Implementing Digital Tools in Assessments for Algebra

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Implementing Digital Tools in Assessments for Algebra

Brandon M. Kapcinski

A thesis submitted to the Department of Education and Human Development of the College at Brockport, State University of New York, in partial fulfillment of the requirements for the degree of Master of Science in Education

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Abstract

This project will give a brief overview of what purpose formative and summative assessments have in secondary mathematics classrooms. Furthermore, this paper will discuss the importance of digital content as it pertains to assessment. Specifically, this algebra curriculum project provides secondary mathematics educators with necessary information on how to utilize digital tools with assessment to deepen student’s content knowledge. The framework of the SAMR Model guides teachers to the smooth integration of digital technology in assessment.
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Introduction

Educators around the world are asking the question, how can we incorporate technology and digital tools into our assessments? Will technological/digital applications for assessments prove to increase student success in the classroom? Educators can also benefit from such assessments by comparing data between students, classes and grade levels, and use using this data to inform future instruction (data-driven instruction).

Many teachers would agree, that the purpose of formative assessment is to assess student’s knowledge to then modify instruction and set students up for a deeper understanding or attainment. “Summative assessments have been blamed for many problems related to assessment in our education system and as an obstacle to the growth of formative assessment” (Taras, 2005, p. 476).

Linking educational technology and assessment in the classroom can be very tedious and time-consuming work. However, with all of the current digital tools, mathematics educators are finding ways to use technology to assess student knowledge of content. Beevers (1999) however, explains that computers can be utilized to target strengths and weaknesses, continuous monitoring, and grade quickly.

“Technology is not one thing but many things that can be woven into the instructional environment by a teacher to assist the teaching and learning process” (Lawless, 2007, p.578). Lawless (2007) provides professional development that explains educators have a long way to go before we can utilize these best practices vigorously. There is evidence of student learning via mathematical applications
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(games, practice software, self-reflection tools). Moreover, these that can help assist teachers identify students’ strengths and weaknesses.

Literature Review

The term formative assessment in secondary mathematics can be used vaguely and defined broadly by many educators. Many teachers would agree, that the purpose of formative assessment is to assess students’ knowledge to then modify instruction and set students up for a deeper understanding or attainment. Black and Wiliam (2009) describes five key aspect of formative assessment. The first is “clarifying and sharing learning intentions and criteria for success” (Black, 2009, p. 4). During instruction teachers clarify learning targets and objectives so students understand what they will be learning. Much of what teachers do is to guide students understanding and provide criteria for their success. The second aspect of formative assessment relates to where the learner stands at that moment in the learning process. It is stated as, “engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding” (Black, 2009, p. 4). At this point quality-questioning techniques are essential to activate prior knowledge and push student’s thinking and learning. The third feature addresses feedback educators provide to their students. This feature is, “providing feedback that moves learners forward” (Black, 2009, p. 5). There are many forms of feedback teachers can provide students in the learning process. The main purpose of teacher feedback is to move learners forward in their understanding of mathematical content. The fourth aspect pertains to students’ collaboration with peers and how
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that collaboration can move a learners understanding. It is stated as, “activating students as instructional resources for one another” (Black, 2009, p. 5). One of the many responsibilities of the teacher is to be the facilitator of the learning process. Teachers must engage their students with the curriculum to allow this feature to occur. The last feature relates to the students effort and engagement in the learning process. Black (2009) stressed the importance of, “activating students as the owners of their own learning” (p. 5). Educators can use formal assessment as a form of “checkpoints” for students’ conceptual understanding of mathematics.

Unlike formative assessment, summative assessment is a more stringent evaluation where the students are assessed for mastery of the learning standards. Taras explains that it is important to view assessment as both formative and summative. “Summative assessments have been blamed for many problems related to assessment in our education system and as an obstacle to the growth of formative assessment” (Taras, 2005, p. 476). It is thought that the ideology behind summative assessments gives the term a “bad rep” in education. “All assessment begins with summative assessment (which is a judgment); formative assessment is in fact summative assessment in addition to feedback which is used by the learner” (Taras, 2005, p. 466). Taras views feedback as an essential component of the formative assessment process and believes it is required to push learning. Her definition of formative assessment states, “for an assessment to be formative, it requires feedback which indicates the existence of a ‘gap’ between the actual level of the work being assessed and the required standard. It also requires an indication of how the work can be improved to reach the required standard” (Taras, 2005, p. 468).
Taras continues to add that summative assessment is a process that uses formative assessment consistently. “The process of assessment leads to summative assessment, that is, a judgment which encapsulates all the evidence up to a given point. This point is seen as a finality at the point of the judgment” (Taras, 2005, p. 468). Indeed, formative assessment is summative assessment with feedback that can be later used to reinforce learning.

A question challenging mathematics educators is how to incorporate technology and digital tools into instruction and assessments. Schacter (1999) analyzed the positive and negative impacts of various technology studies on student achievement and presented benefits such as individualized instruction, which accommodates the needs, interests, proclivities, current knowledge, and learning styles of the student. Schacter further explains that Kulik’s data demonstrated that students who were introduced to computer-based instruction scored higher on tests of achievement, compared to the counterpart of students who did not have computers. Further analysis suggests students, with access to computer assisted instruction and software that encourages higher order thinking, “show positive gains in achievement on researcher constructed tests, standardized tests, and national tests” (Schacter, 1999, p. 9). Although Kulik’s (1994) research was conducted nearly two decades ago, the studies suggest a movement toward differentiation of assessment. Computer assisted instruction has similarities of a flipped classroom approach to learning. Students are able to learn content, through a technological tool, and practice using mathematical software which tracks student
progress and growth. Using a flipped classroom for instruction can be a great way to differentiate lessons and provide a diverse option for learning.

Linking educational technology and assessment in the classroom can be very tedious and time-consuming work. With all of the current digital tools, mathematics educators are finding ways to use technology to assess student knowledge of content. Beevers (1999) explain that computers can be utilized to target strengths and weaknesses, continuous monitoring, and grade quickly. Teachers often use computers for assessing student’s knowledge for multiple choice type problems. For example, “grading in term modules where 40% of the final mark is assessed by computer” (Beevers, 1999, p. 147). Computer-Aided Learning in Mathematics (CALM) seeks to extend answer types, and increase the opportunity for more sophisticated layouts. It’s not the idea that teachers are trying to take the “easy way out”, however technology can highlight certain statistics humans may not be able to see (Beevers, 1999, p. 149).

Lawless (2007) explains that educators have a long way to go before technology driven assessments can be utilized with best practices vigorously. They state, “Technology is not one thing but many things that can be woven into the instructional environment by a teacher to assist the teaching and learning process” (Lawless, 2007, p. 578). Teachers need ample support with technology in their classrooms and there are many variations of current digital tools available. There are mathematical applications (games, practice software, self-reflection tools) that provide evidence of student learning and supports teachers in identifying students’
strengths and weaknesses. Lawless (2007) details case studies where teachers have reported using digital tools and tracked students’ progress towards a goal.

There are limited technology or digital tools available for mathematical assessment and, less research on the topic. Currently educators are receiving mixed results on this effectiveness, but there are crucial reasons why. Roschelle (2001) identifies three key reasons for these mixed results. The first is the variation of computer hardware and software between school districts. The second reason is the “successful use of technology is always accompanied by concurrent reforms in other areas such as curriculum, assessment, and teacher professional development, so the gains in learning cannot be attributed to use of technology alone” (Roschelle, 2001, p. 78). The third reason is technologies are expensive and come with a learning curve so some districts avoiding them all together. Yet, it has been shown that “students who participate in computer connected learning networks show increased motivation, a deeper understanding of concepts, and an increased willingness to tackle difficult questions” (Roschelle, 2001, p. 81). This is a solid reason to proceed with introducing technology-based assessments in mathematics classrooms.

SAMR Model

Educators are molding the mindset of student-centered learning in mathematics classroom across the country. The Substitution, Augmentation, Modification, and Redefinition (SAMR) Model, first introduced by Dr. Ruben Puenteledura transforms technology into a blended learning experience. Picha (2018) explains that Puenteledura believed that technology can “amplify” the learning
experience for students. This model guides the integration of technology in the classroom so it is effectively integrated and has the potential to increase student engagement.

*Substitution* is the lowest level of technology integration. At this stage in the progression, technology replaces an activity that was done in a more traditional way. For example, a teacher may have students watch a video on “how to distribute” rather than show them via notes. In this example, the substitution occurs when the teacher uses a technological tool to replace a traditional “paper and pencil” method. Again, in this lowest level of integration, technology acts as a direct tool substitute, with no functional change. Teachers need to be reflecting, what can students gain by replacing the task with new technology?

*Augmentation* is the next level of technology integration. Not to be confused with substitution, students should gain a deeper understanding of a learning target during this stage of integration. At this stage in the integration process there should be an increase in student engagement and rigor. Students are problem solving and experimenting with the new technology to gain a deeper understanding of the learning target. For example, while graphing linear functions using slope-intercept form, students can use a TI-84 graphing calculator to gain a deeper understanding of the content. While students can graph a linear equation using the y-intercept and the slope, the graphing calculator will provide a table of values and a picture of the graph on the screen. The teacher needs to reflect on whether or not the technology has added to the learning experience and if the overall learning has improved due to the technology integration. During this stage, the technology should add a new
feature that pushes the student through the continuum of learning. Students should gain a deeper conceptual understanding of the learning target and this technology should aid in their mathematical reasoning.

*Modification* is the third level of technology integration. In this step, technology allows for significant task redesign. Technology changes the feel and look of what students perform. Modification allows students the opportunity to proceed with Bloom’s Taxonomy. This may include a technology piece that allows students to collaborate and share ideas virtually or through a presentation. For example, in algebra, teachers may ask students to create a video presentation as an assessment rather than an exit ticket on a piece of paper. This way, students have the opportunity to collaborate and teachers have an alternate form of assessment.

*Redefinition* is the fourth and final level of the SAMR Model. In this final stage, a curriculum has been completely redesigned and received a technological makeover. Nearly every analogous task has been technologically enhanced in some way. In this last step students become the facilitators of their own learning. Students create the opportunities for themselves to be successful in achieving mastery on learning targets. Students are becoming teachers for themselves and other students in this final transformation step of the technology integration process.

The following assessments were developed to address each of these levels of the SAMR model. For each of the first three levels of the model, there is a digital tool used to replace traditional assessment techniques. Each assessment has a NYS
common core algebra learning standard mapped to it. NYS common core algebra learning standards can be found using the following link:

http://www.corestandards.org/Math/Content/HSA/introduction/. The links provided for each assessment, are for teachers and educators use, to view the assessments and utilize them in their own classrooms.

Substitution: Kahoot!

Algebra I NYS Common Core Standard: F-IF. A.2 – “Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.”

Assessment Overview: Students will compete against each other in a game-based Kahoot! to assess the skill of evaluating functions. This is a direct substitute for a traditional exit ticket. Data collected from the application will yield an assessment score as well as indications of misconceptions needed to be retaught for mastery of the standard.
Kahoot! is a free digital tool that encourages friendly competition among students and increases engagement in the mathematics classroom! This game-based learning platform presents students with multiple-choice questions, in a group setting, which they then respond to on their own devices. Teachers have the option of searching for pre-made Kahoot! games or they can make their own. Students type in a pre-set game code, provided by Kahoot!, which takes them to the live game hosted by the teacher. The students then have the option to put in their name or nickname!
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Figure 2. The figure above represents the “teacher account” page. This is where teachers can find their Kahoot! they have created or borrowed. From Learning Games: Make Learning Awesome! (n.d.). Retrieved November 11, 2019, from https://kahoot.com/.

Figure 3. This figure represents the screen for the assessment found in the link https://create.kahoot.it/details/8f97a2ba-650f-42bb-9885-e5a206cc4f8d. From Learning Games: Make Learning Awesome! (n.d.). Retrieved November 11, 2019, from https://kahoot.com/.
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Figure 3. *Kahoot!* even celebrates the top 3 scorers! From Learning Games: Make Learning Awesome! (n.d.). Retrieved November 11, 2019, from [https://kahoot.com/](https://kahoot.com/).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Players</th>
<th>Total Score (points)</th>
<th>Correct Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>hate</td>
<td>10222</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Sherry Cormac</td>
<td>10188</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>babygirl</td>
<td>10129</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>hi</td>
<td>9988</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>m</td>
<td>7711</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>nickname</td>
<td>7515</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>andrew</td>
<td>6851</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Cell</td>
<td>3519</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

*Figure 5. Final scores. From Learning Games: Make Learning Awesome! (n.d.). Retrieved November 11, 2019, from [https://kahoot.com/](https://kahoot.com/).*

As seen in *figure 4* and *figure 5*, Kahoot! has the ability to break down the scores a few different ways. First the application will give you a whole class score for correct answers and incorrect answers. The application will tell you which problems individual students got wrong. This helps locate the most common misconceptions and aides in the re-teaching of standards. As seen in *figure 6 (below)* Kahoot! will also give you an overview on each question in the assessment. The application tells you which students got the correct answer or incorrect answer, as well as what answer option they choose.
Figure 6. **Kahoot!** overview of assessment data. From *Learning Games: Make Learning Awesome!* (n.d.). Retrieved November 11, 2019, from [https://kahoot.com/](https://kahoot.com/).

**Augmentation: Quizizz**

**Algebra I NYS Common Core Standard:** **F-IF. A.1-** “Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If \( f \) is a function and \( x \) is an element of its domain, then \( f(x) \) denotes the output of \( f \) corresponding to the input \( x \). The graph of \( f \) is the graph of the equation \( y = f(x) \).”

**Assessment Overview:** Students will be assessed in a multiplayer classroom format that allows students to use a digital application to measure student conceptual understanding of a standard.
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Figure 7. Quizizz homepage. From Free quizzes for every student. (n.d.). Retrieved November 11, 2019, from https://quizizz.com/.

Figure 8. The “My Quizizz” tab allows you to search through your assessment history to find which application you are looking for! From Free quizzes for every student. (n.d.). Retrieved November 11, 2019, from https://quizizz.com/.

Click on the link below for the “Is the relation a function or not?” Quizizz

https://quizizz.com/admin/quiz/5d939202f7e991001a9c1f45/is-it-a-function

Quizizz allows teachers to conduct student-paced formative/informative assessments. The application provides the teacher with a game code to give to their students. Students log the game code into any device that has a browser (PC’s, laptops, cell smart phones and/or tablets). Teachers have the option of making their own Quizizz or searching thousands of premade Quizizz from the explore section of the application. The reports provide teachers with detailed class level and individual student level performance indicators. As seen in figure 9 hosting a live game allows students to compete individually, answer assessment questions at their own pace, and most importantly enjoy doing it! Teachers also have the option to allow funny “memes” to appear on student’s screens after they have answered a question. Figure 10 (below) demonstrates how teachers are able to download
results as an Excel spreadsheet. It is quick and easy to see which questions students did well on and which questions students struggled with.

<table>
<thead>
<tr>
<th>Questions</th>
<th># Correct</th>
<th># Incorrect</th>
<th># Unattempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which set of values is a function?</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Is the relation a function? Why?</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Is this mapping a function or not a function?</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Is this table a function or not a function?</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Is this table a function or not a function?</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Is this table a function or not a function?</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Is this set of ordered pairs a function and how can you tell?</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Is the following table of values a function or not?</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Is the relation a function? ({(1,5),(1,7),(3,9),(4,11)})</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Is this mapping a function or not a function?</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

| Total | 53 | 17 | 0   |

**Figure 10.** A preview of the downloadable results, Excel spreadsheet. From Free quizzes for every student. (n.d.). Retrieved November 11, 2019, from https://quizizz.com/.
Figure 11. A more detailed outline of the results. From Free quizzes for every student. (n.d.). Retrieved November 11, 2019, from https://quizizz.com/.

Modification: Kami

Algebra I NYS Common Core Standard: **A.REI.C.6** – “Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.”

Assessment Overview: Students will complete an exit ticket on solving systems of linear equations graphically by graphing the functions on their Chromebook. Students use their finger or a stylus to rearrange linear equations into slope-intercept form, graph lines, and ultimately find the solution. Once students are completed they submit their Kami to the teacher. The teacher can then add comments/grades directly through Google Classroom.
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**USING KAMI - PDF Annotator**

*KAMI* is a great way to digitally interact with text or to allow students to complete PDF files on the computer.

It is not a PDF editor; it will not let you physically edit PDF files (although you can do minor tweaks).

First, you need to make sure the *Kami* extension is enabled.

If it is, you will see a blue circle with a K in the upper right corner of the browser.

If it isn’t, here is how to enable the Kami extension:

1. Type “Chrome Webstore” into the browser and click the first link that comes up.
2. Type “Kami” in the search box and hit Enter.
3. Click “Kami Extension -- PDF and Document Annotation” to add the extension. (It may then take you to the website where you have to sign in with Google.)

4. Click on Add to Chrome.

5. Click on Add extension.

How to Download a PDF Document or Upload it to Google Drive

1. Access the PDF document online.

2. To download the document, click the Download icon in the upper right corner. Then choose which folder to save it to.
   --OR--
   To add the file to Google Drive (which is easier, especially if planning to share with Google Classroom), click the Print icon.

3. If adding to Google Drive, under Destination, select “Save to Google Drive.”

Using Kami with Students

The best way to use Kami is to create a Kami assignment in Google Classroom:
Classwork → Create → Kami Assignment → Attach a file or Google Doc and select “Make a copy for each student (recommended)”
Remind students they should click “Open with Kami” to edit the document.

You can also create a Google Doc and Share the link and allow common collaboration, but this is not as smooth as using Classroom and having each student make a copy.
Opening Documents in *Kami*

- You can click on the blue circled “K” in the upper right corner and open a document from the computer, from Google Drive, create a new document, or create a Google Classroom assignment.
- For online documents, hover over the blue “K” and then click on “Open with *Kami*.”
- If you are in Google Drive, right click on the document, hover over “Open with” and then click on “Annotate with *Kami*.”
- Once in *Kami*, you can click on the Open folder icon.

Editing Documents in *Kami*

- The left panel provides several options for modifying the document (highlight text, add comment, add text box, add equation, add drawing, add shape, insert image, Text to Speech, etc.). Some suggestions:
  - To add a comment, click Comment, highlight the text the comment refers to, and then type in your Comment.
  - To add a text box, click Text Box, click where you want the text box to go, then you can change the size of the text box, as necessary.
  - With Chromebooks, students can use touch to draw images as well.
  - You can click Undo if you make a mistake.
Saving Documents in *Kami*

If using Google Classroom, students will receive a “Turn In” option on their page.

*When complete*, students can also:

- Share the file by clicking on the Share icon, turn Link Sharing on, and copy the link. You can also select options for Annotation Settings and Sharing Permissions.
- Print, select “With Annotations”, then click “Save as PDF” to save to the computer or “Save to Google Drive.”
- Save changes to the current file by clicking on the Save disc icon.

- Download the file by clicking on the Download icon. You can open it and save it to a folder of your choice, if you wish.

**Menu Options: Split and Merge PDF files**

- Open *Kami*.
- Click on Split & Merge.
- Drag and Drop files: Either open the file in Google Drive by clicking on the triangle --OR-- drag it from your Desktop or another location into the Drag and Drop box.
- Click Next.
- You can now drag pages to different files. Click on the + to add another file.
- Click Export to save each file.
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In *figure 14*, the menu on the left hand side allows students to write on the assignment, draw lines, and use text boxes to answer questions. For this specific assignment, students are able to use two different colors for the two lines. This makes it easier to visualize the solution. When students complete the assignment they just simply submit it by pressing the "submit" button in the upper right hand corner of their screen. The assignment will be submitted directly to the teacher’s Google Classroom page. As seen in *figure 15*, teachers can view the number of students who have completed the assignment. Teachers now have the opportunity to score the assignment using Google Classroom. By clicking on each individual student’s assignment, teachers can provide feedback directly on the document. This then can be either emailed back to the student or they can view it in Google Classroom! Teachers can also assign a grade for student’s work and submit private comments directly through Google Classroom.

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Validity

Teachers are presented with ample opportunity to implement digital tools in the classroom everyday. Students need to be excited to come to math class. I always ask myself how can I make today’s lesson one they will engage in and enjoy? My students absolutely love Kahoot! and in fact one of my students asks me everyday if we are playing! My students love the friendly competition and normally I will set it up so the top 3 scorers win a piece of candy. This way they are being positively reinforced for their efforts. I love using Kahoot! for informal assessments such as simple checks for understanding or exit tickets.
Since Quizizz is so similar to Kahoot! my students are just as ramped up to play. Quizizz brings a new atmosphere to learning, including funny “meme’s” to give students a good laugh after they get a question right or wrong. This application provides live updates for scoring so students can see where they are at as they move through the assessment. One positive aspect of this application, I have heard directly from a student, was that they liked how Quizizz is more “self-paced” so they don’t feel rushed to finish with their classmates. This was great feedback to hear because it is a reminder that all students work at a different pace, even in a competitive setting.

My students really enjoy playing around with all of the options Kami has to offer. Most of my students like the option it provides to make points and lines different colors. They mentioned that it was easier to keep track of which line was which when graphing. Since all of my students have Chromebooks, they have the option to type their answers or draw with their finger/stylus. This gives students freedom when it comes to completing their assessment!

Conclusion

With all of the current digital tools, mathematics educators are finding ways to use technology to assess student knowledge of content. The SAMR Model provides teachers with the transitional aspect of incorporating digital tools. When developing this model, Dr. Ruben Puentedura had “student engagement” in mind. His hope was to deepen student’s content knowledge by supplementing the learning process with a digital reinforcement.
This new digital era in the classroom had teachers panicked. Many teachers were so used to traditional teaching practices that when all of these digital tools came out they didn’t know how to transition them into their classroom. With districts across the country adopting new school improvement plans, digital content was a huge item on their list. Administration and school personnel began to offer professional development on new digital tools that can enhance classrooms.

Using digital tools can offer educators so much when it comes to teaching mathematics. Students find digital applications engaging and interesting. They enjoy participating in class and engaging in friendly competition with their classmates. It’s a win-win situation for both students and teachers. Teachers have ample resources for grading and checking for understanding. Using digital tools in the form of assessments gives teachers an alternate form to test knowledge of the standard or content.
References


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and Learning Knowns Unknowns and Ways to Pursue Better Questions and Answers/links/54e34e590cf2d618e1963933.pdf.


