Assembling a Case Study Tool Kit: 10 Tools for Teaching With Cases

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Each year, a new group of teachers takes the leap and integrates case studies into their classroom. The more than 600 peer-reviewed cases that now comprise the National Center for Case Study Teaching in Science (NCCSTS) case collection makes it easy to access high-quality case materials on diverse science topics. The cases are one critical component of teaching with cases, but there's another: the strategies and tools that teachers use to manage a case study classroom effectively. Over a period of 15 years of teaching with cases in a small undergraduate classroom of 20 students, I collected my favorite tools. Although most are not exclusive to the case method, together they constitute a case study tool kit that new and experienced case teachers may find helpful. This article is based on a session I led at the 2016 NCCSTS Fall Case Study Conference. The presentation generated much interest, which is why its contents are shared here to a broader audience. The tools are described more or less in the order in which they are likely to be implemented in the case classroom, from forming teams ahead of a case to follow-up assignments at the end of the case.

Tool 1: Faculty Focus

One of my favourite teaching resources is a website called Faculty Focus (www.facultyfocus.com). This website posts short articles (typically less than a page) on topics of interest to the teaching professional, from classroom strategies to instructions on creating a teaching portfolio. The articles have the practitioner in mind and offer concrete tips. The practicality of these pieces is underscored by a 2013 readership survey that found that 90% of faculty have taken action based on something they read (Faculty Focus*,* 2013). Readers augment the usefulness of the articles by contributing their own suggestions in a comments section. These articles are grounded in research, and most offer peer-reviewed references for readers hungry for more information. Access is free, and readers can sign up for alerts when new articles are published.

Tool 2: Forming Teams

A 2015 survey of large U.S. companies reports that the ability to work in a team is one of the most sought after skills of recent graduates (National Association of Colleges and Employers, 2015). Instructors should incorporate group work into their classroom not only because it will make their students more competitive in the workplace, but also because there is strong evidence that group work and peer discussion improve student learning and attitudes toward learning (Felder, Felder, & Dietz, 1998; Smith et al., 2009; Springer, Stanne, & Donovan, 1999; Terenzini, Cabrera, Colbeck, Parente, & Bjorkland, 2001).

When doing cases in the classroom, the first task is to form teams. Several methods exist for doing so—for example, letting students self-assemble, random assignment, or instructors distributing the expertise between teams. The research doesn't currently favor one strategy to ensure high performance, group efficiency, and learning outcomes (Bacon, Stewart, & Silver, 1999; Baer, 2003; Barrick, Stewart, Neubert, & Mount, 1998; Chapman, Meuter, Toy, & Wright, 2006; Fiechtner & Davis, 1985; Hilton & Phillips, 2010; Huxham & Land, 2000; Jensen & Lawson, 2011; Saleh, Lazonder, & De Jong, 2005; Webb, 1982).

With this caveat in mind, my personal preference for forming teams is to distribute student expertise (Barkley, Cross, & Major, 2005). I select the skill to distribute among the teams—for example, knowledge of the case topic. I then ask students to line up according to a gradient, from most knowledgeable about the topic to least knowledgeable. Students estimate their knowledge and go to the position in the lineup that they feel most accurately reflects their background.

I like to form teams of three students, because three people have sufficiently diverse opinions for discussion, but the group is intimate enough to discourage social loafing. Starting at one end of the line, I ask students to count off from one to X, where X is the number of teams that will be formed and is calculated by dividing the total number of students by three. All students who counted off the same number should sit together as a team in a designated space.

This technique works for classrooms of up to about 30 students. Beyond that, I recommend separating students into groups of 30 and repeating the procedure for each group.

Tool 3: Icebreaker

I typically create new teams once per month. This gives time for team dynamics to evolve but provides "light at the end of the tunnel" when team interactions go bad. Because teams work on several cases together, it is worth investing time into an icebreaker activity so that team members get to know one another and work more efficiently together.

Many books, articles, and websites describe icebreaker activities. Examples include West (1999), Chlup and Collins (2010), https://www.cultofpedagogy.com/classroom-icebreakers and http://www.gpb.org/blogs/education-matters/2016/07/21/20-great-icebreakers-for-the-classroom. Many activities are good but require a lot of time or are suited to larger groups.

I call the method I use "Alike and Unique." Teams are given 10 minutes to ask each other questions and identify three things that their members share in common and that are unlikely to be shared by other groups. By asking probing questions, members find out about one another and build team identity. In my class, I have had groups discover that they all share the same favorite restaurant, that they all have attended a Burning Man event, and that they have each visited every continent.

Tool 4: Individual Quiz on Homework

To prepare students for a case, I assign readings or online videos. Not surprisingly, when students prepare for class, they perform better in the course (Moravec, Williams, Aguilar-Roca, & O'Dowd, 2010). To make students accountable, I have them complete a quiz on the assigned material before the case and the answers are graded.

When the homework consists of readings, I quiz students with five multiple-choice questions when they arrive in class. This short quiz takes little class time, but if time is at a premium, it is also possible to use online tools to quiz students ahead of class. Preclass quizzes have been shown to correlate with increased student performance (Orr & Foster, 2013).

When assigning online videos, the quizzes are embedded directly into the videos. This has been shown to increase the amount of time that students spend interacting with the online contents and to improve learning (Vural, 2013). Immediate feedback provided on answers has been shown to increase retention and learning (Lantz & Stawiski, 2014). Free, user-friendly, online tools give instructors the ability to trim an online video, integrate questions at specific points in the video, and collect student answers. Two available tools are PlayPosit (www.playposit.com/) and EDpuzzle (https://edpuzzle.com/).

Tool 5: Group Quizzes on Homework

Short quizzes ahead of, or at the start of, class ensure that each student is accountable for doing the out-of-class preparation. Students value this opportunity to work things out on their own prior to peer discussion (Nielsen, Hansen-Nygard, & Stav, 2012).

The next activity is a group quiz. This is an opportunity for peer learning, and it is used to clarify concepts that students did not grasp on their own. This practice is sometimes called *two-stage cooperative testing*, and it has been shown to increase student engagement as well as learning for both the students who knew the material initially and those who did not (Eaton, 2009; Hollis Gilley & Clarkston, 2014; Jang, Lasry, Miller, & Mazur, 2017; Rieger & Heiner, 2014; Wieman, Riger, & Heiner, 2014; Zipp, 2007). Students repeat the same quiz, but this time they do it in their team and report their answers on an Immediate Feedback-Assessment Tool (IF-AT), an idea I borrowed from team-based learning (Michaelsen, Bauman Knight, & Fink, 2004). An IF-AT is a card reminiscent of a lotto ticket where students scratch one answer for each question: A, B, C, or D. If they scratch the correct answer, they uncover a star. Otherwise, they reveal a blank box. Research has shown that this sort of immediate feedback improves learning (Brosvic, Epstein, & Cook, 2004) and that the physical act of scratching the card helps students remember (Epstein et al., 2002). What I like about the IF-AT group quiz is that each student must articulate the reasoning behind his or her answer to allow the team to come to a consensus.

Students give themselves four points if they get the answer right on the first attempt, two points if they get it on the second attempt, one point if they get it on the third attempt, and no point if they require four attempts to answer the question. This scheme ensures that students have an incentive to continue working on a question until they get it right (Epstein et al., 2002). Although students work on their group quiz, I typically grade the individual quizzes so that students have complete feedback on their performance by the time they leave the classroom.

Students love group quizzes with the IF-AT (Epstein & Brosvic, 2002). In my classes, they high-five one another when they correctly answer a question. The IF-AT regulates group dynamics. A bully who imposes his or her answers on the group but doesn't know much is rapidly "outed," while a quieter student who speaks softly but who grasps the content will be rapidly valued by the group. The group grade is typically greater than the individual grade, so it makes students appreciate the contributions of their peers and value group work.

IF-AT cards are available from Epstein Educational Enterprises (www.epsteineducation.com) at a cost of approximately $90 for 500 quizzes. Instructors are mailed the answer key and can create their multiple-choice quiz to match the IF-AT.

If funds are an issue, it is also possible to make reusable DIY scratch cards (for instructions, see https://youtu.be/P0xDwDYC4Hw).

A student's grade on the quiz comes from two sources: the individual quiz and the group quiz. Both are weighed equally. However, not every student in a team receives the same group grade because I weigh this grade by each student's contribution to the team effort (see Tool 6). Zipp (2007) described an alternative way to combine the two quiz grades into a student grade. In his scheme, a student's grade is calculated by using his individual quiz grade plus half of the difference between the group average on the individual quiz and the group score. This calculation provides equal reward to all students on the group quiz and may serve to incentivize students who performed well on the individual quiz.

Tool 6: Weighing the Group Grade

Not every student contributes equally to a team's success, so it would be unfair if all students in a group received the same grade. I use peer assessment to evaluate each student's contribution and use that to weigh the group grade for each student. Studies have shown that peer evaluation is a reliable method of assessing student performance with high agreement between raters (Dingel & Wei, 2014; Wahawisan, Salazar, Walters, Alkhateeb, & Attarabeen, 2016). Studies have also shown that the feedback received from peer evaluations can result in improved performance (Brutus & Donia, 2010). For this reason, it is important to do a formative (not for grade) evaluation about midway through the life cycle of the team. This provides valuable feedback to students and gives them a chance to address perceived shortcomings. Readers are referred to Guedenzoph and May (2002) and Oakley, Felder, Brent, and Elhajj (2004) for thoughtful discussions of best practices when using peer evaluation in the classroom.

There are many ways to do peer evaluation. The approach I use is borrowed from team-based learning and was described by Herreid (2001). Herreid's article provides a peer evaluation form, which I adopted in my classes. In this approach, each student assigns points to their teammates. The total number of points is equal to 10 multiplied by the number of students in a team (minus the rater). For example, in a team of five, each student has 40 points to assign. Students award points on the basis of each student's contributions to the team effort. Instructors may wish to clarify what "contribution" means in the context of their class (i.e., does it include preparation for the quiz, or participation in group discussion, or both?). A student who contributed fairly should receive 10 points. A student who contributed more than his or her fair share can be awarded more than 10 points. A social loafer can be awarded fewer than 10 points. Not all points need to be spent, but a student cannot award more than their sum total.

The average score awarded to each student is used to weigh the grade of any team assignment. For example, let's say a student received an average of 8 points and the group quiz received a 70% score. The grade of this student for the group quiz will be $0.8 \times 70\% = 56\%$, because this student contributed in a limited fashion to the team assignment. A student in that group who received an average of 12 points from peers will see his or her group grade corrected to $1.2 \times 70\% = 84\%$. Thus, for the same group project, each student may receive a different grade that reflects both the quality of the work produced and his or her contribution to it.

Because my classes are small, I collect answers using paper forms and tally the results. For larger classes, software such as the Comprehensive Assessment for Team-Member Effectiveness (CATME, http://info.catme.org/) can do this automatically.

Tool 7: Formulating Questions

While cases typically contain a set of questions, instructors often add their own. This gives teachers the ability to probe student knowledge at the start of a case, to generate discussion, and to monitor learning. Beatty, Gerace, Leonard, and Dufresne (2006) provided instructions for designing effective questions for class discussion and peer interaction that deepen learning.

I like to ask questions that target student misconceptions. Students' misconceptions are ideas students hold that are inaccurate. They are picked up from past experiences, cultural beliefs, teachers, and textbooks (Cho, 1985; Coley & Tanner, 2015; Kurt, 2013; Sovibo, 1995; Storey, 1989; Tekkaya, 2002). Instructors need to know the most common misconceptions that students bring to the table, and students must become aware that their concepts are inaccurate or incomplete as a starting point to changing those ideas (Limon, 2001; Posner, Strike, Hewson, & Gertzog, 1982).

Project 2061 (http://assessment.aaas.org/) is the American Association for the Advancement of Science's website containing assessment items in the earth, life, physical sciences, and the nature of science (Koppal & Caldwell, 2004). These multiple-choice questions are the result of years of research and target core concepts and common misconceptions. Each question contains data about the percentage of middle and high school students who answered it correctly. It also contains information on the misconception that a student likely holds when he selects an incorrect answer.

Although the tool was tested on middle school and high school students, it applies to college and university students as well, in part because the 2 months of summer between high school and freshman year is unlikely to have shifted student thinking and also because misconceptions are hard to displace. Misconceptions are tenacious because in people's minds, the concept—although inaccurate—makes sense so they aren't aware that it is inaccurate (Anderson & Smith, 1987; Chi, 2005; Duit, 2009). For these reasons, it is likely that misconceptions commonly held in high school are still prevalent in sophomore, junior, and even senior students.

Instructors can integrate Project 2061 questions at several points in a case. Questions can be assigned as homework or a precase quiz. If students receive feedback on their performance at this stage, they may come to class with an incentive to understand why they scored incorrectly on certain questions. Questions can be added in the question section of a case for small group discussion. The questions can also be used in whole class discussion. This application is particularly appealing because it gives teachers the opportunity to address incorrect answers.

Tool 8: Student Response Systems

Although whole class discussions are helpful in exploring new ideas during a case, the students who contribute may not be representative of the entire class's understanding or point of view. To gain an understanding of what every student thinks, individual sampling is required. Student response systems (SRS) are polling methods that give teachers real-time feedback during class about what all students are thinking. Research has demonstrated that classrooms that use SRS have greater student engagement, increased student understanding of complex subjects, improved student interest, and heightened peer interaction (Caldwell, 2007; Fies & Marshall, 2006; Kay & LeSage, 2009; Lantz, 2010; Lasry, Mazur, & Watkins, 2008). Note that certain case formats, such as clicker cases, are dependent on an individual surveying method.

Some SRS use electronic devices to collect answers, whether via texting on a cell phone, the internet, or a proprietary device. They are colloquially called *clickers*. Electronic polling systems are anonymous, increasing participation by shy students (Stowell & Nelson, 2007) and allowing students to volunteer their opinion on questions that they might not want to discuss openly with their peers (e.g., offering their views on abortion).

Many companies offer SRS services, including iClicker (https://www1.iclicker.com/), Kahoot (https://kahoot.com/), Mentimeter (https://www.mentimeter.com/), Nearpod (https://nearpod.com/), Poll Everywhere (https://www.polleverywhere.com/), Slido (https://www.sli.do/), Socrative https://socrative.com/), Turning Technologies (https://www.turning-technologies.ca/), Quiz Socket (www.quizsocket.com), Top Hat (https://tophat.com/), and Verso (http://versoapp.com/). Poll Everywhere has produced a chart comparing the features offered by the different apps (https://www.polleverywhere.com/vs.xlsx). Though readers should be mindful of the source and purpose of this document, it helps to compare the different products.

In selecting a system for my classroom, I wanted to avoid the costs of a proprietary system. I therefore chose a system where students can use their mobile devices. I did this with the knowledge that about a third of students using mobile devices report experiencing difficulty accessing the questions some of the time (Stowell, 2015). Each system has its drawback, and instructors must choose the one that fits their goals and environment.

For my class, I chose Poll Everwhere in part because it offers the flexibility of students participating via text on a cell phone or an online device. Answers come in in real time, and the suspense never fails to amuse students. Surveys can collect different types of answers, from multiple-choice polls, to one-word answers that are summarized into a word cloud, to ranked list, to pinned locations on an image. The system is free for up to 40 survey participants. Beyond that, teachers can choose to ask students to pay for access, or they can purchase classroom access for a fee. Teachers with larger classes may assign students to groups of 40 that take turns answering questions. Statistically, a sample size of 40 is probably representative of the whole class, giving instructors the feedback they require.

Many instructors choose electronic SRS over more traditional (low tech) forms of SRS such as flashcards and paddles because of the novelty of the technology, but it is unclear that the use of technology results in improved learning (Lasry, 2008). The anonymity that makes electronic SRS appealing in some circumstances can hinder the use of the SRS by preventing opportunities for peer learning.

When I want to encourage peer discussions during a SRS component in my classroom, I give each student four index cards. Each one is a different color, representing a different answer on a multiple-choice survey. At set points in the case, I ask a multiple-choice question, and students simultaneously raise an index card of the color that matches their answer. The simultaneity is important; it forces students to think independently. This survey method makes a student's answer public, which can be an asset for learning. What happens next depends on the accuracy of student responses, as described by Mazur and Watkins (2010). In most cases, 30%–70% of students respond with the correct answer. This means that there is sufficient knowledge and resources within the class to proceed with peer instruction. While students are holding up their card, they are asked to pair with another student who is holding a card of a different color (Crouch, Watkins, Fagen, & Mazur, 2007). Next, each student must articulate the reasoning behind their answer and convince the other that his or her answer is correct. This is followed by retaking the survey. The peer teaching typically moves the class toward a greater proportion of correct answers (Knight, Wise, & Southard, 2013; Smith et al., 2009). In situations where there is less than 30% of the class who could correctly answer the question, there is insufficient knowledge in the class, and students would benefit from revisiting the concept before proceeding. In cases where more than 70% of the class got it right, the teacher only needs to explain why an answer is correct to reinforce the concept, and the class can move on. Thus, the index cards serve to provide feedback to the instructor about the need to spend more time on a concept if it is needed and uses peer instruction when it is most likely to be effective and to result in learning.

Tool 9: Follow-Up Assignments

Some case studies suggest follow-up assignments, but many do not. After a case, I assign an individual homework assignment to assess that students learned from the case and can apply what they learned to new settings. Although many assignments are possible, here is a list of staples that I often use after a case.

Venn diagram

If there were two concepts that were teased out of a case, or if there was one concept in the case that I want students to compare with another explored earlier in the course, I ask students to draw a Venn diagram where each of the circles represents one concept, and the intersection represents aspects of the two concepts that are shared. In effect, this is a visual compare-and-contrast exercise. I typically ask students to complete the diagram by including a minimum of 10 unique characteristic for each concept and 10 aspects that are shared by both.

Annotate an article

This assignment was inspired by the website Science in the Classroom (http://www.scienceintheclassroom.org/), in which volunteers annotate articles from the journal *Science* to highlight the Introduction, Materials and Methods, Results, and Discussion sections. *Science* and *Nature* are two journals in which landmark papers are published, yet they can be difficult to read by novices because there are no section headings and the information is not neatly organized as it is in other journals.

If a case study is based on a journal article published in *Nature* or *Science*, then the case presents a nice entry into the scientific literature. Now that students have understood the contents of the experiment, reading the paper—with its weird format and jargon—will seem less daunting. I ask students to highlight in different colors sections that mention past work, what the researchers thought they might find, how the experiment was done, what the researchers found, and the implications of these results. Students can also clarify jargon with a definition. This exercise helps them become comfortable with the scientific literature after a case study.

ID the key researchers

When using a case that is based on research in a field with which I would like students to gain familiarity, I ask students to identify the 5–10 key researchers in that field. Students have to read original research articles and some reviews to get a handle on the landmark experiments that made an impact on the field and are consistently referenced. The key researchers are not necessarily the most prolific authors. This assignment gives students the opportunity to acquire basic research skills. I typically ask students to report who the five key researchers are, where they work, how they have advanced the field (in one sentence), and how the student identified that this person was a key researcher in the field. This latter question gives the instructor insight into the students' evaluation process that can be discussed in class.

Simulations

Models and simulations help students understand a system. Instructors can develop a postcase questionnaire that guides students' exploration of a simulation by playing with the variables and seeing their effects. PhET (https://phet.colorado.edu/) is a project of Nobel Laureate Carl Wieman that has won several awards. This website contains intuitive game-like models in physics, chemistry, biology, Earth sciences, and math. Another simulation collection is The Kings' University Centre for Visualization in Science (http://www.kcvs.ca/site/index.html), which provides simulations in physics, astronomy, and chemistry.

Tool 10: Peer Editing

At least once per semester, I assign a longer written postcase assignment such as a research paper. To improve the quality of the submitted work (Anderson & Flash, 2014), and to give students the opportunity to analyze written work (Ludemann & McMakin, 2014), I make students go through one round of peer editing in their small groups. Left unmanaged, students will choose to be "nice" to their peers and will not provide useful feedback. Moore (2016) described a method of peer editing that is quick to implement and guides students toward purposeful feedback. It begins with a class contract. Students are surveyed about the type of feedback they prefer to receive from peers. Most students typically indicate a preference for feedback that errs on the critical. Sharing the results of this survey sets the scene, giving students permission to be critical in their assessment. Next, authors submit a memo to their team. This memo sets the context for their work—its stage of development, challenges, and areas of pride. This helps to focus the reviewers' attention. The author must also include specific questions for which help is sought. The specificity is important. For example, instead of generally acknowledging that transitions need work, the author can request specific help with one transition and indicate what they wish to achieve. The reviewers' job will be to come up with a solution to these specific questions and, in so doing, will improve their own ability to write. This is a win–win method of improving written work. Gueldenzoph and May's (2002) work corroborates this approach to peer assessment.

In my classes, students do this in a face-to-face meeting. For larger classes, online peer editing tools may be useful. Examples include Calibrated Peer Review (http://cpr.molsci.ucla.edu) and Peerceptiv (http://www.peerceptiv.com/wordpress/).

A Case Study Tool Kit

The tools described in this article may not suit every instructor, or every case study, but they constitute a tool kit from which instructors can pick and choose. For every case, I select appropriate tools to fit the case goals and format. My three staple tools are the formation of teams by lining students up according to expertise, the IF-AT group quizzes, and the peer evaluation to weigh the group grade. Combined with the cases of the NCCSTS collection, this tool kit should provide the novice and expert case study teacher with everything they need to teach with cases. ■

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