Abstract

Learning community (LC) concepts were introduced to the Engineering Diploma program at NSAC during the past two years specifically in the first semester that the students are on campus. The approach allows faculty to integrate the course content of four courses through the medium of a design project which is assigned to teams of students. Emphasis is placed on scientific communication and the ability to work in teams towards a common goal, both being attributes which are deemed to be important by the engineering profession. Students are graded on this linked project for a contribution to the final grade in each of the participating courses. There is currently insufficient data to reliably judge the effect of this approach, but anecdotal evidence from the students indicates that it is popular and does contribute to the students’ overall understanding and abilities.

Introduction

This paper is actually the continuation of a paper and presentation (Pearson, 2002) given at the 2002 AAU Teaching Showcase. In that account a case was made for integrating in some way the various required courses in the first semester of an undergraduate Engineering degree. It was argued that integration of course material and some associated group study would lead engineering students to be more "team oriented" in their work and their thinking. Leadership skills and an Engineering mindset (product development, marketing, ethics) might also be imparted if the curriculum could focus on a typical design problem and the students could bring all their course work into its solution. The concepts italicized above are the qualities most often designated as important educational outcomes by the Engineering profession. Including activities which would teach these skills in the Engineering curriculum would hopefully lead to positive results in terms of such indicators as: improved engineering skills, student success rates, employability, and new applicant rates.
The "Next Steps" as Noted in 2002

In 2002 the "Learning Community for Engineering" was pioneered once at Nova Scotia Agricultural College, and it was admittedly a somewhat cautious step consisting of designating a common tutorial for three of the fall semester courses: calculus, physics, and engineering graphics and design. These tutorials were lead by one instructor, but attended by all three, which facilitated an integration of ideas with respect to the subject of the tutorial. The 2002 paper ended with a list of the measures which we would like to incorporate into the Learning Community in order to improve and advance the experience for our students. That list was:

1. Linked courses and common tutorials.

2. A focusing project which will continue through the semester and will use concepts of increasing complexity from each of the linked courses. One possibility is to redesign the bicycle by applying linked mathematics, physics, chemistry, and engineering design ideas.

3. A professional practice/leadership module in which the students will be introduced to Engineering as a vocation during their first semester of study.

4. “Studio classrooms” where traditional lecture and laboratory facilities are merged into one room and the concept of lecture and lab being separate is dropped.

5. Designated space within the residence halls for the Engineering Community.

It is gratifying now to realize that four of these "next steps" have been implemented with the only item not achieved being the designated space within the residence halls. Indeed there is a possibility that this is being done in an informal way as Engineering students seem to have an innate ability to "find each other," especially when assignments are due.

The "Next Steps" as Practiced in 2003

The Fall semester in 2003 brought 29 first year Engineering students to the Associated University Engineering Diploma Program at NSAC. This coincided with a change in the Chemistry curriculum and organization, which prevented Chemistry from taking part in the course linkages for that semester. The instructors of the courses in Physics, Calculus, and Graphics and Design built upon the common tutorial concept, which had been successful previously, by adding a design problem to the overall requirements and allotting partial credit value in each of the three courses for aspects of its completion. In fact a design problem and its solution had always been a requirement in the Graphics and Design course but the linkage added
the further dimension of the immediate use of mathematical and physical concepts to assist in the design process.

A colleague in the Department of Environmental Sciences had suggested sometime earlier that a request from the golfing industry might provide a useful and challenging student project for a purpose such as this. He had been approached for advice regarding the design and construction of putting greens at which time the matter of how to actually test the greens and their characteristics was raised. Apparently there were no devices available to the golfing industry, which could reliably and repeatedly simulate the impact of a golf ball on a green, and therefore no reliable testing device. We had our design problem!

Initially the teaching team researched the current situation regarding designs of golf green testing equipment from which we selected three papers from the literature to present to the students. We also arranged for a presentation by a colleague to address the matter of golf green construction, and for a second presentation by an engineering design firm which had been involved in a project to produce a launching device for soccer balls (an automated kicking machine). A focusing experiment concerning the nature of real trajectories and several working tutorial periods were then built into the plan for the Fall semester.

The focusing activity bridged the gap from the standard idealized analysis of a gravitational projectile to the real situation of a golf ball actually flying through the air and landing on a green. Students were arranged into design teams, which were set for the entire semester and in the first week a set of observations were made on the characteristics of the flight of a golf ball under whatever conditions were available to the students. It was interesting, and somewhat entertaining to see groups of Engineering students on the campus lawns following the flight of golf balls and trying to control and set the various parameters which were available to them. The matter of how to do this and what observations and measurements they should make was left entirely up to the design teams at this stage. Following this exercise two of the tutorial classes were used by the calculus and physics professors, with input from Engineering, to help the student teams to analyze their observations and become familiar with the concept of building a mathematical model which will approximate a real situation. This is no easy task especially when one considers that this is being done with a group of first year, first semester students. The results were perhaps not as successful as we had hoped but there was at least an appreciation on the part of the students as to the difficulties faced by researchers and designers who would tackle this type of problem.

Armed with this realization the students then were introduced to the issues involved in golf green design and construction and the intricacies of the design concepts and parameters of a device which could launch soccer balls in a predictable and repeatable way. All along it was our hope and conviction that the student design teams were each working towards the goal of designing their own device for the testing of golf greens. A series of built-in deadlines for various aspects of the process had been established by the Engineering instructor and we found out through these that most, but not all, teams were adequately engaged. The next three tutorial sessions were used to delve into the previous work on such devices as exemplified by the three papers, which the
teaching team had previously selected. Student groups worked through the mathematics, graphs, tables, and explanations in the papers and professors acted as consultants and devil’s advocates during the process. It was not easy for students to adequately read and understand legitimate scientific writing at this stage of their education but we were pleasantly surprised with the outcomes of this process and by the possibility that students would build some of these results and ideas into their final design and analysis.

At this stage there were four linked tutorial classes left which had been designated as working sessions for the student teams and consulting sessions for the faculty. Obviously these were woefully inadequate for the purpose of generating a final design and all the required documentation that goes with it. The students apparently knew this and seemed to be up to the task of organizing their time in such a way as to ensure that the deadlines were met and final reports and presentations would be done as requested. There was also the opportunity to get advice and input on the form of their presentations and the logic and analysis, which had been incorporated into their designs.

During this time the Engineering and Design deadlines had been met by all design groups and project presentations were scheduled to take place for an entire afternoon in the last week of classes. It was perhaps only at this point that we realized the wide disparity that existed in the quality and presentation of the designs from group to group. One group absolutely stood out from the rest with respect to the overall design, quality of drawings, uniqueness of concept, and the sheer professionalism of their presentation. However they were very weak on the analytical/mathematical side, which apparently was the forte of another of the design teams. One group had a design, which was obviously flawed to the point of being unworkable, but they continued to defend it. The variety of the solutions to this problem was gratifying and the degree to which friendly competition and rivalry had surfaced indicated to us that these people had gained some insight as to what the life of a professional engineer might be like.

The "Next Steps" as Practiced in 2004

Much discussion, analysis, and debate followed our attempts in 2003 as we decided how to proceed with the next iteration of the integrated first semester of Engineering. It was apparent to all the instructors that we had a work in progress which certainly showed potential but which would need much more in the way of development. The instructors of the three courses involved in 2003 wished to continue with the development of the integrated program and were joined by the instructor of the Chemistry course to design the program for 2004. This meant that only the English course was not involved in the integrated programming, and we hope that it will also be part of the program in future years. An initial meeting of all instructors was used to review the successes and failures of the previous attempts, and a list of priorities for 2004 was drawn up. Amongst the important requirements which issued from that meeting were:

- Mandatory meeting once per week for all four faculty members involved (this was set at every Monday over lunch).
• Emphasis on scientific/engineering communication including literature searching and comprehension of ideas.

• Each design team would be assigned a faculty advisor from the integrated program team. These instructors were not experts in the chosen design problem, but would use their discipline expertise to mentor the design teams.

• A detailed schedule of deadlines for the integrated tutorial and the overall design process must be made available to the students at the beginning of the semester.

• The research interests and capabilities of the Department of Engineering would be utilized to the greatest extent possible to enhance the integrated program.

• The integrated tutorial would be in addition to any other scheduled tutorial and therefore would not encroach on the time available to any one course.

• Field trips and practical experiences would be built into the program.

• Feedback to students would be more frequent and more immediate than was the case in 2003.

• Student design teams would be responsible for the input, participation, and attendance of the members of their group.

The initial design of the integrated program was done during July at which time we considered possible design projects and produced the presentation/assignment schedules which would be given to the students at the first meeting of the integrated tutorial. The expertise of the Department of Engineering was brought into the program by designating the design project as a constructed wetland which would be receiving agricultural or industrial waste water. Several faculty members with research interests in this area offered input to the tutorials and the assistance of their graduate students. Also two experimental constructed wetlands are in operation on the NSAC campus which provided a further opportunity to familiarize the students with this type of operation.

Several tactics addressed the scientific communication component of the program. The instruction team initially investigated literature sources concerning the design of constructed wetlands and selected three, which would be presented to the students in successive weeks at the beginning of the semester. The literature sources included a “Fact Sheet” (Atlantic Committee on
Land and Engineering, 2001) for farmers on the use of wetland technology in their operation, a non-mathematical article (Kinsley and Crolla, 2001), and a mathematically–based design monograph (ASAE, 1999). To accompany this the teaching team generated a help sheet for students on successful strategies for reading and understanding scientific articles. During this time a slide-based presentation on the use of constructed wetlands for treatment of agricultural waste water was presented by a member of the research team currently investigating that topic. This was useful not only for its content, but also to model a “slide presentation” which the students would be doing themselves for several scheduled presentations.

Later in the semester one of the integrated tutorials was turned over to the Chief Librarian who presented a session on effective literature searches using constructed wetlands as the search topic. After this presentation it was expected that the design groups would be making full use of the Library resources and would incorporate literature searches into their investigations. Progress reports were required of each of the design groups at approximately 3-week intervals and feedback from the teaching team was provided for each of these including comments and criticism on the effectiveness of the presentation, be it written or oral. In the third week of November a seminar on the methodology of technical/scientific writing was provided by a member of our Department of Business and Social Sciences. It was expected that the content of this session would be incorporated into the final presentations and the submitted reports at the end of the semester.

At about the halfway point of the integrated project two field trips were undertaken by the class, one to the operating constructed wetlands at the Bio-environmental Engineering Centre of NSAC and also to the waste water treatment facility of Kimberly-Clark at Abercrombie Point. As the following pictures show, these trips were taken very seriously by the students because they were currently in the process of designing a similar facility, even though they were in just the first semester of their studies.
First Semester Undergraduate Engineering Students and Integrated Learning

After our second full semester of using this approach to Engineering education it is obvious that much has been gained through the learning situation for both students and faculty. The students have been exposed to research and engineering methodology which formally would not have been seen until the upper years of the first degree, and the faculty have discovered the huge potential of finding out what their colleagues are up to, not just in research but in course design and presentation. We have come a long way since the first tentative steps into integrated programming two years ago, and clearly we have some more territory yet to cover before the goal of truly blended and relevant courses is reached.

The students gained much from this approach and the emphasis on scientific communication certainly was realized in tangible improvements in the presentations and reports, which were received. As with any system involving collaborative learning there were groups which worked well, and others not so well. Much was achieved in terms of teamwork and organizational skills, both being characteristics of the practicing engineer which are valued by the profession.

The goal of impressing upon the students the inherent inter-connectedness of the fundamental sciences and engineering design also appeared to be well served by this strategy. Reports based on the integrated design project were required for the Graphics and Design course and for the Calculus course, with a considerable portion of the overall course grade being derived in this way. There were also optional tasks available in the Chemistry and Physics courses which were completed by about half of the engineering students utilizing the results of their integrated project. Overall it was felt by the instructional team that the quality of all work was improved over the 2003 version and that student understanding of an integrated system and how to analyse the processes of such a system was well served by this approach.

An exit interview was conducted with the students in this year’s course, which confirmed that they were very much in favour of the approach even though they were concerned initially about the amount of extra work which might be involved. There appeared to be agreement that the
benefits of the integrated courses outweighed the workload fears. There was a suggestion that the integrated design project and its concomitant requirements in all four of the courses be designated as a sixth full credit course in the fall semester. Among other suggestions received from the students were:

- Make the integrated projects in Chemistry and Physics mandatory rather than optional.
- Double the number of classes in scientific writing and place them earlier in the program.
- Extend the design project through the whole first year with further requirements such as detailed design drawings and scale models.
- For next year use a real-life problem from the community or possibly from the third world to address a specific need.

The Next Steps?

Integrated programming and the Learning Community concept of undergraduate education has now become a feature of the first semester of the Engineering program at NSAC. It has been approved by the Engineering Department and will be used as part of the recruitment information on the Diploma program. In addition the Learning Community approach is being evaluated for possible implementation in other degree and technical courses at NSAC.

Statistical evidence of the effect of integrated courses on the various indicators of successful academic programs is difficult to obtain reliably, and certainly is not adequate when applied to just two iterations. Evidence available from other experimental programs of this nature (Pendergrass, 2000) indicates that learning and general experiences are more beneficial when presented in this type of academic environment rather than in the traditional insular course-by-course mode.

References


Atlantic Committee on Land and Engineering. Constructed Wetlands for the Treatment of Agricultural Wastewater in Atlantic Canada. 2001.
