
AC 2012-3833: ADMINISTRATIVE ADVICE FROM COORDINATORS OF LARGE-ENROLLMENT FIRST-YEAR ENGINEERING COURSES WITH SIGNIFICANT ACTIVE-LEARNING COMPONENTS

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Administrative Advice from Coordinators of Large-Enrollment First Year Engineering Courses with Significant Active-Learning Components

Introduction

Course coordinators are often used to manage the logistics of instructing courses that enroll large numbers of engineering students. In this paper, four faculty members present advice based on their experiences as course coordinators for three first-year courses at Virginia Tech, which enrolls 1,400 – 1,600 freshman engineering students each year. The first course, Engineering Exploration (ENGE 1024), focuses on introductory engineering topics such as problem solving, ethics, graphing, hands-on design, programming with LabVIEW™, and contemporary issues like globalization and nanotechnology. The second course, Exploring the Digital Future (ENGE 1104), focuses on design and problem solving from an electrical and computer engineering and computer science perspective and MATLAB™ programming. The third course, Exploration of Engineering Design (ENGE 1114), focuses on design, graphics communication and solid modeling with Inventor™, and programming with MATLAB™. All freshmen are required to complete ENGE1024 with a C- or better. Students are required to pass either ENGE1104 or ENGE1114 with a C- or better depending upon their choice of major.

The number of students enrolled in each course ranges from 100-1600 per semester. The typical format for each course consists of one weekly 50-minute lecture in a large classroom (150-300 students) and one weekly 110-minute workshop in a small classroom (30-36 students). All three courses have elements of active learning in the form of small group discussions, problem-solving activities, and network-enabled polling and real-time collection/display of student-generated content in the large classroom settings. In the workshops, students are involved in hands-on engineering learning activities including design projects. In a given semester, the teaching team for each course has historically included up to 10 faculty, 17 graduate teaching assistants (GTAs), and 15 undergraduate graders.

Each course coordinator has 5+ years of experience in the role of coordinator. The paper will discuss tips in management of personnel, hiring and training of GTAs, mentorship and evaluation of GTAs, hiring and training of graders, course websites, common assignments, and the role of technology in and out of the classroom. In addition, the authors will share their experiences in creating course content, generating common tests, and determining the degree of autonomy faculty and GTAs can have.

This paper is designed to provide useful information to those who may be coordinating a common engineering course for the first time and to provide new ideas for those who are already course coordinators.

Background information for the three courses

ENGE 1024: All engineering freshmen at Virginia Tech are required to take the 2-credit “Engineering Exploration” during their first semester. In fact, this is the only common engineering course for undergraduates in the College of Engineering and typically enrolls

approximately 1,300 students in fall and 180 students in spring semesters. Two authors (Lo and Lohani) have served as the co-coordinators of this course since spring 2005 and have implemented a number of activities into ENGE1024 to make it learner-friendly, contemporary and research and assessment-driven^{1,2,3}. Several NSF grants under programs like the Department-Level Reform (DLR), Course, Curriculum and Laboratory Improvement (CCLI), Nanotechnology in Undergraduate Education in Engineering (NUE), and Creative IT facilitated the development and implementation of these activities. A number of publications have been brought out to document these activities^{4,5,6}. In addition, this course has also provided opportunities to doctoral students to conduct engineering education research^{7,8}. This course is a prerequisite for ENGE 1104 and ENGE 1114.

ENGE 1104: "Exploring the Digital Future" is a two-credit course that is coordinated by Walker and typically taken in the second semester of the first year. Enrollment during the on-sequence semester is approximately 300 students; enrollment during the off-sequence semester is approximately 100 students. In addition to weekly group activities, there is a semester team project and presentation involving appropriate technology topics. Although specifically designed for students leaning towards electrical engineering, computer engineering, or computer science, other majors often take this course. Approximately one-third of the course is an introduction to MATLAB™ programming. This is followed by appropriate material and workshops on topics such as computational modeling of Cochlear implants, implantable defibrillators, national electric power grid modeling with software, introduction to electronic components and circuits, and computer graphics programming.

ENGE 1114: "Exploration of Engineering Design" is also a two-credit first-year, second semester course and is coordinated by Knott. It is required for students intending to major in aerospace engineering, mechanical engineering, or ocean engineering, and is accepted by the other engineering programs except computer engineering and electrical engineering. Enrollment during the on-sequence semester is approximately 1000 students; enrollment during the off-sequence semester is approximately 200 students. ENGE 1114 is organized into three modules, Engineering Design, Graphics Communication, and Programming and Algorithm Development, each lasting one-third of the semester. Unlike ENGE 1024 and ENGE 1104, a team teaching model is used in ENGE 1114 during the on-sequence semester. Depending on the number of faculty assigned to the course, one or two faculty members are assigned as the module leader(s) for each module. The module leaders prepare the materials for both lecture and workshop during the module and deliver the lectures.

Personnel Roles

In the on-sequence semester the teaching team for one of these first-year common courses may include up to 10 faculty, 17 graduate teaching assistants (GTAs), and 15 undergraduate graders. One or two of the faculty serve as course coordinator(s). In ENGE 1024 and ENGE 1104, the course coordinators have primary responsibility for course content, including lecture materials, workshop materials, assignments, project, tests, and exams, in addition to administrative issues such as website and personnel management. Each faculty member assigned to the course teaches one or more of the lectures for the entire semester. In ENGE 1114, the coordination role is split between the course coordinator and the module leaders. A module leader is responsible for the

course content in one of the three modules. The faculty member serving as module leader will also teach one or more lecture sections for the duration of the module. The course coordinator assists the module leader for each of the three modules with the course content and materials and oversees the administrative issues for the entire semester. Additional faculty may be assigned to teach a lecture section of the course for the entire semester.

In all three courses, a GTA is assigned to lead the coordination of workshop activities for the entire semester. The lead GTA helps prepare the other GTAs to lead workshop, helps prepare materials for workshop, and serves as a liaison between the GTAs and the faculty.

Undergraduates are hired as homework graders for ENGE 1024 and ENGE 1114. A lead grader may be appointed to help prepare homework solutions and grading instructions for the other graders. The titles of lead GTA and lead grader are valued by the appointees.

Logistics for hiring personnel

One of the biggest issues regarding the hiring of personnel is knowing how many GTAs and graders to hire. We recommend you try to hire enough of each to have coverage for one more section of the course than will be offered. This way if someone has to back out at the “last minute,” you will not have to scramble as badly to find a replacement. Remember to employ enough GTAs and graders to fill the inevitable, unscheduled gaps due to illness, travel, etc.

Be aware of your university’s hiring practices and deadlines. Note that GTA hiring cycles may not coincide with GRA hiring cycles. Work with the department administration to establish policies for when teaching assignments will be made (e.g., a deadline for when graduate student funding must be decided) and policies for what has to happen for a change in funding to be made after the deadline. This may involve a higher level of cooperation and interface among faculty in various departments.

Remember that hiring undergraduate students can sometimes take time because non-local students do not necessarily have the original forms of identification needed for employment with them. Consider the possibility of hiring federal work study (FWS) students and working with your financial aid office to advertise in appropriate venues; be aware of deadlines for FWS students.

During the interview process, develop a standardized interview format and questions and ensure that course coordinators are available to attend the interviews. Be wary of inflated resumes – if you are looking for a skill set that can be quickly assessed, such as a programming language or computational proficiencies, consider using some kind of written assessment tool. Make sure that those hired to lead a class have excellent communication skills. This can be easily assessed by having potential GTAs give a 5 minute lesson to you on topics of their choosing. As you explain the job responsibilities to potential hires, make sure the applicants are fully aware of the work hours that are expected. Be realistic; expecting a full-time graduate student to take on an additional half-time job is not realistic. It is important to try to determine the candidate’s academic priorities and interests. A graduate student who is in the beginning of his/her graduate course process typically has a heavy course load, which may impact his/her ability to handle a full GTA teaching load. Those at the end of their degree process are often trying to wrap-up

their research/thesis and looking for employment (requiring multiple absences due to travel), which may skew their performance.

As you are deciding whom to hire, choose GTAs with good people skills and good listening abilities, in addition to excellent command of the language in which they will be teaching. Consider hiring GTAs who may want to use curriculum development work towards their PhD dissertations and have interest in publishing in engineering education conferences/journals. When selecting a lead GTA, identify a GTA who can communicate the concerns of his/her fellow GTAs frankly with the faculty coordinators as the lead GTA serves as the link between the faculty members and the GTA group.

Try to hold on tightly to the experienced successful personnel hired for previous semesters. This is difficult with our model where course enrollment varies significantly between the fall and spring semesters.

Management of personnel

Since responsibilities for large enrollment courses can be time-consuming and numerous, consider having multiple coordinators for a course. With multiple coordinators, responsibilities can be divided; additionally, there is the added benefit of multiple viewpoints.

In order to increase efficiency, when a course has multiple lectures that break into smaller workshops, attempt to schedule GTAs to lead workshops that all have the same lecture. This will reduce the number of faculty that each GTA needs to interact with as well as lessen the impact of possible inconsistencies in messages relayed by different lecture faculty members. Likewise, pair GTAs and graders as much as possible – have one grader grade student work for all students in a GTA's workshops.

To ensure that personnel have an ongoing understanding of their responsibilities, we recommend that you conduct common weekly meetings throughout the semester, with mandatory attendance. Hold meetings with graders to review assignments that cover concepts where you know students often have misconceptions. Chances are at least some of your graders still have these same misconceptions.

When a GTA or grader asks a question about policy or grading, be liberal in sharing your response with all in that position. Chances are there are others with the same question. This will help with consistency. If possible, use a forum or discussion board that has an email alert for policy and grading questions. This way the response is archived in a location that all have access to, and those who prefer to receive the message via email have this option. The importance of maintaining a level playing field with respect to grading, grading policies, and timely grade posting must be stressed.

Implement a standard policy for GTA and grader substitutes to be followed in the case of both emergent and predictable absences. Additionally, you should monitor grading on a weekly basis. If someone is falling behind with grading, address the issue immediately.

Most importantly, ensure that communication links with faculty members and GTAs are available and that faculty members, GTAs, and the course coordinators are responsive to communications; cell phone numbers should be shared in case of classroom emergencies. GTAs and graders need to feel that they can get help whenever needed.

Mentoring and evaluation of teaching assistants

Having graduate teaching assistants involved in instruction provides unique and valuable experiences for the entire teaching team. As a coordinator, encourage GTAs/faculty to go beyond the normal teaching experience by discussing educational research and possibly conducting an educational research study.

Try to have weekly routines for GTAs to follow. In order to help prepare GTAs for their upcoming teaching experiences, run the weekly “training meeting” as a workshop; have the GTAs do what you want the students to do. It is important to conduct short surveys or receive feedback from GTAs to determine things that worked well or did not work well in workshops. This gets them in the habit of reflecting on their teaching and provides the coordinator quick feedback. Also, provide opportunities to all GTAs through anonymous surveys to express their concerns regarding course (lecture and workshop) activities.

In general, most GTAs want to teach well and learn technology-driven pedagogies. Most GTAs appear to appreciate praise and constructive criticism of their teaching abilities. As coordinator, it is important to provide evaluation of your GTAs’ performance. Set up a schedule for classroom visits at the beginning of term. The course coordinator(s) should share the responsibility to attend class periods of any newly hired GTA to observe and assist for, at least, the first half of the semester or until the new GTA has demonstrated his/her ability to function individually. If GTAs have other responsibilities such as grading, website management, etc., try to review these aspects so that they can be included as part of their evaluation. New GTAs should receive timely feedback in individual meetings with course coordinators with regards to their instructional skills and related performance. These meetings should be documented; if corrective action is required on the part of the GTA, this should be noted and the GTA should signify, in writing, that he/she has been formally notified and that he/she understands the required improvements. A formal, one-page evaluation of each GTA should be provided to his/her home department. Student teaching evaluations should be administered and evaluated on a mid- and end of semester basis. If GTAs desire more feedback from students, have them consider doing minute papers in class throughout the term. Finally, treat GTAs as colleagues, not forced labor.

Curriculum development

As coordinators, we have set ‘continuous improvement’ as an important goal for our courses and will recommend you the same. As much as possible, the content presentation should require a problem-based, hands-on, collaborative approach to learning without downplaying individual student responsibility. The course delivery and content should reasonably reflect the high-tech nature of the engineering profession. Classroom discussion of contemporary engineering issues and technologies should be encouraged to improve communication skills.

Faculty members should be encouraged to contribute ideas for improving course delivery and content. Let them know up front what lead times are expected for incorporation of new materials. In order to facilitate this, consider a modular course structure to allow for new and different course materials to be piloted in one semester and, assuming successful piloting, delivered to all sections of the course in the next semester. Pilot this new material in an “off” semester if possible.

GTAs often have fresh, contemporary ideas for course material. Encourage GTAs (individually or in teams) to explore innovative curriculum development ideas and to develop a workshop or activity for the course. You may find that a GTA needs to do a project involving curriculum development for his/her graduate-level course. Provide constructive feedback; the amount of guidance you will need to provide depends on the familiarity of the GTA with the course, and the latitude you are willing to allow with respect to changes in the course. You will probably need to be specific about the desired objectives/learning outcomes for the activity. Encourage them to publish their curriculum development work in engineering education conferences and journals, and provide GTAs with funding support for procuring various supplies needed for curriculum development. Use examples of prior GTAs who successfully developed activities and give appropriate credit to the GTAs by including their names on documents that describe the new curriculum modules.

Note that “service learning” is possible with a large class, but requires significant support. Check to see how existing programs at your institution might be willing to help with organization (e.g. identifying appropriate community partners and soliciting projects, connecting student teams with community partners)^{9,10,11}.

While challenges exist with developing curriculum for large enrollment classes, try to view curriculum development as an exciting opportunity to affect a large number of future engineers. Particularly, this offers an exciting opportunity to graduate students who want to become a faculty member.

Common assignments/tests

We elect to use common assignments and tests in order to create a sense of uniformity for all enrollees. This also allows to us to assess students across sections using the same metrics. There are various models that can be employed to generate common assignments and tests.

Common homework also has a number of implications, one of which is that any error will be magnified due to the sheer number of students accessing the homework. For all material, proof read – proof read – proof read. Have someone else on the instructional team (a lead GTA, a lead grader, or a faculty member) work the homework problems before assigning them.

Assessments given during workshops should be drawn from a large pool of questions that are maintained and updated across semesters. To reduce cheating, those questions should be randomly administered by a course management system in class.

All three of our courses administer common tests. We accomplish this by requiring students to register for a specific “free-time” to ensure they are available during the common test time. Reserving rooms that meet your test environment criteria should be done at the beginning of the term. Room sizes and number of students per room will influence the number of proctors you will require for the tests.

Encourage GTAs and faculty to submit test questions. Consider having test development teams that propose questions with the final test content controlled by the course coordinators. We use a separate “private” course management site to share common test materials, so that drafts can be easily accessed and reviewed by all faculty involved.

Because common tests may be given to a large population at one time, split into multiple rooms, there is generally no opportunity for whimsical changes during the testing time. Therefore, it’s important to make the test as bulletproof as possible. In general, we have found that for a 20 MC question, 1 workout question test, it takes at least 1.5 hours to review a first draft of the test and at least 7 iterations to finalize the test with a teaching team of 8 faculty members. The amount of time it takes for a majority of students to complete a test is also important. Have GTAs who were not involved in creating the test take it to make sure timing is adequate.

One of the challenges of a large common course is trying to maintain fairness across all sections. Departmental test “reviews” and any developed “study guides” must be strictly controlled to prevent prejudicial test preparation between sections. One solution is to have one common-time review session which is jointly presented and administered by all faculty members/GTAs or only presented and administered by the coordinators. Also, individual test grades should not be curved – the only “curving”, if at all necessary, should be done with final course grades. For the same reason, there should be no individual “extra credit” work to make up for a student’s poor test performance.

Management of supplies

For courses with large hands-on lab components, supplies will need to be coordinated. We conduct a number of workshop activities that require a variety of reusable and consumable supplies. In order to facilitate the management of materials, generate a budget and timeline for ordering and assembling supplies. Budgetary resources for equipment repair and replacement must be allocated.

Given that the workshops may use a great deal of material that must be shared throughout the week, there must be appropriate personnel resources to manage and coordinate that material along with appropriate preparation and storage space.

Take steps to minimize the impact of “scalability” on what can be done in a workshop – that is, just because the required materials are inexpensive and easy to coordinate does not mean that the workshop experience is valid – that is a “tail-wagging-dog” scenario that strikes us too often with large enrollment courses.

Role of technology inside the classroom

We have tried to make sure that the latest technology is used appropriately in our course instruction. We feel that students and faculty members absolutely must have broadband access inside the “classroom”, anything less is analogous to a library without books. However, use of technology comes with its own set of issues.

These are engineering “classrooms,” “technology” should be immersed throughout – in course delivery and management as well as content. Technology should be used in the classroom to enhance student learning. Student computers should be used actively to encourage student participation and contribution; be careful not to design presentations to “force” computer use. Do not fall into the trap of disallowing student computer use in the classroom to discourage “digital day dreaming”. If it is not computers, it will be smart phones or tablets. Ensure that classroom presentations/activities make use of the technology ubiquitously so that student “digital day dreaming” is discouraged rather than legislatively controlled. During GTA and faculty training, provide examples and articles on use of technology for developing a feedback-based learning environment in classrooms.

Inevitably there will be problems when using technology in the classrooms. Find university personnel who can help with technology issues and have them attend meetings so everyone is familiar with support personnel. When using software that allows polling and display of student work interactively during class, have a GTA take the role of a student so they can monitor and report difficulties such as poor image transmission or slow transmission times. Have a backup plan when trying something new like giving an electronic quiz through the course management system during class time. Specifically in the area of technology, our students can be a major asset because it is pervasive in their lives and they often know applications and procedures that faculty members are not aware of. Therefore, encourage the free interchange of this kind of information. This is one area where faculty members cannot expect to be the all-knowing experts.

Create an environment that allows faculty to use the technology that they feel comfortable without sending conflicting messages to students. For example, if a particular operating system and hardware specification is required of the students, faculty need to use the same in their instructional role. Unless you are willing to spend additional resources on technology and technology support personnel, student-owned technology such as laptop computers should meet a very specific, narrow standard. Incompatibility and maintenance issues have potential to interfere with course delivery and administration.

Collect exit survey data from students to demonstrate effectiveness of technology in enhancing classroom learning environment; use this information to inform future teaching experiences. Encourage faculty/GTAs to publish their technology-related experiences.

Role of technology outside the classroom

Try to use technology such as PowerPoint or Camtasia™ to deliver content that would normally be “lectured” asynchronously outside of the physical classroom and then use technology during

the face-to-face time to utilize/assess that information. Do not fall into the trap of repeating that information; students will learn quickly that they have to prepare for meeting times. In order to keep your students' attention, keep the length of "presentations" delivered outside of class through technology to 20 minutes or less. Or, consider using the technology to actually reduce the number of in-classroom meeting times and to possibly reduce the need for a large classroom. However, do not fall into the trap of using the technology to load more content into the course.

A reliable, user-friendly course management system is indispensable when delivering a large enrollment course. In our courses, we use a Sakai-based course management system to deliver assignments, quizzes, etc. electronically to our students. The organization of course sites is dependent on the course management system in use at your institution.

In ENGE 1024, we have one common site that has all common assignments, copies of old tests, and general announcements. We also collect common weekly HW through the site. GTAs are responsible for workshop websites (one per section), which allows them the freedom to customize content for their sections. We use two internal private sites to distribute materials (one for faculty/GTAs for dissemination of lecture and workshop teaching materials and agendas, and a second for graders to share rubrics and solutions of weekly assignments).

In ENGE 1104 and 1114, we create a course site for each large lecture which includes 6-8 workshop sections. The lecture faculty has access to materials for all sections and grades for all students in the site. GTAs are given access to materials that are available to their students and to their students' grades. Graders are given access to the assignments for students in the section they grade. Material posted on the course site can be available to students in all sections, or to students in specific sections. When material is made accessible to specific sections, the GTAs have the ability to change the availability of the material to students in their workshops. The benefits of this organizational structure are: (i) students access a single course site for all course materials, (ii) the faculty member of each lecture only needs access to one site for each lecture he/she teaches and can post lecture specific materials to all students in his/her lecture on one site, and (iii) the lecture faculty member can see grades for all student in his/her lecture on a single site and can help verify that graders and GTAs are keeping up with grading assignments. The downside of the organization is that materials (i.e., homework assignments and lecture/workshop material) must be posted multiple times, once to each lecture site. An internal private site is also used to share/distribute materials to members of the instructional team.

Autonomy of faculty/GTAs

An inherent characteristic of common courses is the lack of "ownership" and "autonomy" by the faculty/GTAs. While most material must be common in this model, as briefly mentioned earlier, it is critical to give personnel opportunities for individual expression.

While it is helpful to provide presentation slides and grading rubrics to GTAs/faculty to ensure basic common coverage across various sections of the course, do not force the GTAs/faculty to be talking heads by requiring that everyone use the exact same slides. Discuss prepared presentation slides with faculty/GTAs at weekly meetings. Keep an open mind. Encourage comments and incorporate good suggestions. Make sure the topic objectives are clearly stated to

all faculty/GTAs so they know what is expected for that material. Identify key points that must be communicated and activities that must be done for each workshop. While instructional support materials are provided for the activities as planned, allow GTAs/faculty to modify the presentation as long as the key points are not lost. Make sure that the GTAs/faculty are knowledgeable enough to prepare their own material from the text/preparatory meetings and encourage them to put their “spin” on it and to talk about their expertise in the classroom. If material can be generalized across sections, encourage faculty/GTAs to share materials.

One model that you can consider is a team teaching approach, where each faculty is responsible for a module, keeps the faculty engaged, at least during the module, but does allow the faculty member to “check out” before and after their module.

Encourage GTAs/faculty to share specialized knowledge, tips, links, and procedures – provide them with both virtual and physical space where this is facilitated.

Summary

Coordination of large enrollment courses is a challenging activity and consumes a significant amount of time. However, coordination activities present an opportunity to develop people skills, receive and learn from diverse feedback on course content and pedagogies, develop systems to ensure efficient use of resources and engage in curriculum enhancement activities informed by educational research. The coordinator has the important task of ensuring that things are well managed for the entire teaching team. Getting buy-in from the members of the teaching team and making people feel valued are helpful for effective coordination. In general, people on the instructional team are interested in student learning and making sure that students have a positive experience. As coordinator, do not be afraid to ask others on the teaching team for help and take advantage of your university’s resources. Finally, while the authors have enjoyed the course coordination work discussed in this paper, we do not recommend the course coordination work to a faculty member who has yet to earn tenure assuming he/she is holding a tenure track position.

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