Flipped Learning:
An Alternative Pedagogical Model for Unidata Training Workshops?

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October 7, 2014

I. Introduction

My colleagues at San Francisco State University (SFSU) and I have used Unidata software as a vital tool in our teaching, service, and research since the mid-1990s. We could not have done so without Unidata's software training workshops, most of which employed a pedagogical model comprising intensive lecture. However, evidence amassed from research on how people learn identifies alternative approaches that can help people learn more effectively.

Recently a framework for implementing some of these alternative approaches, called "flipped learning", has attracted widespread interest. Could Unidata training workshops adapt to this framework? If so, could they become more effective than they are now?

II. Unidata Training Workshops and a Traditional Pedagogical Model

From 1992 to 2011, I attended between half a dozen and a dozen of Unidata's one- to four-day training workshops (specifically, for WXP, SDM, LDM, GEMPAK, IDV, and THREDDS). These workshops shared a number of characteristics, such as:

- The instructors employed mostly "direct instruction" (i.e., lecture).
- An online workshop tutorial (supported by online software documentation) usually provided the instructional framework.
- The workshops presented much more information than I could absorb at the time (or ever).

For comparison, a traditional pedagogical approach, employed in science and mathematics higher education, comprises iterations of:

(1) direct instruction (that is, lecture) with occasional exams, in class; and

(2) reading and graded problem-solving homework assignments.

With this traditional pedagogical model in mind, I note several other characteristics shared by Unidata workshops:

- The workshops assigned no homework (beforehand, during the workshop, or afterwards), administered no tests, and provided no feedback to participants about their learning.

Hence, the workshops implemented part of the traditional model (the direct instruction) but not the rest (homework, feedback). (Participants created their own "homework" problems back home, with access to email support from the exceptionally dedicated Unidata staff.)

Although I learned something valuable from every workshop that I attended, I could remember only a fraction of what each workshop covered. To solve problems back home, I spent long hours wrestling with the software, searching online user guides, tutorials, and email archives, and seeking help asynchronously (and laboriously) by email from the exceptionally dedicated Unidata staff.

However, I've also been fortunate to visit Unidata staff in Boulder often and to work with them in person to solve problems that I'd struggled to solve myself at home. These collaborative problem-solving sessions following my "homework" were productive and effective, and I was struck by how much, how fast, and how easily I learned (relatively speaking). Might such experiences offer lessons to improve Unidata's workshops?

III. Flipped Learning

Evidence amassed from research on how people learn shows that for most people in most situations, direct instruction is by itself not the most effective pedagogical approach. This is true even when out-of-class reading and graded homework problems complement lecture, as in the traditional pedagogical model. Instead, people learn measurably better when instruction*:

- engages them in (preferably real-world) problem solving,
- especially in collaboration with others;
- provides frequent, timely feedback; and
- asks participants to communicate their learning in multiple modes.

Direct instruction can contribute to learning, but it is most effective in small, well-timed doses. (One study measured the average attention span of a group of engaged adults listening to a dynamic speaker at about 15 minutes.) The effectiveness of direct instruction improves when listeners are frequently assessed and given feedback about how they are learning.

* This is not an exhaustive list. For example, see http://www.utexas.edu/academic/ctl/assessment/iar/teaching/plan/why-practices.pdf

The most practical place to engage students in collaborative, facilitated problem solving with timely feedback is, of course, the classroom. However, students still need to learn background content knowledge to solve problems. If direct instruction is largely banished from the classroom, how can students acquire such knowledge? Unfortunately, reading assignments alone don't appear to be the solution because many students won't complete them reliably (Bishop and Verleger, 2013).

However, instructional multimedia, with automated assessment and feedback embedded, can in principle provide the necessary background content learning. In recent years, such materials have become increasingly easy to produce and to disseminate via the internet, and so have become a potential practical solution. (UCAR's COMET program has produced training materials of this sort for many years.)

The combination of (a) effective, easy to produce, online instructional materials for out-of-class instruction, and (b) collaborative, facilitated problem solving activities in class, completes and extends a "flip" of the components of the traditional pedagogical model: in-class direct instruction and out-of-class, solitary problem-solving swap places (the flip), and the solitary problem-solving becomes collaborative and facilitated, with timely feedback (the extensions that makes problem solving much more effective pedagogically).

This combination is referred to in the literature as "flipped learning", defined (FLN, 2014) as a "pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter."

IV. Assessment of Flipped Learning

Although assessment of the flipped learning model is in its early stages, Bishop and Verleger (2013) cite "studies [that] show that video lectures (slightly) outperform in-person lectures, with interactive online videos doing even better…. Pre-recorded lectures can be assigned to students as homework, leaving class time open for interactive learning activities—activities that cannot be automated or computerized." Moreover, "students did tend to watch the videos when assigned, and even when they were not [assigned]. DeGrazia et al. notes that students supplied with optional video lectures came to class much better prepared than when they had been given textbook readings." And finally, "Day and Foley conducted their study in a senior-level computer interaction course. They taught concurrent experimental and comparison sections of the course, and matched sections on topics, assignments, and time on task. Students in the experimental section watched narrated PowerPoint videos outside of class, and participated in interactive learning activities inside class. Students in the flipped environment scored significantly higher on all homework assignments, projects, and tests."

Aside from the demonstrated benefits to student learning of collaborative problem-solving over direct instruction alone, Bishop and Verleger (2013) offer insight into other possible reasons why flipped learning might improve student learning. They describe flipped learning this way: "With instructor-created videos and interactive lessons, instruction that used to occur in class is now accessed at home, in advance of class. Class becomes the place to work through problems, advance concepts, and engage in collaborative learning. Most importantly, all aspects of instruction can be rethought to best maximize the scarcest learning resource—time." They also observe that "the most important benefit of videos is that they allow the instructor to work individually with students (particularly, spending more time with those who need it the most). This Fosters better relationships, greater student engagement, and higher levels of motivation."

V. Opportunities for Flipped Learning in Unidata Training Workshops

The NSF panel that reviewed Unidata's most recent (2013) five-year grant proposal encouraged Unidata to explore online, multimedia instructional materials as an alternative to its traditional in-person training workshops. The motive for this suggestion was probably more financial and logistical than pedagogical (online instructional materials are likely to reach a larger audience than in-person workshops can, and do it more cheaply per user). Unidata recognizes the potential value of supplementing its online software documentation with short, online instructional videos, and has begun producing them for the IDV (where Julien Chastang contributes a calm, soothing narrative voice). At least one IDV user (Brian Mapes, University of Miami) has produced one as well. Hence, Unidata has already started begun implementing elements of what could serve as the out-of-class component of a flipped learning model for its training workshops. And Greg Byrd of the COMET program is aware of Unidata's efforts in this direction and has expressed interest in contributing COMET's considerable online instructional design expertise (though probably at a price).

Nonetheless, although such materials should add value to written documentation, static tutorials, and asynchronous email support from Unidata, the greatest pedagogical benefit of these materials most likely comes when they provide preliminary background ("pre-class homework") for in-person collaborations on problems of shared interest, facilitated by an expert. For this reason I encourage Unidata to continue to offer training workshops, and in particular to continue the trajectory it has already started toward experimenting with the flipped learning model.

VI. Additional Topics Yet to Be Addressed by This Opinion Piece

- Costs and other obstacles to implementing the flipped learning model for Unidata training workshops.
- Implementation details:
    - Motivating workshop participants to prepare for and contribute actively to a flipped learning workshop.
    - Structure and materials for the pre-workshop component of the flipped learning model
    - Structure of the in-person workshop component.
    - Candidate model: Excellent professional development workshops for college and university geoscience instructors offered by the Cutting Edge program (http://serc.carleton.edu/NAGTWorkshops/index.html)
- Assessment of a Unidata flipped learning training workshop: how would we know if it's really worth the effort?

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