# Chapter 14
# TACTivities:
## A Way to Promote Hands-On, Minds-On Learning in a Virtual Learning Environment

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## ABSTRACT

*The need to keep students engaged is particularly acute in virtual environments. In this chapter, the authors describe TACTivities (learning activities with tactile components), designed to help encourage student participation, collaboration, and communication. Originally developed for in-person instruction, TACTivities are readily adaptable to online learning environments. TACTivities are intended to foster a sense of play, creative problem-solving, and exploration among the students who undertake to complete these tasks, and also among the teachers who design them. Unlike other tactile learning ventures, which may involve various kinds of physical props, TACTivities entail only moveable pieces of paper, or electronic equivalents. This feature means that TACTivities are quite portable, and they are easily implemented, shared, and modified (particularly in remote settings). Further, TACTivities allow for inclusion of discipline-specific content, language, and formalism, while still cultivating physical engagement in problem-solving and critical thinking in any subject area.*

## INTRODUCTION

K-12 teachers must make decisions in their classroom on a daily basis to help their students learn. Pedagogical reasoning (Niess & Gillow-Wiles, 2017) and technological pedagogical reasoning (Smart et al., 2016) help teachers make such decisions in their classrooms. One way to make such decisions is that

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K-12 teachers often use hands-on activities and manipulatives to cultivate creativity and playfulness in the classroom, and to engage their students in the learning process. Indeed, engagement (Claxton, 2007), creativity (Beghetto et al., 2015; Bourdeau & Wood, 2019; Cooper & Heaverlo, 2013; Nadjafikhah et al, 2012), and playfulness—especially creative play (James & Nerantzi, 2019; Michelman, 1971; Russ, 1998; Singha et al., 2020), have all been identified as key factors influencing student learning.

When K-12 students have something to do with their hands, they are likely to naturally play with that object and figure out how it works – whatever it may be. Remember Fidget Spinners? They were advertised as a way to provide students something to do with their hands that was quiet and not distracting (more specifically they were advertised for students on the autism spectrum, with attention deficit hyperactivity disorder (ADHD), stress, or anxiety) (see Schecter et al., 2017 for more information). So why not have those random objects in the students' hands to serve a purpose and a so-called solution to a problem the students did not even know existed, or multiple solutions to really get their brain juices flowing? Such approaches have been implemented in face-to-face environments; now the challenge is to find ways to apply similar approaches to help engage students in the online context. Teachers who are teaching in an emergency remote environment are faced with the challenge of how to motivate and engage their students without being able to provide them with concrete items that help students be actively involved in the learning process.

Many teachers around the world have turned to emergency remote teaching on virtual or online platforms due to the COVID-19 pandemic. It has been reported that the online platform is proving to be frustrating and/or boring for K12 students and teachers alike (Dhawan, 2020; Lake, 2020), mostly because the existing curricula were not intended to be taught in an online manner (Hodges et al., 2020). Remote emergency online teaching is not the same as planned online classroom teaching (Hodges et al., 2020), activities are different and student attention span is different. Some children (and adults) can spend hours playing video games in front of a computer but are not able to spend more than an hour or two in front of a remote online classroom. It is pretty obvious why – because the classroom is boring and they are just listening and maybe doing a little talking, whereas video gaming is active, fun, and action-packed time. So how can the monotony of the remote classroom environment be changed, and pedagogical reasoning be used to make teaching decisions in a digital age (Starkey, 2010)? The authors of this chapter believe they have found one solution to increase student and teacher engagement and help make online learning more fun. The suggested learning activities have already been implemented effectively in face-to-face classes, and as the third author has said many times to the first author, "tell me something you do face-to-face and I'll help you figure out how you can do it online" (personal communication, 2017). In fact, all three of the authors are now, of necessity, experienced at figuring out how to do something online that they typically do in a face-to-face classroom, as are many other teachers who have had to teach online because of COVID-19.

That said, many K12 teachers do not have the experience or know-how to figure out how to do some of the hands-on activities they typically do in a face-to-face classroom, in an online classroom. Activities might not look exactly the same, but the authors believe that with a bit of creativity, this type of learning can still be accessible in online classrooms. That said, with emergency remote teaching, sometimes the best a teacher can do is try to replicate online what they do face-to-face; the authors believe this is acceptable in the age of COVID-19. However, true online teaching should examine school reform over merely replicating a face-to-face classroom; see Cuban (2013) for more information on school reform.

In this chapter, the reader is provided with one way in which K12 teachers can still provide their students with these hands-on experiences in the online classroom using tactile learning activities that the authors call TACTivities (Hodge et al., 2015). In order to accomplish this task, active learning is first defined and discussed for better understanding regarding engaging learners. Then, TACTivity is defined and how it works is described. Finally, how to implement TACTivities in an online environment is discussed, as well as providing the reader with TACTivity examples they can immediately put to use. This chapter uses the terms online environment and virtual environment interchangeably.

## WHAT IS ACTIVE LEARNING?

Like art, active learning can be difficult to define precisely, though one tends to recognize it when one sees it. In one of the early comprehensive investigations of the subject, Bonwell and Eison (1991) proposed that "active learning be defined as anything that 'involves students in doing things and thinking about the things they are doing'" (p. 2). Those authors supplemented that working definition with some "general characteristics" of active learning approaches: for example, "students are involved in more than just listening", "students are involved in higher-order thinking", and "greater emphasis is placed on students' exploration of their own attitudes and values" (Bonwell & Eison, 1991, p. 2).

At the heart of the active learning paradigm is the theory of *constructivism*, which has its origins in the work of Piaget (Piaget & Inhelder, 1969). Constructivism posits that students (and learners in the more general sense) are architects of their own understandings of the world, rather than mere vessels into which knowledge is to be transferred. Various other teaching and learning philosophies and theories support, complement, and overlap with the active learning approach: student-centered learning, inquiry-based learning (IBL), inquiry-based mathematics education (Laursen & Rasmussen, 2019), collaborative learning, metacognition (e.g., Bonwell & Eison's (1991) vision of "students…thinking about what they're doing" (p. 2)), discovery learning, and others are among the ideas that often surface in the context of active learning discussions. The common thread in all of these ideas is an acknowledgement of—indeed, a respect for—students as a primary agent in their own learning. For more information on instructional learning theories, see https://www.instructionaldesign.org/theories.

Because of its emphasis on exploration and on doing things, active learning helps foster creative thinking and creative problem solving. As noted by Mayer (1989), "Creative learning occurs when students use active learning strategies for mentally representing new material in ways that lead to problem solving transfer" (p. 203).

The effectiveness of active learning has been documented extensively; see, for example, Laursen et al. (2014), Freeman et al. (2014), and Deslauriers et al. (2019). Much of this assessment has been performed in the context of STEM (science, technology, engineering, and mathematics) disciplines. However, there is also compelling evidence in favor of active learning in other fields (McCarthy & Anderson, 2000; Mello & Less, 2013).

The recent shift to remote learning, born of necessity, heightens the need for increased student engagement. Online learning can exacerbate feelings of isolation and alienation and can negatively impact a student's sense of community and feelings of agency (Farrell & Brunton, 2020; McInnerney & Roberts, 2004). To help address some of these issues, the authors of the present work have developed an electronic framework for what they call *TACTivities*: instruments, originally designed for the physical classroom, that foster participation, collaboration, and active—indeed, tactive (to coin a term)—learning (Hodge et al, 2015; Hodge-Zickerman et al., 2020). The innate aspect of TACTivities, promoting engagement and collaboration among students, can address the lack of social aspects in online learning, when used appropriately (Khan et al., 2017).

## WHAT IS A TACTIVITY?

The term TACTivity is a portmanteau of the words tactile and activity (Hodge et al., 2015). Thus, a TACTivity is a tactile activity. The authors emphasize that with TACTivities, it is the students, and not (just) the teacher, who are engaged in the tactile experience (Hodge-Zickerman et al., 2020).

It should be noted though, the authors' meaning of tactile only entails moving pieces of paper, or the virtual equivalent (Hodge et al., 2015). This idea can differ from other approaches that involve physical manipulatives (e.g., pipe cleaners, yarn, Spirographs, building blocks, and so on). The authors believe their TACTivities add a different dimension to tactile learning. For example, an advantage of TACTivities over props is that the former look more like formal mathematics (or whatever discipline the TACTivity encompasses) rather than just a fun activity (Hodge-Zickerman et al., 2021). If teachers really want to teach relevant subject matter to their students, at some point teachers have to get the students to appreciate the appropriate language, notation, and formalism of that subject. TACTivities do this, but in a way that can perhaps be more engaging than only using pencil and paper, or word processing software, to do this work. Additionally, TACTivities are easier to adapt to and implement in a virtual environment than are activities requiring physical props (Hodge-Zickerman et al., 2021).

TACTivities are also collaborative in nature and allow for inherent engagement with the subject matter (e.g., mathematics) by the nature of the design (Hodge et al., 2015). In a face-to-face classroom, TACTivities were designed to be completed collaboratively in groups of two to four students ideally on flat tables (Hodge et al., 2015). However, in an online learning environment TACTivities have the flexibility to either be used as an individual learning activity or as a group activity (Hodge-Zickerman et al., 2021), which the authors discuss in greater detail later in this chapter. When presented with a bag of movable pieces, students are expected to align or combine the pieces in such a way that a mathematical outcome is determined (in other words, how do these pieces fit together or align mathematically). The students are engaging with mathematics concepts via the nature of the particular TACTivity and while working, they are talking aloud to each other about the TACTivity (Hodge et al., 2015). Each TACTivity is designed to be given to students with little to no written instructions, and the teacher saying very little other than helpful hints or posing directed questions to the students about their thinking process. In fact, sometimes figuring out the rules to the sorting TACTivities is part of the learning process (and what generates a lot of the rich discussion among students). Another feature that makes TACTivities so appealing is that many of them are self-checking (Hodge-Zickerman et al., 2021). For example, the students will know when they are done with the dominoes TACTivities because they will have completed an enclosed shape with the cards (and all ends match up in a meaningful way – like the game of dominoes).

Although the bulk of the authors' examples and experiences are from the field of mathematics, TACTivities are activities designed to be utilized in any level classroom, from preK-12 to higher education and beyond. TACTivities merge art and science in a manner that requires both students (as TACTivity end users) and teachers (as TACTivity designers) to think creatively, and playfully, while learning and/or teaching content skills.

## Virtual TACTivities

The framework used to inform the development of the virtual learning experience provided through doing TACTivities stems from an active learning perspective (Ernst et al., 2017) as previously described. The authors' goals for virtual TACTivities are the same as their goals for TACTivities in a face-to-face classroom. The constructivist goal of active learning approaches is to encourage students to engage vigorously in the building of their own knowledge and understanding, with teachers playing the crucial role of guiding students in their journeys of discovery, rather than merely delivering content. The authors also have a goal to foster creativity and communication through collaborative learning using TACTivities (Hodge et al., 2019; Hodge-Zickerman et al., 2020). To show the readers how one can achieve these goals, the authors will describe what this looks like in the classroom.

In a face-to-face classroom, the collaborative nature of the TACTivities provides the teacher with the knowledge of what the students are thinking as they must *think aloud* to work with other students (i.e., say aloud what they are thinking so others will know what is going on in their head). From this, the teacher can facilitate the situation, providing hints and tips, but not solutions, if and when students get stuck. Or, the teacher can use the time to guide students by asking them questions that will further their thinking about the mathematics (Hodge-Zickerman et al., 2020). In both cases, the students are actively engaged in the learning process. How does a teacher facilitate such active learning in a virtual setting by using TACTivities?

In order to understand what a virtual TACTivity (Hodge-Zickerman et al., 2021) is (or options for what a virtual TACTivity can be), how a teacher can facilitate active learning in a remote environment, and what student engagement looks like in a virtual environment, three examples of virtual TACTivities are presented. In these examples, options are provided for different types of virtual TACTivities, as well as ways in which some of the activities can be printed and administered by parents/guardians (keeping the tactile nature of the original TACTivity design while discussing how to integrate these into a remote learning setting). The authors would like to point out that TACTivities are different than Techtivities (Olson & Johnson, 2021) in that TACTivities are more about having students sort moving pieces to learn or review subject matter (Hodge et al., 2015) whereas Techtivities are designed to have the students interacting with technology to learn mathematical concepts.

### Examples of Virtual TACTivities

Three examples describe the virtual TACTivities: a tactile variation on the classic *four fours* order-of-operations activity, a card sort TACTivity that can be completed either virtually or with printouts and the sharing done virtually, and a domino matching TACTivity that is completed by moving virtual cards. Two of these TACTivities have a mathematical theme, and the other is geographical in nature. However, they are all aimed at general audiences, and are intended to be accessible to teachers of any grade level who teach any subject. The solution strategies that these TACTivities entail are not subject-specific; the game play is adaptable to any discipline.

Three different styles of TACTivities are provided that can be completed by anyone to offer opportunities for any teacher to benefit from this chapter. These three examples illustrate the online instructional strategies that are employed when both designing and implementing TACTivities. Actual experiences using these TACTivities in the virtual classroom is discussed as well as other successes and challenges while guiding the reader through these example TACTivities. The utility of Google Slides and Desmos

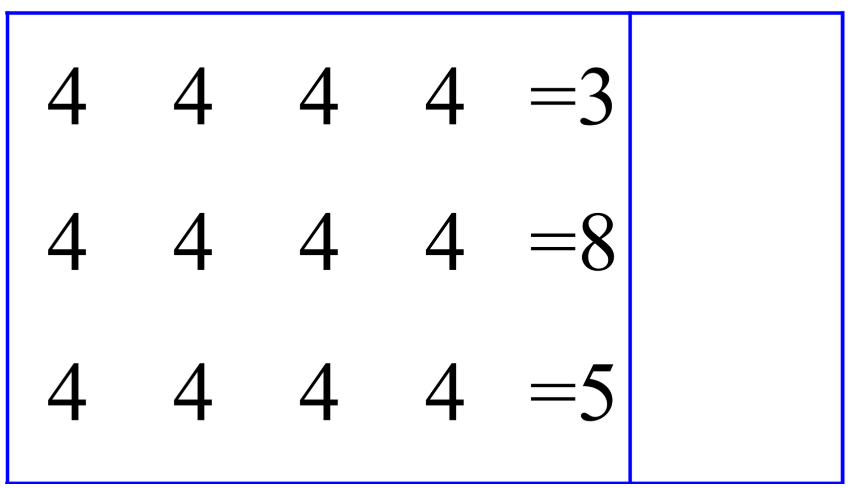
Activity Builder as a means of creating TACTivities are demonstrated and can be shared freely (without requiring additional apps be purchased), and performed remotely, in synchronous or asynchronous modality, using breakout rooms. The TACTivities should be tried as if the teacher were a student to get the experience of being a student completing the TACTivities. The TACTivities do take some thinking time, so try not to be in a race or under a time constraint when exploring each of the example TACTivities.

### *Four Fours*

In the iconic *Four Fours* activity (Anderson, 1987), students' understandings of order-of-operations rules and strategies are tested through construction of various whole numbers, using only the four basic operations (addition, subtraction, multiplication, and division), parentheses, and four instances of the number four. The paper-and-pencil version of this activity is well-known in elementary education circles. The authors of the present work have developed a tactile version of this activity and have found their TACTivity to be popular with students—and teachers—at all grade levels, even outside of mathematics teaching-and-learning communities. This TACTivity has proven to work well as a hands-on introduction to TACTivities in general.

A virtual version of this TACTivity may be created using Google Slides. It begins with one or more placemats, or slides, onto which the students build their mathematical sentences. Figure 1 is an example.

*Figure 1. A Four Fours master slide*



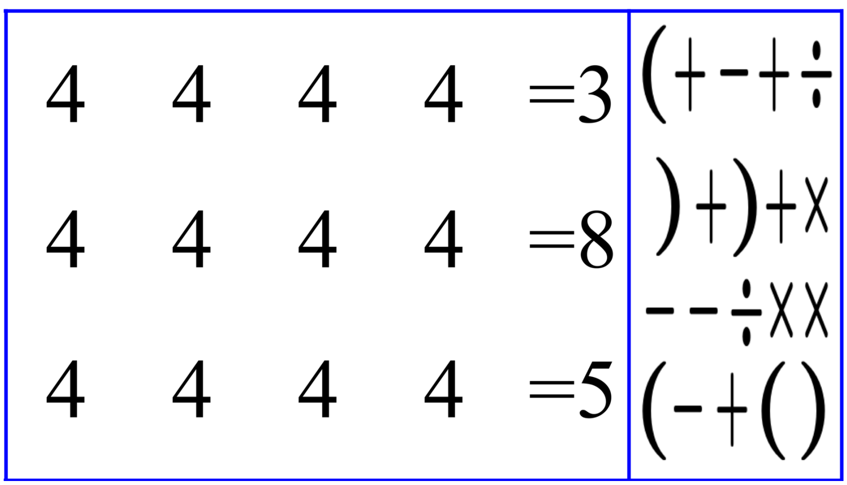

Note the empty space on the right part of the slide; this space is used for the operation signs (addition, subtraction, multiplication, and division) and parentheses that are needed to construct the appropriate equations. Also note the spacing between the fours, which allows placement of these signs and parentheses.

First, though, some comments are in order about developing the master slides themselves. The one in Figure 1 was created using only the text box and line tools within Google Slides itself; no external apps were needed. However, an extra step or two was implemented to assure that the master slide was not editable, so that neither the text nor the linework could be modified, or accidentally moved, deleted, etc. This was achieved using the following steps:

**Step 1:** After the side was created, it was saved to the computer desktop as a JPEG file, using the Download tool under the File menu within Google Slides.
**Step 2:** A new slide was opened up within the existing presentation.
**Step 3:** Using the Background menu in the Google Slides menu bar, the saved JPEG was selected from the desktop as the background for the new slide.
**Step 4:** Operation symbols and parentheses were added to the sidebar on the right.

Unfortunately, certain mathematics symbols, like the division symbol (÷), do not seem to be native to Google Slides. As a work-around, a PDF file with the desired symbols was created (using the LaTeX mathematical typesetting package, although the equation editor in Microsoft Word will work as well). Screenshots of each symbol were then taken from the PDF file, and those screenshots were then pasted as image files onto the slide. Note that if this process is to be followed, it might be necessary to first magnify the PDF image before taking the screenshot, so that it will appear at sufficiently high resolution when pasted onto the slide. Obtaining a suitable resolution seems to be something of an art, may be machine-dependent, and will likely require some experimentation. See Figure 2.

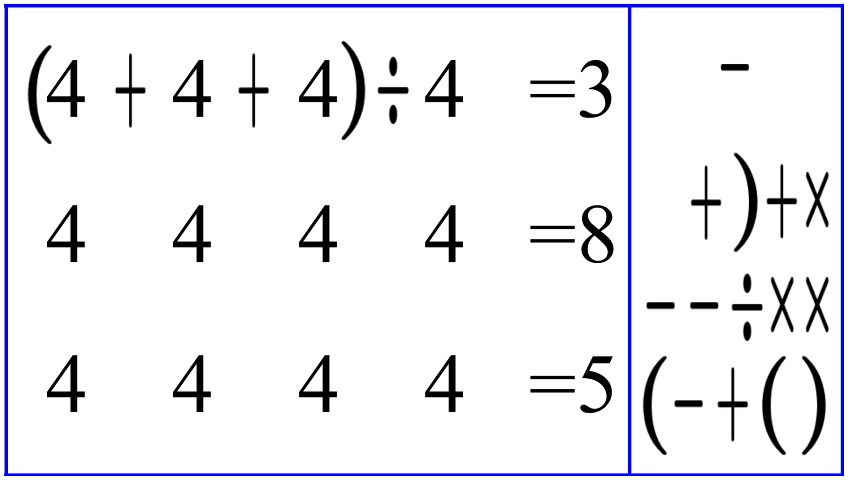
*Figure 2. Master slide with symbols added*




(Alternatively, a division symbol might be constructed "from scratch" within Google Slides, using the Circle and Line tools.) The symbols were added one-at-a-time, so that they can now be moved into the appropriate places among the numerals, to construct correct equations, for the TACTivity itself. A partial solution is presented in Figure 3.

In the example shown in Figure 3, more symbols were provided than was strictly necessary for correct equations. This provision allows for some variety in solutions to the exercises. On the other hand, some students may at first believe that there are too few symbols—in particular, that there are not a sufficient number of parentheses. In such situations, students should be encouraged to reflect further on the problem, and determine whether some parentheses might be redundant, or might be removed, because of appropriate precedence rules.

*Figure 3. Partial solution to the Four Fours TACTivity*




A set of three Four-Fours slides, one as above and the other two involving the other six single-digit whole numbers, with symbols that can be moved around, is available at https://tinyurl.com/6qbxj6th. Teachers are encouraged to adapt and modify these slides as desired. A view-only version is provided, but teachers can make their own copy of the slide and manipulate the copy. It is easy to duplicate an entire presentation, using the Make a copy command under the Google Slides File menu. To do so, questions like the following might be addressed: What other integers can be constructed from four fours? What if one also allows exponentiation? What about juxtaposition—for example, 44+4÷4=12? In this case, one might prefer a master slide that is editable, so that a pair of 4's may be moved closer together.

To use a Google Slides TACTivity in a virtual classroom, a teacher should first make sure to give the students edit access to the presentation, using the Share button in the upper right corner of Google Slides. Also, if Zoom breakout rooms are to be employed to divide the class into small groups, it is advisable to have a separate Google Slides copy of the given presentation made up for each room. Then each breakout room can be supplied with a link to a presentation that is unique to that room, so that each group can operate independently of the others.

Also, the authors strongly recommend that this TACTivity be presented to the students without explicit instructions on how to complete it. Figuring out the rules of the game can be part of the challenge, and often leads to fruitful brainstorming and collaboration among the participants.

## *Math Joke Card Sort*

Card sort TACTivities are always a student favorite (Hodge-Zickerman et al., 2021). Every student can contribute something to sorting a pile of cards, and by working together a group of students can have a rich discussion while learning the subject matter. In person, students would see a baggie of laminated cards (or paper cards if it is the teacher's first time trying out the TACTivity) on their tables when they walked into the room. Then they would dump out the contents of the baggie and figure out what they were supposed to do with the cards on their tables. Sometimes the cards are sorted with only one match and other times they are sorted in piles of three. In any case, the card sort game is complete when all cards have a match (or two), depending on how teachers choose to design their card sort TACTivity.

Virtual card sort TACTivities are very similar, in that Desmos has a free program called Desmos Activity Builder where teachers can create their own cards. These cards can include pictures, words, graphs, or a combination thereof. There are even options that allow teachers to use larger print for visual accommodations in the card sort – a virtual bonus! The teacher can create an answer key to the card sort. Although, if the teacher is doing a paired card sort, the cards are often self-checking. The student is done when all pairs match in a way that makes sense leaving no cards unused and ensuring the final cards left also make a match.

In order to create a virtual card sort TACTivity using Desmos Activity Builder, a teacher should take the following steps:

**Step 1:** Go to the website: https://teacher.desmos.com
**Step 2:** Create a free account, so activities can be saved and easily accessed.
**Step 3:** Click Custom on the left-hand side of the screen.
**Step 4:** Click New Activity near the top of the screen.
**Step 5:** Give your new TACTivity a title.
**Step 6:** Select if you would like your TACTivity to be private or publicly available.
**Step 7:** Add a description of your TACTivity.
**Step 8:** Click Create new activity.
**Step 9:** Scroll down to the bottom of the card options on the left-hand side and select Card Sort.
**Step 10:** Click on the type of card you would like to create (math or text, image, or graph). You can create different types of cards in the same activity.
**Step 11:** Add as many cards as you would like.
**Step 12:** Click Answer Key when you are ready to create a key for your TACTivity.
**Step 13:** Click Preview to give your TACTivity a beta test.
**Step 14:** Click Publish to complete your TACTivity.
**Step 15:** Select Student Preview to make sure it is ready to go.
**Step 16:** Select Assign to get a link to share with your class.
**Step 17:** Practice with a friend before sending the link to your class.

Note there are help features if you want to learn more such as *teacher tips* and *learn more*. There are also YouTube videos to help you learn new features of Desmos Activity Builder as the program develops.

Teachers may also use any of the already created mathematics card sort activities, which are currently available at no cost to both teachers and students. Most activities can either be modified to fit the teacher's learning goals or used as they were created by the author of the activity. Again, although most of the activities found on Desmos Activity Builder are mathematical in nature, teachers of all subject areas are encouraged to explore these activities. Most activities found here can be an inspiration to ideas in other subject areas.

The readers of this chapter can actually try it! The authors encourage the reader to explore a *Math Joke Virtual Card Sort* TACTivity using the Student Preview mode: . See Figure 4. Using the Student Preview Mode will not change the original TACTivity, but the teacher can see what is being done in real time when these activities are given to a class.

Figure 5 illustrates the beginnings of a solution to the Math Joke Virtual Card Sort TACTivity.

*Figure 4. Math Joke Virtual Card Sort TACTivity*

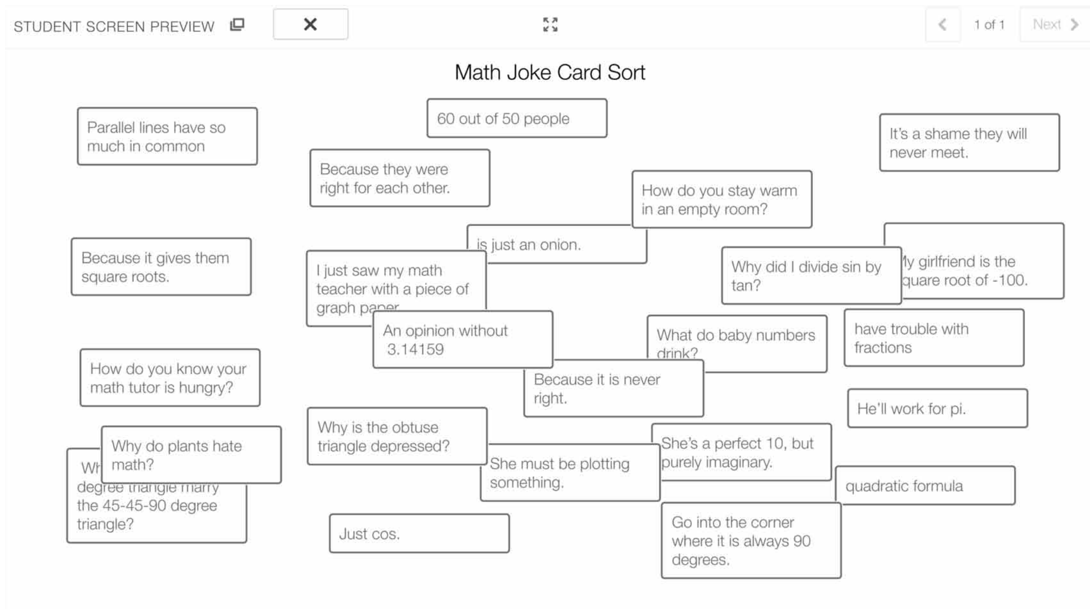
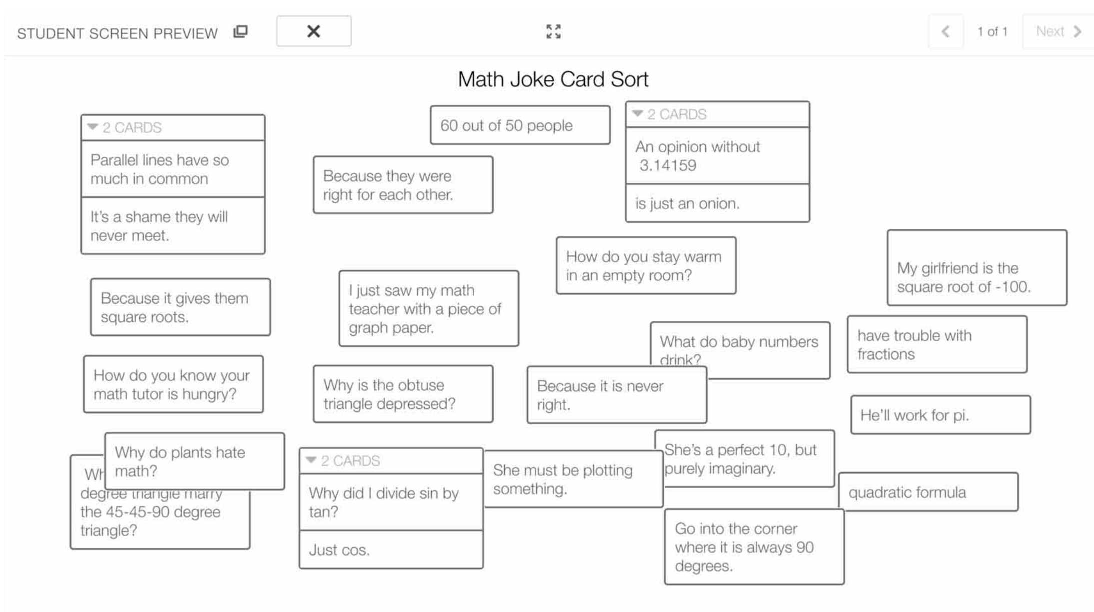



*Figure 5. Partial Solution to the Math Joke TACTivity*




As previously mentioned, a teacher can import this Math Joke Card Sort TACTivity into their own Desmos account (using the Copy and edit command underneath the three vertical dots in the top right-hand corner of the above page) and can then customize this TACTivity to their own goals.

While the card-sort TACTivity entails the pairing of cards, various other sorting paradigms are possible. In the context of mathematics, for example, the authors have created a TACTivity where cards are to be grouped into sets of three; in each set, one card gives a formula for a function, another card a graph of that function, and a third card a unique property of that function. In the example provided, a different color was used for each of the three categories of cards. One could also create a large batch of cards, each of which names a country; students might be asked to group these cards by continent. Another option is for students to be supplied the cards without direction; it might prove interesting to see how they decide to sort them. Or perhaps a group of cards containing individual words could be sorted according to which parts of speech they represent.

Other sorting paradigms might require cards be arranged in a particular order. In a mathematics course, for example, the goal might be forming an increasing sequence of numbers. Depending on the level of that course, the numbers to choose from might include only whole numbers; only integers (positive, negative, or zero); only rational numbers; rational and irrational numbers; and so on. Such a card set could in fact serve multiple purposes—one might also sort them according to type (i.e., whole number, integer, rational, irrational, etc.). Card sets that can be sorted in more than one way are especially effective, not only because they can provide material for multiple lessons, but also because they can be used to reinforce multiple representations of related concepts.

Yet another variation on the sorting notion is the *fridge magnets* idea. Here, one might create a large batch of cards that can be strung together to form complete sentences. The authors have had success doing so with mathematical sentences as well! A card set of this type can be used to teach parts of speech, syntax, poetry (for example, students might be asked to write haikus using the cards), and so on.

### *Domino State Matching*

The authors have used variants on the domino theme as the basis for a number of TACTivities. In the physical manifestation of this concept, the dominoes are actually rectangular pieces of paper, where either the upper or lower half of each piece contains a question of some sort, and the other half an answer. More specifically, the question on one half (upper or lower) of a domino will match the answer on the other half (lower or upper) of a different domino.

A virtual implementation of this idea may be achieved through Google Slides (for example). In Figure 6, each domino is a union of two squares chosen with the Shape tool under the Google Slides Insert menu. The questions and answers are then added to each domino via the Google Slides Text box menu.

As an example, the authors have developed a *Fun Facts: States* domino TACTivity. Only twenty states are represented in this example. Even with this limited subset, the slide is quite dense.

This TACTivity may be also presented without preamble or specific directions. Students should be afforded the satisfaction of determining the desired procedure on their own.

In particular, players should eventually notice that, if a domino is selected, a short line segment ending in a dot will appear at the top of the domino, and the domino may then be rotated by clicking and dragging on this dot. Thus, a domino can be juxtaposed at right angles to another; dominoes can be placed in an upside-down orientation, and so on. See the beginnings of a solution in Figure 7.

A self-check has been built into the above TACTivity, in that a correct solution will loop back to the start. That is, the state specified on the last domino placed will correspond to the Fun Fact cited on the first one. This, too, is a feature that students may be left to discover on their own. Some virtual engineering skills are required to fit such a loop on the slide, with all dominoes properly matched. Instead

*Figure 6. Fun Facts: States—a virtual domino TACTivity*

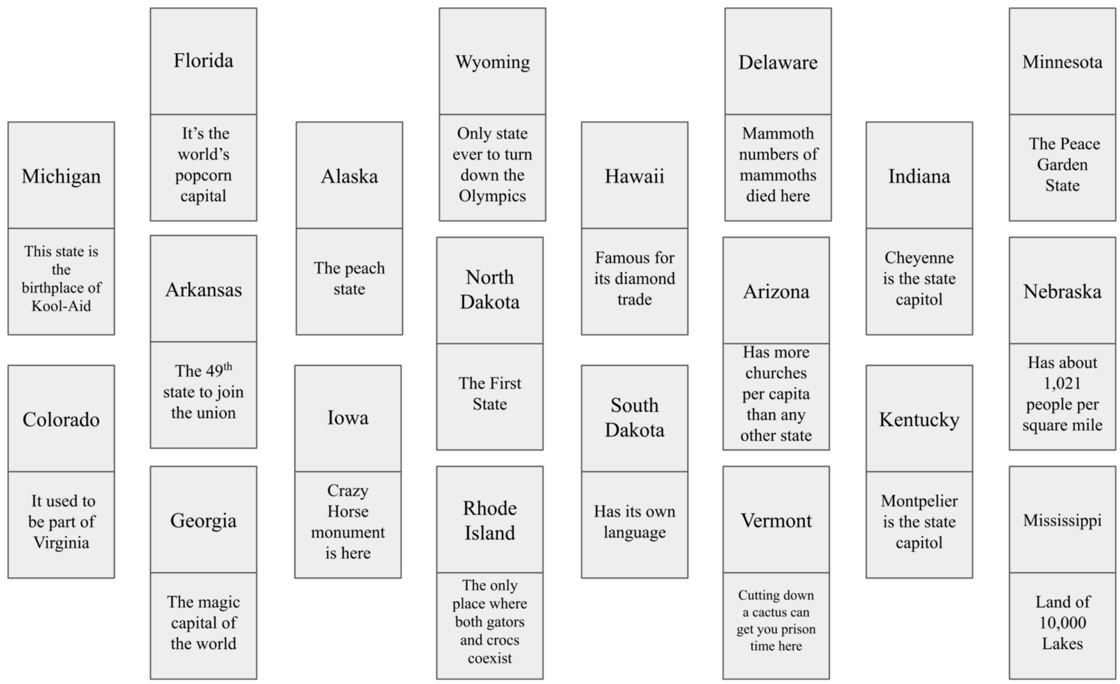
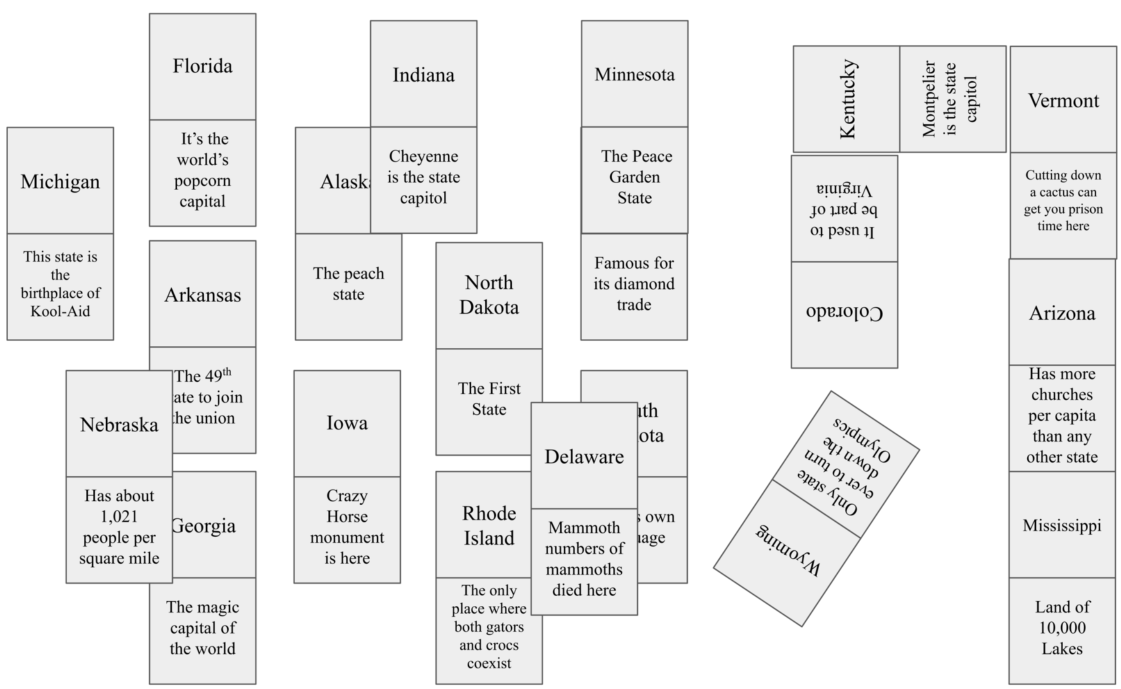



*Figure 7. An incomplete solution (commencing at the bottom right) to Fun Facts: States*



of requiring that the TACTivity be completed in this way, the teacher might leave it to the students to recognize that such a solution is possible, and to fashion such a solution if they wish.

It may not be possible to include a self-check in every TACTivity that one might imagine, but the authors do try to incorporate such a feature when possible. Dominoes are a great example of when the self-checking feature of a TACTivity is evident and easily done.

In the development of the above domino TACTivity, some technical issues were encountered. For one thing, the dominoes that were originally used were constructed from a single rectangle with a line added across the middle. However, the resulting dominoes ended up not fitting together very well. It works best if each half of the domino is an actual square, so that the dominoes line up correctly when placed at right angles to each other.

There was also an issue regarding movement of the dominoes. The Arrange menu in Google Slides contains a Group tool, which will, presumably, lock together elements added separately to the slide. However, functionality of this tool seems inconsistent. That is, attempting to drag a domino seemed sometimes to move only the half that was selected. Further, clicking on or near the text within a domino would sometimes lead to selection of the text itself, rather than the domino as an object, at which point any attempt to drag the domino would fail. Such an issue will not doom the TACTivity. Students are generally adept at recognizing these kinds of pitfalls and working around them. Further, glitches and imperfections constitute important teachable moments, and are therefore hallmarks of the skillful teacher. Still, if these technical irregularities are a concern, one might want to create the dominoes in a separate drawing or word processing program, and import them, via screenshots, as indivisible images into Google Slides. As noted in the context of the Four Fours TACTivity, one might need to experiment with scale when using screenshots, to assure sufficient resolution in the imported images.

The above Fun Facts: States TACTivity is freely available for modification, adaptation, and play, here (remember it is view only, so make a copy first): https://tinyurl.com/qu4vz1ig.

Another helpful hint when creating a domino TACTivity is to draft the virtual card sort on paper or in a Word document in way such that you have an answer key. To do this, start in the upper-left hand corner of the paper and have the upper-left hand entry match with the lower-right hand entry. If all other entries match with the card below until the bottom entry matches with the top entry in the next column, a ready-made key will be created.

Opportunities for virtual domino TACTivities are not limited to fun state facts—or limited at all. For example, the authors have used dominoes in mathematical contexts, where half of each domino is a math problem and the other half a solution. Doubtless there are myriad applications in other disciplines as well. And if inspiration is lacking, students are an excellent resource. Tasking them with designing their own domino TACTivities will engage them in next-level active learning.

## TACTivities as a Creative Outlet

The literature abounds with evidence that creativity is integral to learning and to problem-solving, even in disciplines that are not always associated with creativity, such as mathematics and science (e.g., Bourdeau & Wood, 2019; Cooper & Heaverlo, 2013; Nadjafikhah et al., 2012; Scheerer, 1963). The authors are strong proponents of encouraging creativity in all teaching and learning environments and experiences as part of pedagogical reasoning.

Further, the authors share the point of view (see, for example, Laudel, 2001; Paulus & Nijstad, 2003) that creativity is fostered by collaboration. Certainly, TACTivities can be completed—or designed—individually. But the richness of dialogue and of shared inspiration that occurs when TACTivities are created or solved in small groups is valuable and rewarding to all involved (Hodge-Zickerman et al., 2020).

TACTivities can cultivate a spirit of creative problem-solving, as well as collaboration and communication skills, in students (and hopefully address any feelings of tedium). Encouraging student communication may be of particular importance to teachers who are unsure how to get their students talking in a classroom that is not face-to-face. This communication could be in the form of virtual breakout rooms where smaller groups of student-to-student collaboration on the TACTivity takes place versus whole classroom discussion.

TACTivities not only serve as a way to make both the face-to-face and the online environments more engaging for students, but they can also serve as a creative outlet for teachers when engaging in pedagogical reasoning in a digital age (Starkey, 2010). This creative outlet can perhaps provide some relief from the monotony the virtual environment sometimes seems to bring about for teachers. TACTivities provide an opportunity for teachers to think of ideas that match up on cards in ways that are creative. They can all challenge themselves to design the pairing or sorting of cards to require students to use what they have learned (or are learning) and think deeply about what the cards have in common. TACTivities can put the tactile back into the classroom – even remotely. They can give students something to discuss that is fun and more than merely comparing their answers on a worksheet. The authors have shared a few variations of TACTivities, but they challenge all readers of this chapter to develop other variations of TACTivities (both virtual TACTivities and ones that can be completed in a face-to-face classroom). The virtual TACTivities, however, provide new opportunities for teachers to use free apps, sites, and card sorts to make their virtual classrooms come to life. Our inspirations for creating TACTivities often came from childhood games – games with simple rules that spark curiosity and provide a fun way to learn. The remote/virtual world provides many opportunities for teachers to transform existing lesson plans, tasks, and assignments into TACTivities that foster the kind of active, discovery-based learning that is, in the view of the authors, so important.

## THE FUTURE OF TACTIVITIES

The future of TACTivities is multifaceted. The authors plan on conducting research comparing and contrasting the success of the paper TACTivities versus virtual card sort TACTivities. Some questions to examine: Are the students engaged at the same level in the face-to-face classroom and in the virtual classroom when using TACTivities? How can the less engaging TACTivities be improved? Does the engagement level depend on the technology used to support the online TACTivity? What will happen to engagement and learning if a computer-based TACTivity is used in a face-to-face classroom? In what ways can computer-based TACTivities enhance the face-to-face classroom after the COVID-19 pandemic? What are the best practices for collaboration in the virtual implementation of TACTivities?

In addition, the authors plan to consider possible avenues for assessing the effectiveness of TACTivities in promoting various kinds of learning goals. Some of these learning goals for students include communication, creativity, problem solving skills, enjoyment in the subject matter, and daily learning objectives related to the TACTivity that is being completed. Explorations for successes and challenges could be conducted across different grade bands and different subject areas.

Funding will be sought to create a website of TACTivities that are open-educational resources for all teachers and students to use around the world. It is the hope that all users of TACTivities will submit their TACTivities to that website with perhaps a Creative Commons license. Funding will also be sought to host both virtual and in-person workshops to train teachers on the creation and implementation of TACTivities in a variety of classroom settings.

## CONCLUSION

Small children excitedly learn through play (Singer et al., 2006). Sadly, the authors have noticed anecdotally that students and adults often lose the sense of play in learning somewhere along their educational journeys. The authors have found that TACTivities can help bring back that sense of play, in their students as well as in themselves. Perhaps the latter is particularly important, since teachers still have not really finished school/learning. The authors hope they have communicated the real learning and the real playing that TACTivities provide in all types of learning environments.

TACTivities use the tactile, but simple, play paradigms of childhood games and turn them into activities that promote learning and/or review of a subject. As illustrated in this chapter, this subject matter can be anything from procedural skills (e.g., order of operations in arithmetic as illustrated in the Four Fours TACTivity) to sense making of words (e.g., creating pairs that match in a meaningful way such as the Math Jokes TACTivity) to factual knowledge (e.g., sorting dominoes in a way that all ends that meet make a true statement match). Since this chapter is written to be inclusive to a wide audience, it was not shown how the TACTivities could also be used to enhance both procedural and conceptual knowledge of subject matter such as mathematics. An example of how this is done is when students have to match graphs to functions to other cards in ways in which the matching may not be obvious without a deep understanding of the content. It is envisioned that when teachers who are subject matter experts start to share new ideas for TACTivities that the use of TACTivities and how they can help students learn will grow in many ways.

TACTivities not only make learning more playful, but they can also foster creativity in both teachers and students (Hodge-Zickerman et al., 2020). Teachers can be creative in how they modify existing TACTivities and in how they design new formats for TACTivities that best fit their learning objectives, students' interests, grade-band, and subject matter. Students will naturally be creative in solving the TACTivities, especially when little to no directions are provided as to how they should complete the TACTivities.

In a world where our classrooms have been transformed and many classrooms have become virtual environments, playfulness and creativity can make a two-dimensional windowed classroom come to life. By taking a more holistic approach and sparking the interests of the students, TACTivities can make even a virtual learning environment more engaging and fun. In turn, students are more engaged in active learning and the creation of their own knowledge.

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## KEY TERMS AND DEFINITIONS

**Active Learning:** Teaching and learning approaches, philosophies, paradigms, and strategies that leverage and cultivate students' own agency in their acquisition of knowledge and construction of understanding.

**Asynchronous:** Not happening at the same time. Asynchronous work is work that may be completed at the students' own pace (though typically subject to due dates). In the context of remote learning (see definition below), asynchronous activities may include watching a pre-recorded lecture; completing online homework.

**Manipulative:** An object—physical or virtual—that can be moved around, or otherwise engaged with in a tactile manner, a part of a learning exercise or activity.

**Online Environment:** The use of a computer-based internet learning environment in which a class between teacher and students is taking place. This is used interchangeably with virtual environment in this chapter.

**Remote Learning:** Education that takes place with participants in separate physical spaces. This usually refers to situations where teachers and learners are communicating, sharing, and engaging over the internet.

**Student Engagement:** Mental presence, attentiveness, and enthusiasm of the learner.

**Synchronous:** Happening at the same time. Synchronous remote learning activities might include attending a lecture presented live over the internet; engaging in live online discussions with other students; working together with other students to complete guided learning activities.

**TACTivity:** A portmanteau of the words *tactile* and *activity*. A TACTivity is a tactile learning activity. For the authors, this means not physical props, but pieces of paper—or electronic equivalents—that may be repositioned, linked, matched, sorted, and so on to answer questions and solve problems embodied within the activity itself.

**Virtual:** The simulation of something done in an online, computer-based manner instead of face-to-face (or in person). It is made to appear to exist via the use of software.

**Virtual Environment:** The use of a computer-based internet learning environment in which a class between teacher and students is taking place. This term is used interchangeably with online environment in this chapter.