

A Collection of gifts



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Great Ideas For Teaching

13.4 Think-Pair-Share With Flashcards: Low-Tech, High Return

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You've probably seen or heard about the active learning method known as "peer instruction" or "think-pair-share" (TPS). The technique is research-validated in numerous disciplines as a powerful tool to help students learn at a deep, conceptual level by constructing their own knowledge. It also works for any class size...no kidding. My collaborators at the Center for Astronomy Education (CAE)¹ are successfully² using the technique with flashcards (not clickers!) at the University of Arizona in classes of 700+. Regardless of class size, it goes something like this:

- 1) Pose a cognitively engaging multiple-choice question to the students. It should challenge them to think beyond the superficial layers and have the ability to foster deep discussion. (What creates deep discussion? Consider the following: How long would the conversation continue before students were convinced of the correct answer? How many steps of reasoning must they go through in order to arrive at the correct answer?)
- 2) The students think about and ultimately vote on the answer as individuals.
- 3) The results of the vote dictate your plan of action which often times—as the name indicates—has the students discussing

their reasoning with their neighbors and taking a second vote.

Also popular in the research on TPS is the ever-present debate: clickers vs. flashcards—which is "better"? While it's largely a matter of personal preference, the well-versed instructors will tell you that it should always be about proper implementation of the technique and the pedagogical value added to your course, not the technology itself.

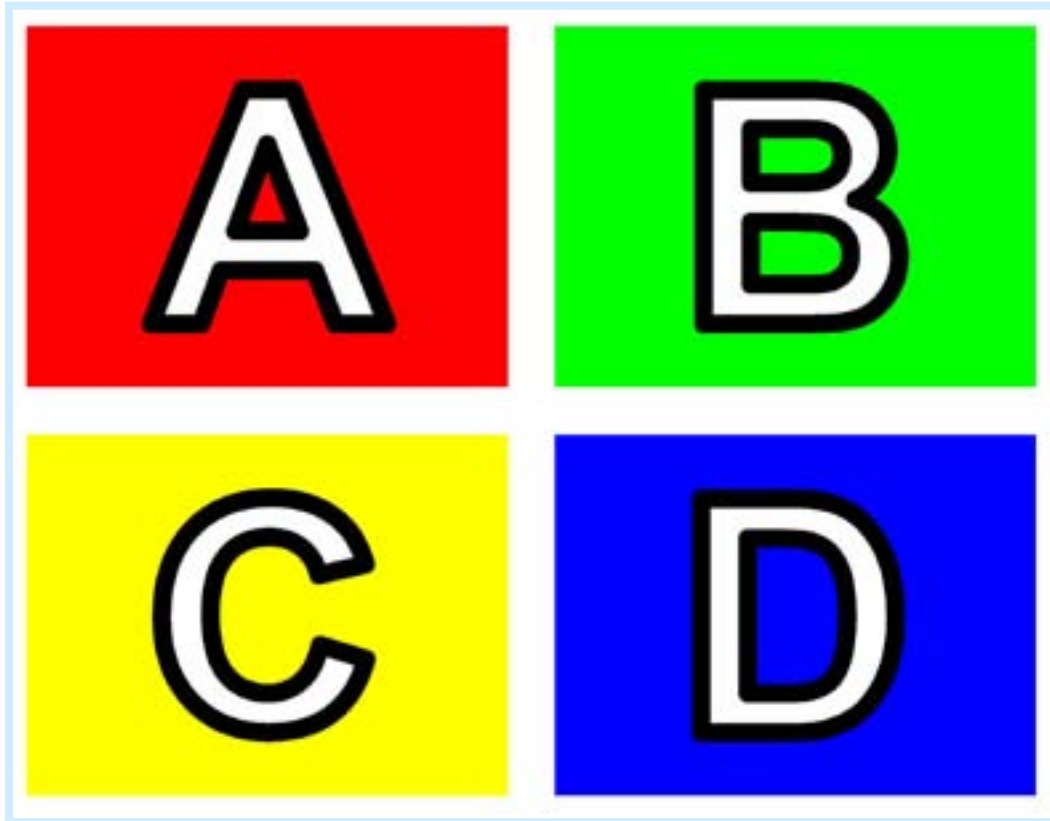
Like my collaborators at CAE, I have had experience with and conducted research on both tools. Also, like each of my collaborators, I now harbor a special fondness for one tool over the other. While a few of them are still staunch proponents of clickers, most of us are overwhelmingly fans of flashcards, myself included.

Regardless of the tool in use, there are two rules for voting that are required to maintain the integrity of the technique: (1) simultaneity and (2) anonymity. Since the students first vote individually, it is critical that they not be influenced by others. I remind my students that this is a free chance to be honest with themselves and see what they really do and do not understand before being graded (exams, homework, etc.). I do not grade any aspect of TPS because I don't want them to give just any answer for the sake of getting points. It's part of my job to help them see and experience the importance of participating legitimately for learning.

To ensure that voting is both simultaneous and anonymous students must be told precisely when to show their votes and how to hold the cards. The correct way to vote with a flashcard means holding it right up against your chest. This ensures that the votes are anonymous with respect to the other students; only the individual student and the

instructor can see the card. Holding it in any other position means it's now possible for other students to see or figure out what letter you are holding up.

I use an ABCD card: a single sheet of 8-1/2" × 11" paper with color-coded letters in large print. I give everyone a card on the first day of class then



A sample of the ABCD card. Students hold up a letter to discreetly answer questions.

post the PDF on the course website so they can print replacements at will. Voting A, B, C, or D means simply folding the card so that you show only the appropriate letter. Option “E” can be selected by folding it so that the back (only white) is displayed.

Here’s an implementation scenario that has been research-validated right down to the specific words used for certain prompts:

- 1) The multiple-choice question is displayed on the classroom screen while everyone reads and thinks about it silently.
- 2) You do the same as your students: focus your attention on the question, read it

slowly to yourself just as they are, then silently go through each step in the reasoning necessary to arrive at the correct answer. This accomplishes two goals: it validates the experience for the students by showing them this is a real question

that even you have to take the time to read and work through; and it ensures you give them an authentic experience by not reading the question to them. Reading the question aloud wastes time—they’re just going to read it again to themselves when you’re done. And despite your best intentions, you inadvertently give away clues via your vocal inflections and body language when you read aloud. Besides, you won’t always be there.

They must learn to think it through for themselves.

- 3) When you are finished with step 2, or you hear the rustling of cards being folded, turn to the class and ask, “Does anyone need more time?” I suggest you use these specific words. That is the precise question you need the answer to. If even one student signals yes, give it to them; it shows how important it is for them to really try and give a legitimate answer. I typically count to ten slowly to myself.
- 4) Turn to the class and say “prepare your

votes.” If they haven’t already done so, this is their signal to fold the card to the letter they want to show. In the beginning when I am “training” them in the technique, I tell my students to be a little stealthy about it. “It’s anonymous and you don’t want anyone mooching off of you, right?” After a few class periods of implementation they of course get the hang of it and know that “prepare your votes” also means to keep it a secret.

- 5) To ensure students vote simultaneously, say “show your votes on the count of three” or something similar. On “three,” they should be holding their cards close up against their chests as previously described. I also train my students to keep them up until I tell them what to do.
- 6) Use the percentage of correct answers to determine your course of action.

A. If 80% or more got the question right then it’s enough to move on. You do always need to validate their correct response but resist the urge to simply tell them the answer yourself. It’s much more pedagogically valuable if it comes from them. For example, I typically say something like “Wow, that’s really good! The color of the right answer is…” and they are trained to yell out what color they voted (it’s much less confusing than trying to hear the letter, all but one of which sound very much alike). If I don’t get the level of confidence in the yell that I know I saw in the votes, I’ll make them do it again: “That wasn’t very convincing. Let’s try that again. The color of the right answer is…” and they will typically step it up. (Besides, who doesn’t enjoy permission to yell during class?)

This is a powerful moment for those who

didn’t get it right: when their incorrect “blue” or “green” responses were drowned out by a sea of people yelling “RED!” they just saw that not only was the question a fair one to ask but that nearly the entire class got it right...except for them. Those who got it right also become conditioned that I, as the instructor, am not the source of answers: they can do this too and need to learn to trust in their thought processes. This is, of course, why it is critical to always validate the correct response and not leave them wondering.

There are numerous other ways to debrief votes. If you want to reinforce a concept after they’ve called out the right answer, don’t just launch into another lecture; have them tell you the key pieces of reasoning.

B. If less than 80% of the class gets it right, it’s time for a discussion. First, do not reveal anything about the distribution of votes! In doing so, you would bias their discussion and might inadvertently give away the answer. There would be little if any deep engagement required on their parts to get it correct, which leads them to not engage deeply enough to know why that is the answer. They just know it’s right, so they’re done thinking about it.

Also, if less than 50% are correct, don’t assume it’s because they don’t understand. You don’t know that to be true. Couldn’t some of them just have misread the question? Read “west” when it actually says “east”? Somehow thought that arrow pointed up and not down? There’s nothing wrong with letting a “rainbow” talk it out. They’ll vote again afterwards, and you’ll take it from there.

While still holding up their votes say, “When I say ‘go’ you have 60 seconds to

convince your neighbors that you're right. Just because you have the same answer doesn't necessarily mean you're right so you'd better explain your reasoning. You have 60 seconds. Go!" Be clear that their purpose is to convince each other. You don't want them just to have a discussion: "Hey man I got 'A'; what did you get?" "I got 'B'." "Okay, cool." You need them to do precisely what you said: convince their neighbors that they're right. It forces them to own up to the answer they chose, defend it, and try to debunk others' different answers. The instructions also require them to explore if they have the same answers for the same reasons since ultimately the reasoning is key.

You have also created a sense of urgency by telling them they have only 60 seconds (no time to waste off topic). If they're slow to start, begin counting backwards, "59, 58, 57..." That works like nothing else does. (Just like saying "go" is magic compared to other terms you might try there).

As they're talking, I'm walking around the room, listening closely and getting ideas for new questions and multiple-choice distractors! I might not use the full 60 seconds if I hear the conversation dying down. Alternatively, I might give them more than 60 seconds if I hear rich discussions still ensuing. When I'm satisfied with the discussions, I'll give them a warning, "You have ten more seconds." By this time I've returned to the front of the room, and now we're ready to re-vote. Repeat numbers 4 and 5 to vote again.

At this point, you're probably up to the 80+% level and can proceed as in "A" above. If not, there are still options

available. Do you see any patterns in the distribution? Bimodal? Predominantly wrong because they fell for the distractor that you know means they still didn't notice that arrow? Here are some things you can say to get them to help you understand what's going wrong: "Did we all notice that this arrow points down and not up?" You might hear a chorus of "Oh!" Time for another vote. "Is there something about the question that I can clarify for you?" You might be able to dispel confusion to their satisfaction and vote again. Then again, you might realize there is actually a problem with the question (it happens!) or maybe this question is just too complex right now, and you need to back up to one that covers only the core idea they seem to be struggling with.




Now for the pros and cons of clickers and cards. Probably the biggest drawback to using clickers instead of cards is the inability to tie a vote to a specific individual in real time. Sure you can assign the same numbered clicker to the same student all term, but how long does it take you to see exactly who is selecting what answers? Can you tell that the pocket of incorrect answers is all in one corner of the room? The real-time benefit of the cards here is unmatched. Patterns are easily identifiable and you can do something about it right then and there. Additionally, CAE has conducted research showing that there are small but statistically significant increases in learning gains for classes using cards over those using clickers.³ There is some evidence to show that the students are more vested in trying to do well when they know the instructor can see their votes in live class.

One plus for clickers is the ability to save the data. This sounds like a clincher and if you're doing research using the numbers it very well may be. But be honest with yourself: how often are you really going to refer back to the data? Do you really need the exact numbers? Or would jotting

down a quick note about that question suffice?

Then there's that argument of using the clicker to assign participation credit. I mentioned before how I don't grade any part of TPS and wouldn't advocate for it. While some (even CAE collaborators) do, there's so far no correlation of credit with learning gains that we know of. Of course the students get really good at "gaming the system" when they know points are earned just by pressing a button on a remote control in anonymity. Besides, there are tons of other ways to assign participation credit that span the gamut from those with real pedagogical value to some as easy to grade as looking at a clicker roster.

What about cost to the students, set-up time, techno-glitches, dead batteries, forgotten/lost clickers, and the ability to insert new questions on the fly? Cards easily win all these rounds.

Granted, some of the more user-friendly clicker systems are making it easier to insert questions on the spur-of-the-moment. However, the instructor still has to set up the receiver properly. The cards are always ready to go. If a student forgets his/her card, s/he can "give me the finger" (or fingers: , , , etc.) during that class period. Because it's harder to call out the color of the right answer when you voted with two fingers instead of "green," they usually make a new card pretty quickly.

Regardless of the method of voting you use with TPS, make sure to maintain the integrity of the technique by practicing proper implementation.

Happy voting! 🎲

Notes

1. See <http://astronomy101.jpl.nasa.gov>
2. Student learning gains on validated concept inventories are directly in line with gains achieved by students in smaller classes nationwide.
3. Learning gains measured using validated concept inventories.