Perspectives on instructional methods from the ExCEEd Teaching Workshop

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ABSTRACT: A subset of the various instructional methods taught at the ExCEEd Teaching Workshop is discussed in this article along three broad categories: awareness, preparation and techniques. In a condensed fashion, each of the three authors offer their own perspectives on the various subheadings examined. A pair of measures were taken to avoid introducing bias, namely, that of the three authors; the first two were ExCEEd Teaching Workshop graduates, while the third had never participated in the programme. Also, to truly maintain unique perspectives, the authors formulated their responses without any prior discussions. Finally, each of these methods were independently ranked by the authors on a numbering scheme to quantify their collective perspectives as to what devices they deemed as being most essential in shaping sound teaching practices.

INTRODUCTION

A number of instructional methods are covered in the six-day intensive ExCEEd Teaching Workshop (ETW), where ExCEEd stands for *Ex*cellence in *C*ivil *E*ngineering *Ed*ucation), which, as indicated by the acronym, is specifically geared at formally educating civil engineering faculty to teach. While such an objective may seem ridiculous and redundant on the surface (ie why teach a teacher to teach?), there is merit to offering a specialised workshop to faculty who were, in all likelihood, never *taught* how to teach prior to their entering the field of higher education as instructors.

In this vein, the authors hope to achieve two main objectives through this article:

- To extend to the international reading audience a highlight of the major teaching devices discussed during the ETW since many educators may not have the opportunity to attend themselves;
- To offer individual perspectives, by each author regarding the efficacy of employing such measures in the classroom.

Introductions of the authors are thus in order. David Boyajian (DB) has taught at West Virginia University (WVU) and now at the University of North Carolina at Charlotte (UNCC) for four years; he has also tutored students in Science, Mathematics and Engineering (SME) related subjects for 10 years, and worked as a substitute teacher in the Los Angeles Unified School District in California for two years. Shen-en Chen (SC) has taught at the University of Alabama at Birmingham (UAB) for six years and at UNCC for two years. David Weggel (DW) has taught in the capacity of instructor at Drexel University over a three-year period, as a teaching assistant at UT Austin for a year, as Assistant Professor of Architectural Engineering at Cal Poly San Luis Obispo for three years, and at UNCC as an Assistant Professor of Civil Engineering for five years. It is important to note that the following two measures were taken to minimise the possibility of introducing bias in the discussions that follow: to try and strike a balance in perspectives offered – of the three authors, DB and SC were former ETW fellows, while DW was not; and to collect individual responses to the instructional methods with no prior discussion among the authors.

Although it is not feasible to cover every instructional method discussed at the ETW in this article because of space limitations, the authors believe that they have selected 14 of the major points that are routinely covered. Also, the authors have taken the liberty of arranging these instructional methods in three overarching categories (although it should be noted that this is not how they are grouped or presented at ExCEEd): Awareness, Preparation and Techniques. Wherever an author is not aware of, or has not implemented, an instructional method during their classroom experiences, their response is *N/A*.

It should be noted that each ETW fellow is required to formally teach three mock-classes on a subject(s) of their choosing. The *classroom* in this case consists of a total of six people: their peers (three participating ETW fellows), an assistant mentor and an assigned senior mentor, all of whom play the role of students who are charged with the responsibility of offering critical feedback to the instructor at the end of each teaching session. The instructor is also required to assess his/her own personal strengths and areas upon which they believe they need improvement. These evaluations are facilitated by the use of *teaching assessment worksheets*, a sample of which is given in Figure 9 of ref. [1].

AWARENESS

As a first step towards achieving success as an educator, a teacher must be cognizant of his/her instructional strengths and weaknesses and, moreover, be attuned to his/her student's

aptitude for comprehension; therefore, having an awareness of what constitutes effective instruction in the classroom holds a place of foremost importance. The following is a list of the four areas discussed at the ETW that can heighten such an awareness:

- Various learning styles;
- Lowman's two-dimensional model of teaching;
- Body language;
- Communication and presentation skills.

Various Learning Styles

Although there are many different modes by which students assimilate information, if only two pairs of categories were to be considered; the *visual-verbal* and *inductive-deductive* styles might be most insightful from a general standpoint. Engineering students typically possess a greater bent towards visual-based learning, as attested by the many figures, tables and graphs that they necessarily encounter throughout the course of their instruction, whereas those majoring in the humanities are more inclined to grasp concepts descriptively through the media of speech and text. It is also argued that, while the natural process of learning in humans occurs *inductively*, ie observations are used to piece together specifics, the common practice of teaching – a *deductive* process that emphasises details before arriving at the *big picture* – on the other hand, may unwittingly be responsible for obscuring comprehension.

- DB: Was intuitively aware of learning differences, though at a superficial level; has always tried to adjust the speed of instruction, either by a slowing-down or a speeding-up in material-coverage, based on the needs of any one class;
- SC: Had observed the different learning styles of students and has tried to change pace based on their performance;
- DW: Is aware that students have different learning styles and tries to accommodate these variations as they become apparent; however, feels the common lackadaisical student attitudes towards learning, especially in a difficult class, is a far greater problem that needs to be solved first.

Lowman's Two-Dimensional Model of Teaching

Joseph Lowman proposed that effective teaching is based on an instructor's skill to create both of the following two dimensions:

1. Intellectual excitement;
2. Interpersonal rapport with students [2] (see also [3]).

With three rows descending in rank of *high*, *moderate*, *low* with regard to the first dimension and three columns ascending as *low*, *moderate*, *high* for the second dimension, Lowman formulated a 3 × 3 matrix to classify teachers in one of nine categories, ranging from the *inadequates* – those incapable of presenting material and motivating students – in position (row,column) = (low,low) = (3,1), to the *complete exemplars* – excellent for any student and situation – in (1,3).

- DB: N/A prior to attending ETW; following ETW, has made, and will continue to strive to make improvements in second dimension, ie interpersonal rapport with students; believes the intellectual excitement dimension imparted to students is relatively high by virtue of innate passion to teach;
- SC: N/A;
- DW: N/A.

Body Language

A great deal of information is actually being communicated continuously between teacher and students, and the amazing thing is that this is true even if a single word is not uttered between either party. Vital perceptions of others are formulated at the subconscious level based on things as subtle as the position of their shoulders, hands and feet; dress and overall appearance; facial and hand gestures; and, eye contact.

- DB: Had a vague idea about this unspoken language, but did not appreciate the extent of its influence prior to ETW;
- SC: Instead of facing the blackboard, has striven to maintain some degree of eye contact with students;
- DW: Has always believed body language during lecture is important. The professor should be relaxed, confident and possess a subdued dynamism to keep students engaged. Has always felt that an awareness of students' body language is important as well, since the instructor can tell when students are lost or overwhelmed by their facial expressions and their posture.

Communication and Presentation Skills

Good communication practices involve the following:

- Projection;
- Articulation;
- Varied volume;
- Varied speed;
- Varied pitch, tone and intonation.

Other suggestions to enhance a presentation include the use of drama, humour, music, spontaneity and continuity to avoid silent periods [4].

- DB: Even prior to attending ETW, has always attempted to talk with enough projection so that everyone in the classroom can hear; also tries to mix some humour into the lectures to keep the atmosphere light;
- SC: N/A prior to ETW; following ETW, tries to modulate voice to sound interesting; also tries to use humour;
- DW: Has been committed to keeping communication skills sharp, since they are immensely important. Faculty can completely master a subject, but if fundamental concepts cannot be effectively communicated (logically and clearly presented in a way that will foster student comprehension), then this mastery can be largely inconsequential.

PREPARATION

If faculty were to recall their own experiences as students, they would likely remember certain teachers who wasted class time on things such as flipping back and forth through the textbook in search of content, writing equations on the board that were full of errors, etc. This lack of preparation on the part of the instructor can quickly translate to a loss in their credibility as an authority on the subject matter, not to mention it engendering feelings of apathy, boredom and frustration among students. The likelihood of trying to redeem oneself after such a poor display is dubious. Three of the approaches presented at the ETW and considered herein are, namely:

- Learning students' names;
- Formulating learning objectives based on Bloom's taxonomy;
- Board notes.

These are devices that can be used to cultivate preparedness among educators and range in the amount of effort required, respectively, from low to moderate to high.

Learning Students' Names

To this day, the first author recalls with amazement how, during the start of his second calculus class meeting as a freshman held in a large auditorium with approximately 200 students, the professor, walking from one aisle to the next with roll sheet in hand, had managed to identify every person by name. As basic as it may seem, becoming familiar with students' names can leave an indelible impression upon them; this sort of preparation serves also to heighten the second dimension of Lowman's teaching model involving interpersonal rapport ([2][3]; see also previous section). For those who struggle with remembering names, a few suggestions made at the ETW included using assigned seating and/or name-plates or -tags and/or taking pictures of the students to help associate faces with names.

- DB: Never really thought of this as being so important until after attending ETW; now, the author makes a greater effort to address students by name, even when seeing them outside of class;
- SC: As a beginning faculty, had tried to learn students' names by devices such as assigned seating, this being prior to attendance of ETW; over time, however, with the intensifying workload, does not place as much emphasis to learn students' names;
- DW: Feels that learning students' names likely makes them feel more like an individual that receives a faculty's direct attention. Tries to remember as many names as possible in a limited time but for large classes, and depending on contact time, learning students' names may be impractical unless special measures are taken (ie require student name tags or the like).

Formulating Learning Objectives Based on Bloom's Taxonomy

Teachers who put forth the effort to carefully delineate their desired outcomes of students following instruction, reap benefits that range from having a roadmap for conducting classes and writing examinations, to assessing both student learning and the course itself, among others. Only a few learning objectives should be used for each class (≈1-5) as expressed in terms of measurable action verbs (see below) relative to Bloom's taxonomy [5-7]. Bloom's taxonomy consists of the following six categories of learning (a few descriptors are given beside each category parenthetically; sample action verbs are italicised):

- Knowledge (ie listing, reciting; *acquire, attend, choose, complete, define, state*);
- Comprehension (ie explaining, paraphrasing; *arrange, chart, distinguish, paraphrase*);
- Application (ie calculating, solving; *calculate, generalise, operate, show, solve*);
- Analysis (ie comparing, contrasting, classifying, modelling; *appraise, deduce, defend, structure*);
- Synthesis (ie creating, constructing, designing, proposing; *alter, design, document, modify, systemise*);
- Evaluation (ie judging, critiquing, justifying, assessing, recommending; *argue, decide, interpret, judge, justify, recommend, standardise, validate, optimise*).

The upper two levels – ie synthesis and evaluation – should ideally be addressed in every course in order to develop students' higher-order thinking skills, although such abilities are generally achieved in a somewhat building-block, sequential manner throughout the curriculum.

- DB: N/A prior to ETW; used during the mock-classes taught at the ETW where it was quickly discovered that objectives were perhaps being stated too ambitiously, as some were left unfulfilled at the end of the lecture period; following the ETW, discovered that device had always been implemented intuitively;
- SC: N/A prior to ETW; now uses Bloom's taxonomy by emphasising analytical ability over application;
- DW: N/A with regard to Bloom's taxonomy. However, learning objectives are outlined using independent techniques.

Board Notes

It is recommended that teachers prepare their lecture material onto a standard A4 sheet of paper that is subdivided in either four or six rectangular panels, each of which represents a single frame of space on a chalkboard where the lecture will be presented before the students. This gives the instructor a precise glimpse into the form of the content to be written on the board during a given class, and the extent to which detail may be included or omitted – referred to as the *irreducible minimum*. A sample board note from a Statics class on the subject of dry friction is given in ref. [7]. As contradictory as this may seem, an ultimate goal of using board notes is to liberate the teacher from having to rely on notes in the first place, by impressing upon them a style of lecturing that tends towards and originates from the irreducible minimum, and thereby weans them off of having to depend on such a paper crutch.

- DB: N/A prior to ETW; did prepare board notes during the mock-classes delivered at the ETW, and was pleasantly surprised to discover that the exercise of formerly preparing the content in this manner had become so firmly rooted in mind, that the use of notes were no longer necessary; unfortunately, the timing between the ETW and the beginning of the fall semester was too short to formally craft board notes in time for instruction – will have to revisit this at a later date;
- SC: N/A prior to ETW; following ETW, uses board notes extensively;
- DW: N/A with respect to board notes, as content for each individual blackboard panel during lecture is not used. (conventional notes are, however, used to assist during lectures most of the time).

TECHNIQUES

A resourceful professor once used something as ordinary as a box-shaped eraser to impart a lasting impression upon his students about the shape of a beam's cross section under flexure due to the Poisson effect. Teachers should use a number of means to positively impact students' learning

experience. Seven such techniques as presented at the ETW are discussed in this section: classroom assessment techniques, teaching assessment worksheets, questioning techniques, use of colours, use of props, models and multimedia, movement throughout classroom, and in-class exercises.

Classroom Assessment Techniques

Several methods were introduced during the ETW by which a teacher might get a sense for how much their students know and have learned. A few examples of these (see also [1][8]) include the *background knowledge probe* (to glean how much students know on a subject), *preconception check* (to discover what impressions students may have on a topic), *approximate analogy* (a stream-of-consciousness approach in which the student is asked to think of an analogy that closely resembles the subject under study), *muddiest point paper* (a technique where students state the one aspect of the lecture they had the most difficulty in comprehending), and the *minute paper* (to have students answer a couple of questions such as the most important thing they learned and what important question remains unanswered, all within a minute's time).

- DB: Had successfully used assessments prior to ETW;
- SC: N/A;
- DW: N/A, except for occasional in-class exercises, quizzes and tests.

Teaching Assessment Worksheets

It is not only important to assess what students know or have comprehended during lecture, but to also receive feedback from students and colleagues, and to honestly gauge one's own performance as well. Most colleges and universities already conduct routine teaching evaluations wherein students can anonymously rate their professor's performance. The University of North Carolina at Charlotte also requires all untenured faculty to be evaluated by their tenured peers on an annual basis. In Figure 9 of ref. [1], a sample teaching assessment worksheet is provided by which strengths and areas of improvement, along with a host of other criteria, can be recorded by anyone auditing the class. Following each mock-class at the ETW, *students* evaluated the *teacher's* performance using this device, and the teacher was also, simultaneously, required to candidly fill the form out on his/her own performance.

- DB: N/A;
- SC: N/A;
- DW: N/A.

Questioning Techniques

Several *real-time* assessment techniques as afforded by questioning were also discussed. These included the *volunteer* (wait for raised hand), *jump ball* (following question, ask *Anybody?*), *directed* (name an individual, then ask a question), and *default* (ask a question, pause briefly, then name an individual). A benefit of using the latter two approaches is that students are more prone to pay closer attention to the lecture when they know that they may be called on to offer an answer. Of these two, the default questioning technique operates at a higher level since students do not know prior to the question whether or not they will be called on to give an answer, and so everyone is more likely to pay attention to the question and think about an answer (the reader should also see [9]).

- DB: N/A prior to ETW; following ETW, has begun implementing some of these techniques, but will require a little more time to improve in this area;
- SC: N/A prior to ETW; now tries to prepare questions that help students think about the problems being discussed;
- DW: Uses questioning techniques in lecture and during office hours. If questions are carefully couched, students can be made to think and *guided* through the solution procedure; they can also be guided to make important linkages of concepts and to extend learned concepts to other applications.

Use of Colours

Five colours of chalk (or markers, pens, etc, depending on the type of media being used) – white, yellow, green, red and blue – are suggested for use when writing during the lecture. These can be used to distinguish between headings and set standards, eg forces in a statics class can be drawn in red.

- DB: Had always relied on colour, although is of the opinion that the use of five colours is excessive and makes the presentation appear *too busy*, thus rendering a potentially negative impact on the learners' experience;
- SC: N/A prior to ETW; now uses colour chalks for differentiating between various structural components and effects such as forces and displacements;
- DW: Has used colour on the board and feels, although overrated, can be somewhat effective in *conveying ideas in layers*. However, students must have the same multiple colours for their note-taking. Faculty should also consider that some students may be colour blind.

Use of Props, Models and Multimedia

The value of using a prop was already illustrated by the boxed-shape eraser example in the opening paragraph of this section. Some class topics are best illustrated by the use of models, eg when discussing wide-flanged steel beams, the undergraduate student may not comprehend what the 2D cross sectional view drawn in the shape of the letter *I* is supposed to represent, whereas this same concept can be instantly grasped if the instructor were to bring in a small model of such a beam. Moreover, the content of some lectures is best delivered by the use of a medley of media, eg when discussing the various bridge types (trusses, arches, suspension, cable-stayed, etc.), it may be most expeditious, advantageous and striking to use a tool such as *PowerPoint* where students could quickly gain a visual appreciation of each of the different varieties used in practice [10].

- DB: Had always used such tools, but feels that the instructor must be wary not to fall into certain traps, such as the *pitfall of automation* in the case of *PowerPoint*, for example, where whole lectures can be presented by a few clicks of a mouse-button at the expense of true learning as students either cannot keep up with the pace or do not have the opportunity to go through the actual development of concepts to appreciate and comprehend certain notations and subtleties as embedded, stepwise processes that are implemented, or just simply begin nodding off to sleep since such presentations are usually found to be rigid, prefabricated, passive and boring experiences;
- SC: Had always used some form of props, models and multimedia, for example, *PowerPoint* is used for introductory content;

- DW: With very careful planning, this has been used effectively in illustrating difficult concepts and can reduce the potential monotony of a class. However, all too often, impressive graphics and animations are at the expense of scientific/engineering substance. The mind, if exercised rigorously, is more powerful than graphics like a book is often better than the movie made from it.

Movement throughout the Classroom

Get out of your comfort zone was a frequent phrase of admonishment coming from senior ETW mentors and faculty. Moving around the classroom has a number of benefits and functions, although these may be of a more secondary nature. Both student and teacher get a fresh perspective in vantage point – this may heighten the awareness of the instructor, for example, if by moving to the back of the classroom, they discover that their handwriting is too small to be comfortably perceived at such a distance; from the student's point of view, a small change of position may be sufficient to elevate and/or maintain their attentiveness during a lecture. Furthermore, moving amid the aisles may serve as an ice-breaker in coaxing dialogue with students as they may, both, literally and psychologically, feel closer to the instructor. If it serves no other purpose, movement conveys a perception of self-assurance to students; one that imparts a sense of authority and ownership, and one that is overall emblematic of classroom presence.

- DB: N/A prior to ETW; following ETW, has tried to employ this technique, but with the recent arrival of the newest teaching tool on campus – the *smart lectern* – has discovered this device to have a counteracting effect by practically anchoring the instructor to one location, thereby restricting regular movement even more than before;
- SC: N/A prior to ETW; now frequently walks around the classroom during a lecture;
- DW: Has always made an effort to do this, since movement throughout the class probably makes the course feel more dynamic and keeps the students more focused and alert.

In-Class Exercises

It should not come as a tremendous surprise that when a professor skips over steps they believe students to be capable of filling outside of class, for no one to actually have taken that extra measure of due diligence in heeding such a prescription. Moreover, if a compulsory homework assignment is not prepared involving similar steps to ensure that students have a mastery over such assumed concepts, the resultant effect can culminate in an undermining of the instructor's noble intentions and efforts to teach. In-class exercises serve not only as a remedy in such cases, but have the added benefit of identifying areas of incomprehension among students there and then, during class time, and under the auspices and support of the instructor.

- DB: Have used in-class exercises from the very start;
- SC: Prior to ETW, had only 1-2 in-class exercises; now, uses 3-4 in-class exercises as a means of reviewing what was learned from previous lectures;
- DW: In-class exercises, where student participation is intensive, is regularly used and has been found useful for a number of reasons: it keeps students on their toes, more serious in class and more focused in general for fear of looking foolish in front of their peers; it allows students to learn from the common mistakes of other students; it gives the instructor a means to observe real-time a student's learning process.

CONCLUSIONS

Each author independently offered their perspectives on the various instructional methods taught at the ETW. To maintain an unbiased view of these techniques, viewpoints were gathered from a non-ETW faculty, together with those from graduates of the programme.

As a means of quantifying some of these perspectives, each author ranked the 14 points described on a scale of 0 - 3, where 0 = unimportant, 1 = of minimal importance, 2 = important, 3 = extremely important. After tallying the rankings, the most important matter found was *communication and presentation skills* (9); the following six rankings were: *in-class exercises*, *learning objectives* (8); *board notes*, *learning styles*, *questioning techniques* (7); *use of props, models and multimedia* (6); *body language* and *use of colour* (5); *learning students' names*, *classroom assessment techniques*, *teaching assessment worksheets* and *movement throughout the classroom* (4); and *Lowman's two-dimensional model of teaching* (3).

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