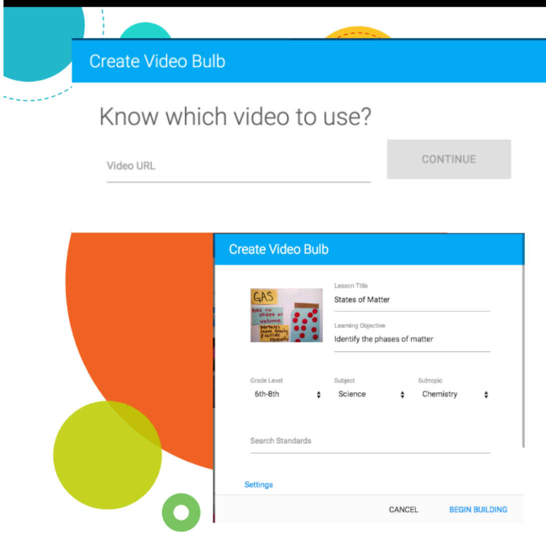

Playposit
Make classroom videos interactive!
Click Here for an example Playposit Video

Playposit

Using any YouTube video, insert questions and get automatic data based on results.

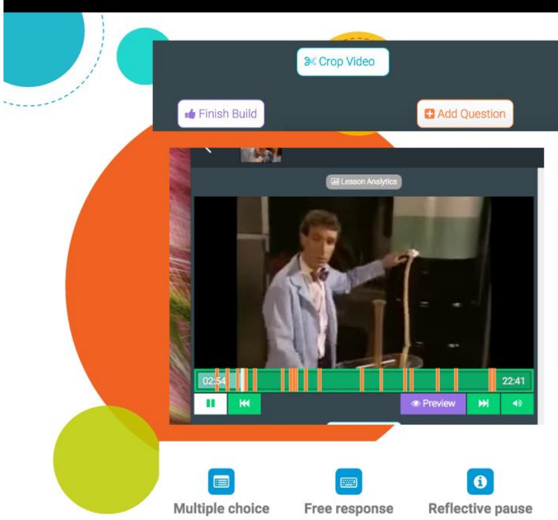
Get instant feedback on student progress!

How to use tutorial click here



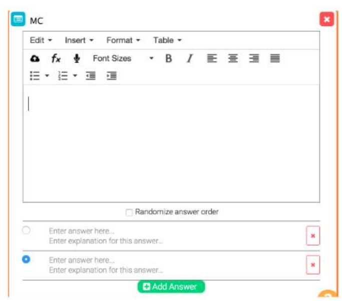
Copy any video URL and paste it into Educanon's Playposit.

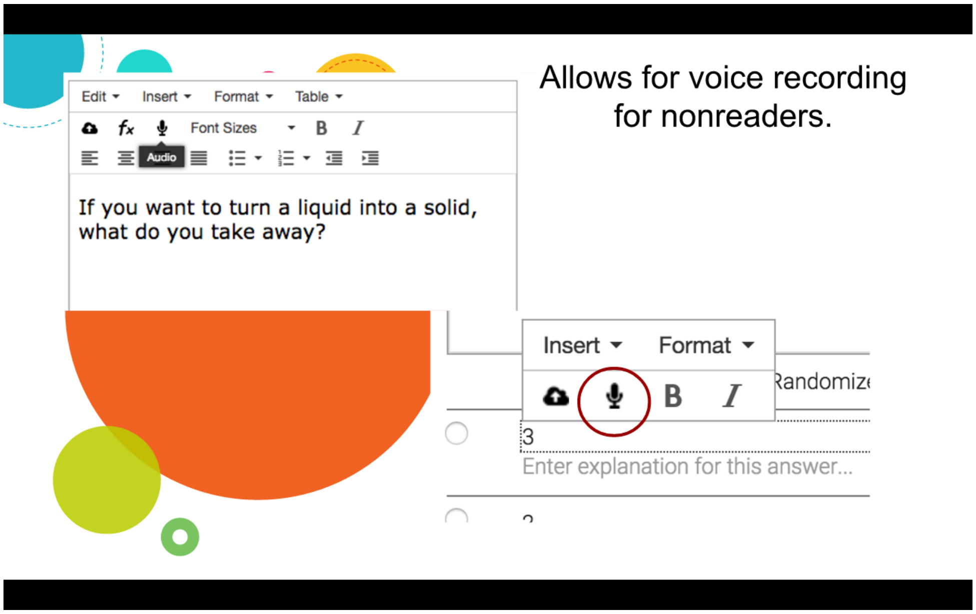
Insert title, learning objectives, and search standards.

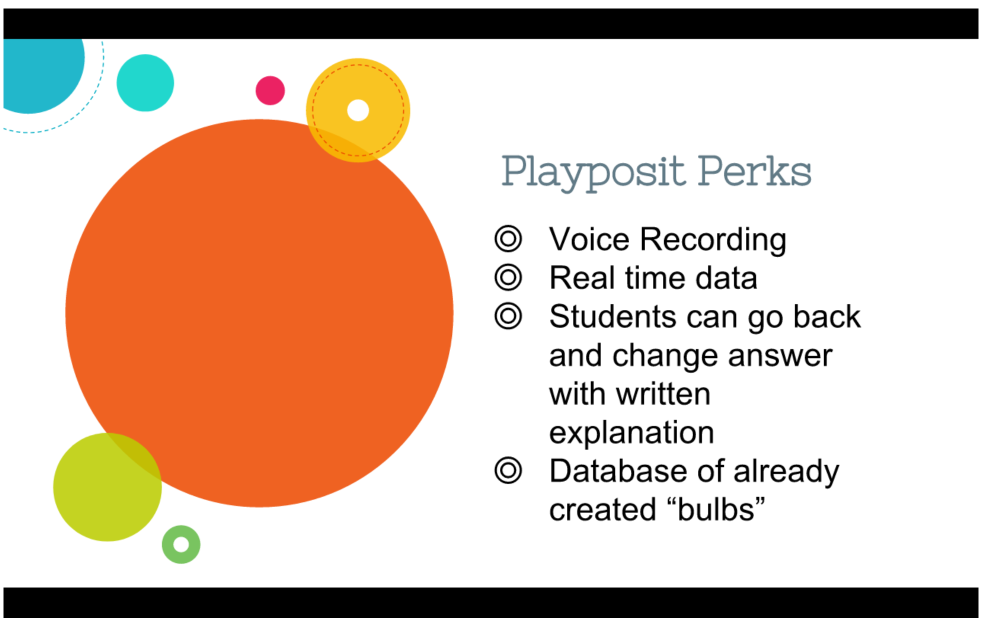


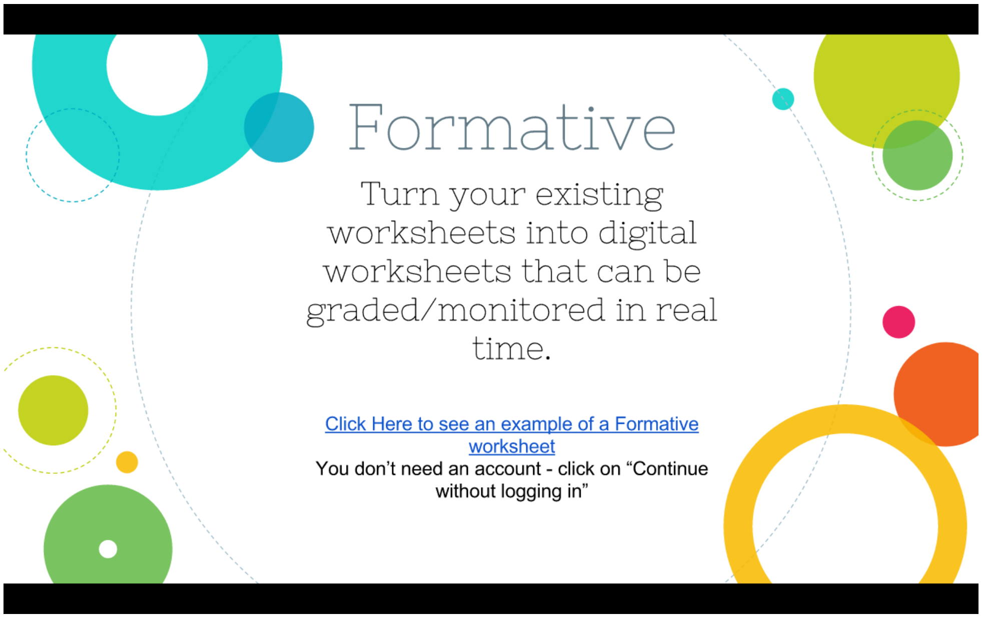
Simple navigation

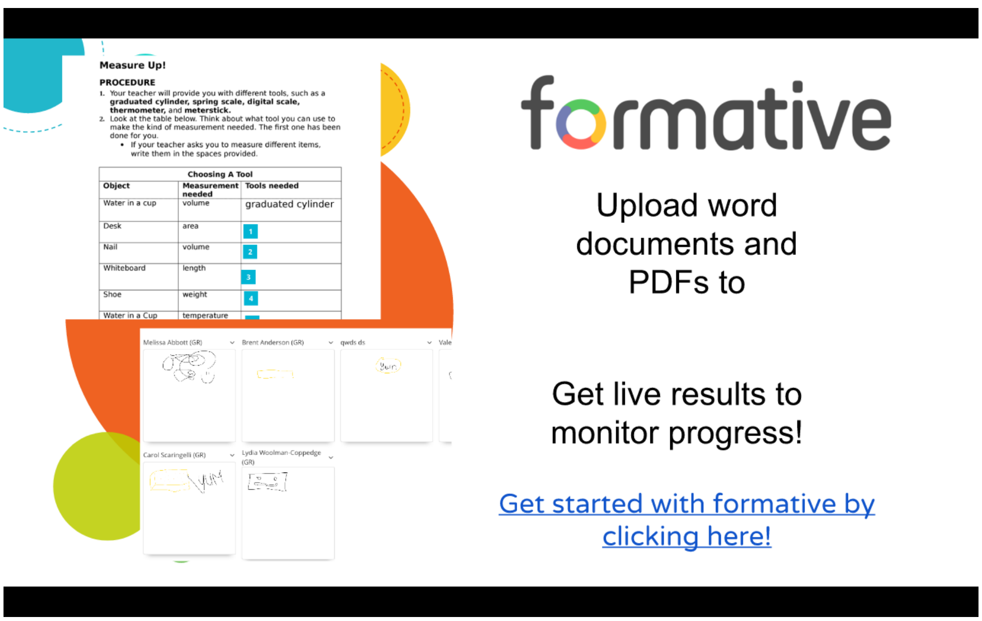
Add questions anywhere in the video.

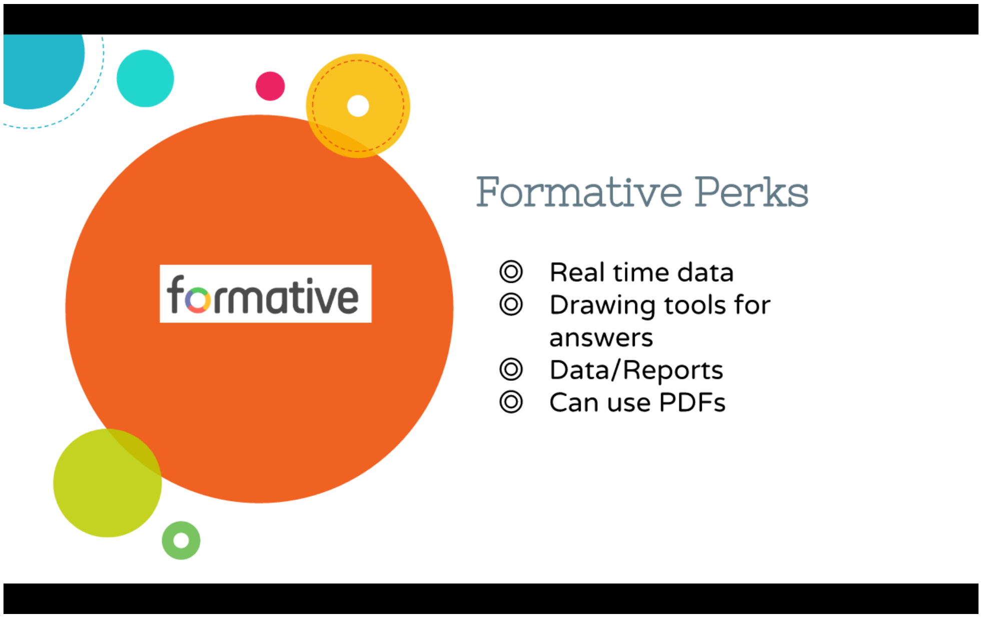



Allows for voice recording
for nonreaders.
Edit Insert Format Table
Font Sizes B I
Audio
If you want to turn a liquid into a solid,
what do you take away?
Insert Format
B I
3
Enter explanation for this answer...

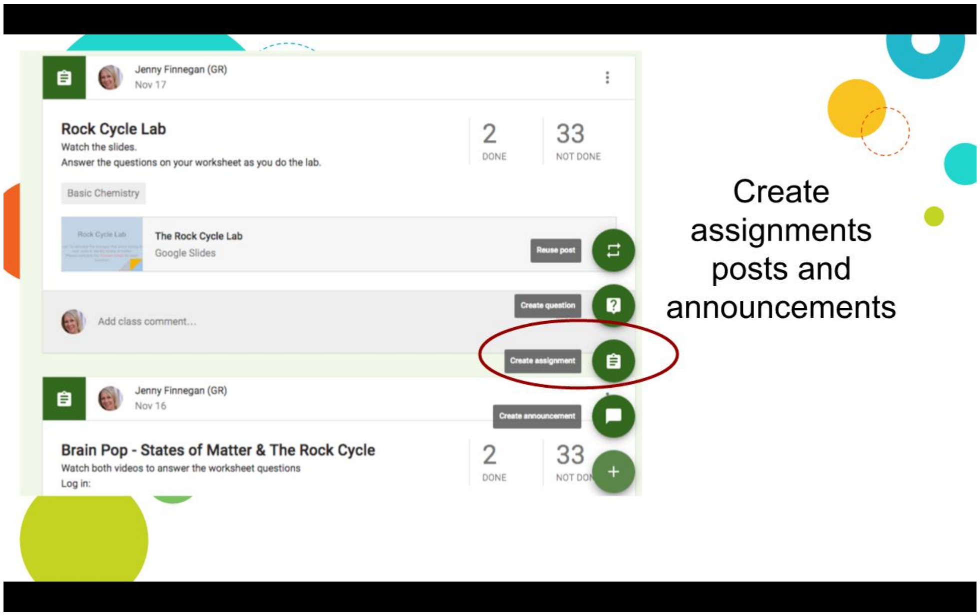

Playposit Perks
Voice Recording
Real time data
Students can go back and change answer with written explanation
Database of already created “bulbs”

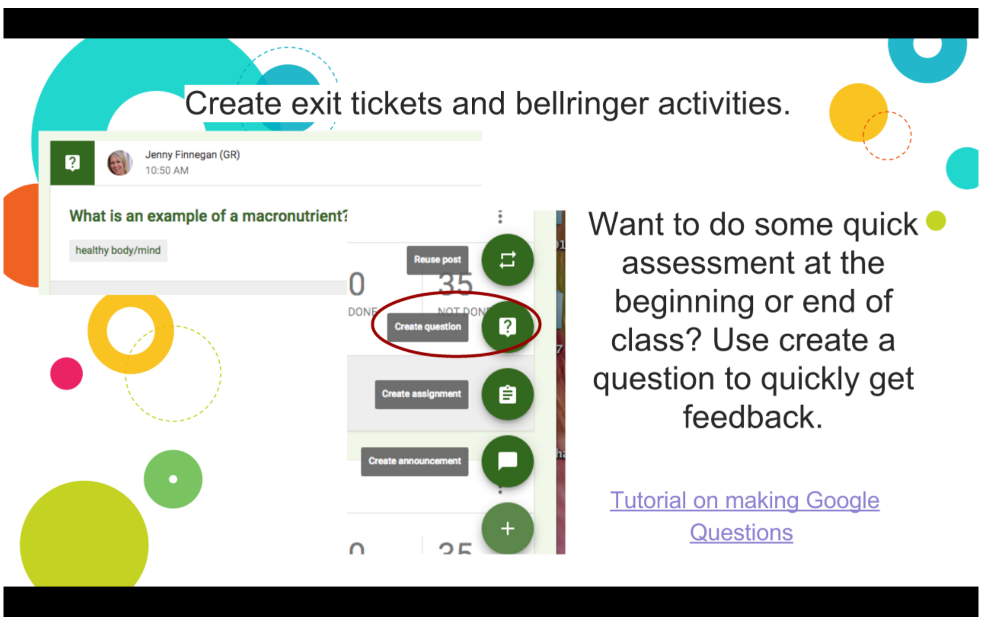

Formative
Turn your existing worksheets into digital worksheets that can be graded/monitored in real time.
Click Here to see an example of a Formative worksheet
You don't need an account - click on "Continue without logging in"

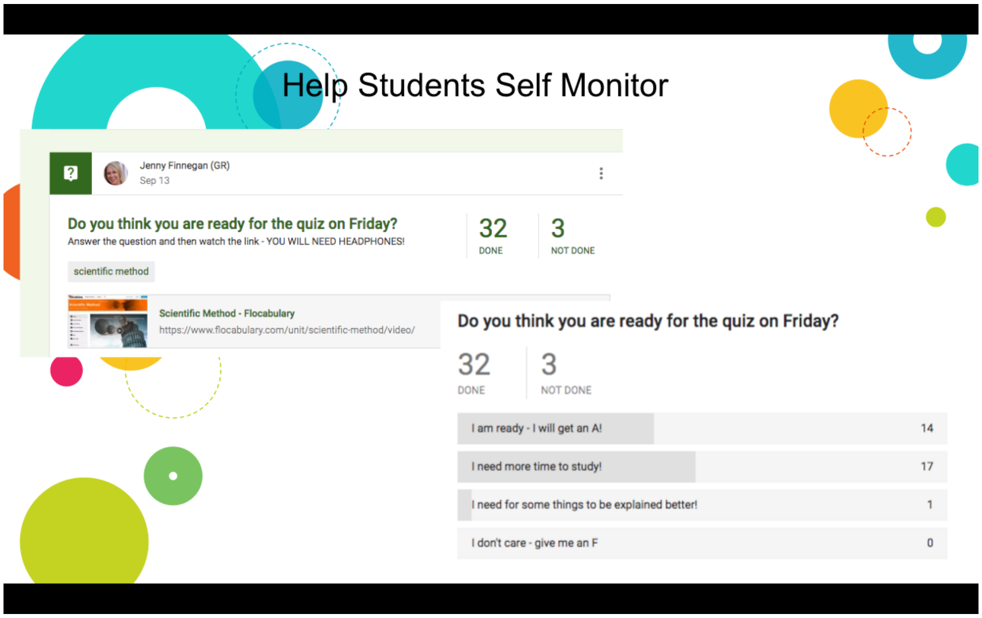

Measure Up!
PROCEDURE
1. Your teacher will provide you with different tools, such as a graduated cylinder, spring scale, digital scale, thermometer, and meterstick.
2. Look at the table below. Think about what tool you can use to make the kind of measurement needed. The first one has been done for you.
• If your teacher asks you to measure different items, write them in the spaces provided.
Choosing A Tool
Object
Measurement needed
Tools needed
Water in a cup
volume
graduated cylinder
Desk
area
Nail
volume
Whiteboard
length
Shoe
weight
Water in a Cup
temperature
formative
Upload word documents and PDFs to
Get live results to monitor progress!
Get started with formative by clicking here!

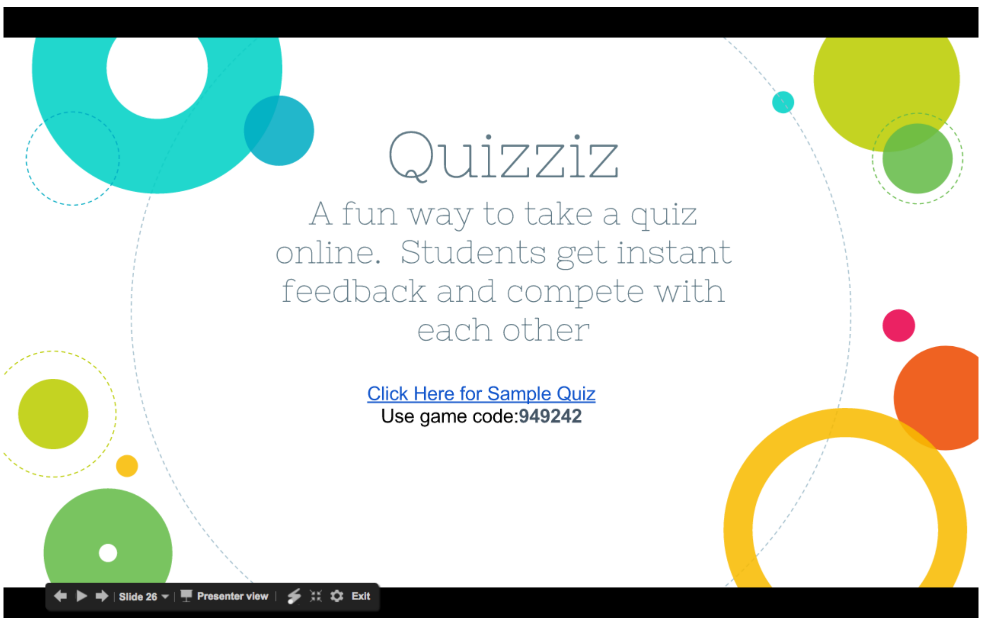

formative
Formative Perks
Real time data
Drawing tools for answers
Data/Reports
Can use PDFs

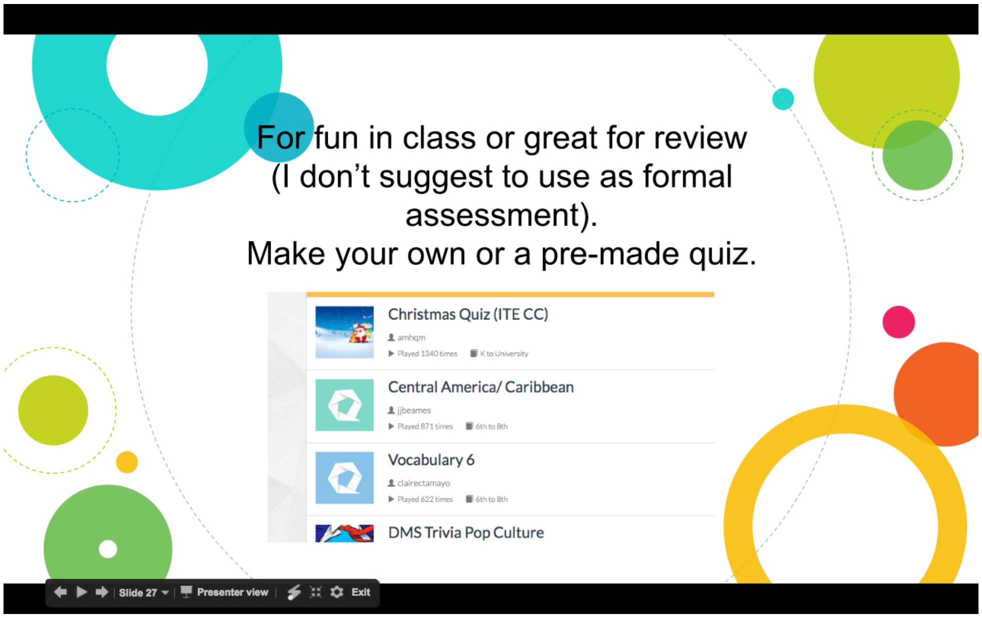

Google Classroom
Structures the informations you distribute to class. Students upload work.

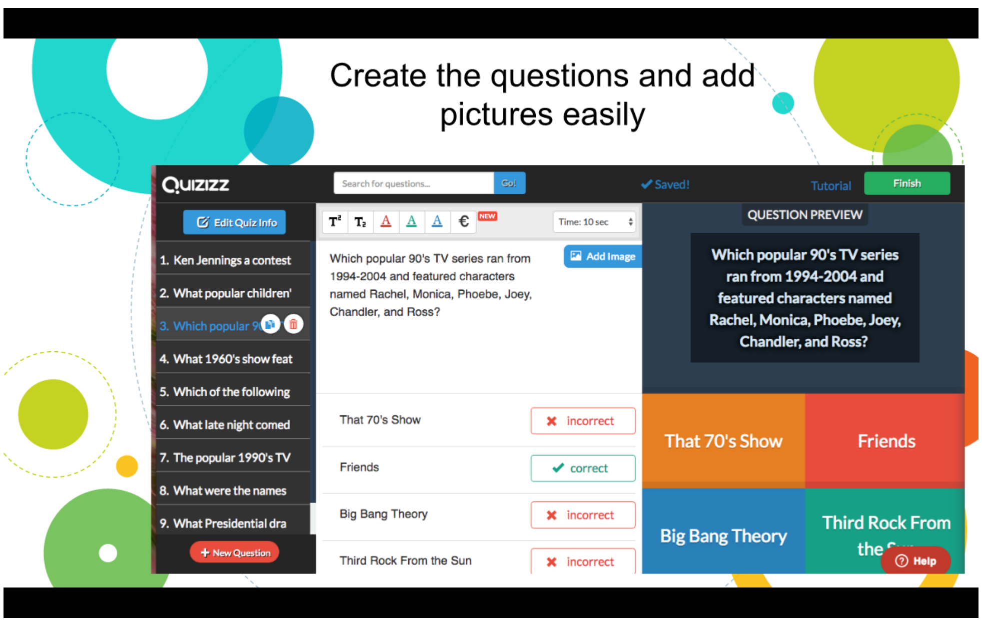

Jenny Finnegan (GR)
Nov 17
Rock Cycle Lab
Watch the slides.
Answer the questions on your worksheet as you do the lab.
2
DONE
33
NOT DONE
Basic Chemistry
The Rock Cycle Lab
Google Slides
Reuse post
Create question
Add class comment...
Create assignment
Jenny Finnegan (GR)
Nov 16
Create announcement
Brain Pop - States of Matter & The Rock Cycle
Watch both videos to answer the worksheet questions
Log in:
2
DONE
33
Create assignments posts and announcements

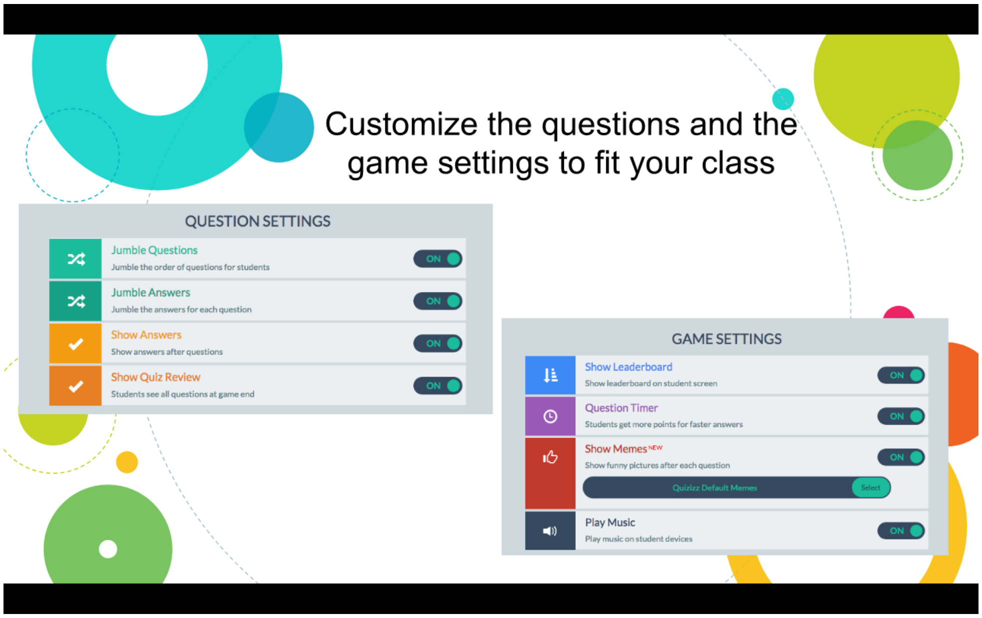

Create exit tickets and bellringer activities.
Jenny Finnegan (GR)
10:50 AM
What is an example of a macronutrient?
healthy body/mind
Reuse post
Create question
Create assignment
Create announcement
Want to do some quick assessment at the beginning or end of class? Use create a question to quickly get feedback.
Tutorial on making Google Questions


Help Students Self Monitor
Jenny Finnegan (GR)
Sep 13
Do you think you are ready for the quiz on Friday?
Answer the question and then watch the link - YOU WILL NEED HEADPHONES!
scientific method
Scientific Method - Flocabulary
https://www.flocabulary.com/unit/scientific-method/video/
32 DONE
3 NOT DONE
Do you think you are ready for the quiz on Friday?
32 DONE
3 NOT DONE
I am ready - I will get an A! 14
I need more time to study! 17
I need for some things to be explained better! 1
I don't care - give me an F 0

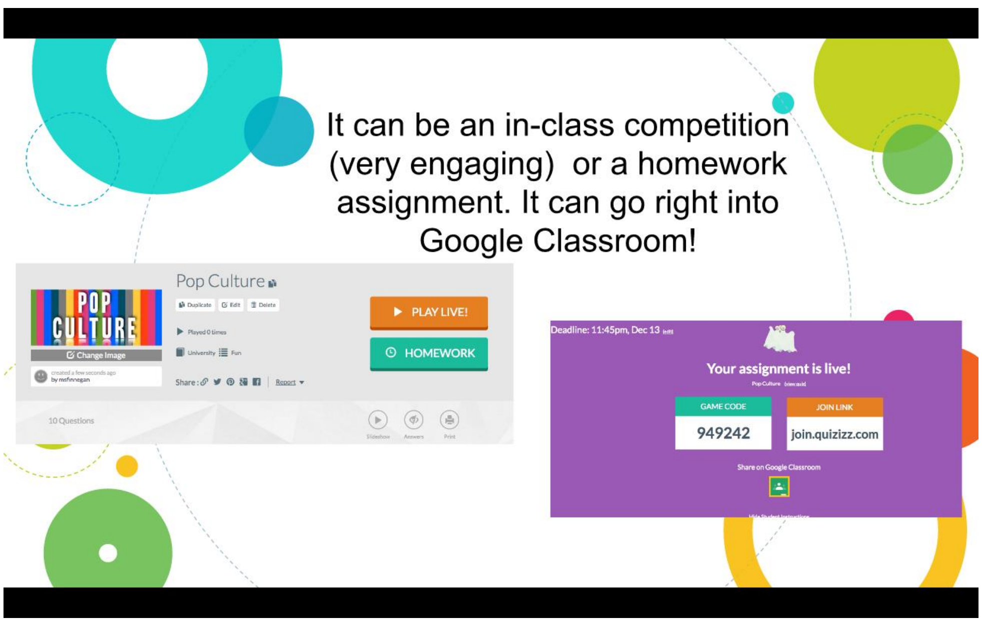

Quizziz
A fun way to take a quiz online. Students get instant feedback and compete with each other
Click Here for Sample Quiz
Use game code:949242
Slide 26
Presenter view
Exit


For fun in class or great for review (I don't suggest to use as formal assessment).
Make your own or a pre-made quiz.
Christmas Quiz (ITE CC)
Central America/ Caribbean
Vocabulary 6
DMS Trivia Pop Culture
Slide 27
Presenter view
Exit

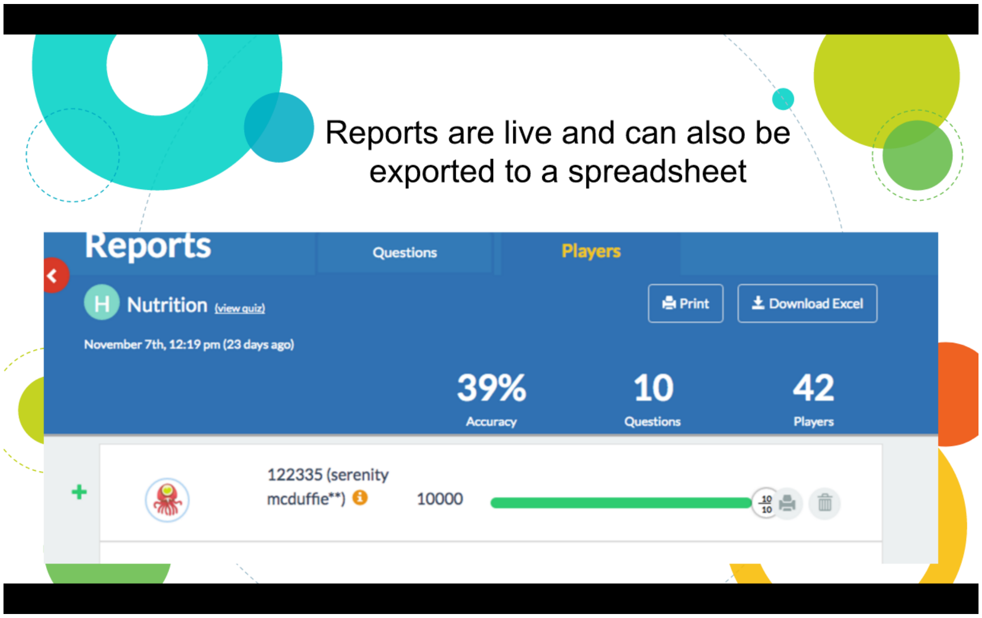

Create the questions and add pictures easily
Quizizz
Search for questions...
Go!
Saved!
Tutorial
Finish
Edit Quiz Info
1. Ken Jennings a contest
2. What popular children'
3. Which popular 9
4. What 1960's show feat
5. Which of the following
6. What late night comed
7. The popular 1990's TV
8. What were the names
9. What Presidential dra
New Question
Time: 10 sec
Add Image
Which popular 90's TV series ran from 1994-2004 and featured characters named Rachel, Monica, Phoebe, Joey, Chandler, and Ross?
That 70's Show
incorrect
Friends
correct
Big Bang Theory
incorrect
Third Rock From the Sun
incorrect
QUESTION PREVIEW
Which popular 90's TV series ran from 1994-2004 and featured characters named Rachel, Monica, Phoebe, Joey, Chandler, and Ross?
That 70's Show
Friends
Big Bang Theory
Third Rock From
Help



Customize the questions and the game settings to fit your class
QUESTION SETTINGS
Jumble Questions
Jumble the order of questions for students
ON
Jumble Answers
Jumble the answers for each question
ON
Show Answers
Show answers after questions
ON
Show Quiz Review
Students see all questions at game end
ON
GAME SETTINGS
Show Leaderboard
Show leaderboard on student screen
ON
Question Timer
Students get more points for faster answers
ON
Show Memes NEW
Show funny pictures after each question
ON
Quizizz Default Memes
Select
Play Music
Play music on student devices
ON



It can be an in-class competition (very engaging) or a homework assignment. It can go right into Google Classroom!
Pop Culture
POP CULTURE
Change Image
PLAY LIVE!
HOMEWORK
Share :
Report
10 Questions
Deadline: 11:45pm, Dec 13
Your assignment is live!
GAME CODE
949242
JOIN LINK
join.quizizz.com
Share on Google Classroom



Additional Recommended Resources

Glogster: You need a license
Digital Posters
http://www.glogster.com/#love

Stupeflix: Free video editor.
Similar to animoto
https://studio.stupeflix.com/en/

My Maps: Free
Create your own maps on Google Maps Platform.
https://www.google.com/maps/d/

Doc Hub or Kami: Free with subscriptions for more tools
Digital annotation
https://dochub.com/
https://web.kamihq.com/web/viewer.html

YouTube Editor: Free
Create Videos
https://www.youtube.com/editor

Screencastify : Free with subscriptions for more tools
Record what is on your computer screen and add dialogue
https://www.screencastify.com/