

Application of Team Teaching Concepts in an Integrated Science and Technology Program

O. Geoffrey Egekwu[#], Prince N. Anyalebechi^{*}

[#]College of Integrated Science & Technology
James Madison University

^{*}Padnos School of Engineering
Grand Valley State University

Abstract

A unique baccalaureate degree program called *Integrated Science and Technology* (ISAT) was developed at James Madison University in the early 1990's in response to industry need for university graduates with a broad knowledge of science and technology and excellent analytical and problem-solving skills. The goal was to produce university graduates with the ability to manage a broad range of technologies and solve science, technology and engineering related problems. A second important goal was to attract and retain students, including minorities, who ordinarily would not have selected an engineering program. Accomplishing both goals from a pedagogical viewpoint required a paradigm shift in the way science and engineering courses are traditionally taught in universities. It required the design of interdisciplinary courses with careful and deliberate integration of concepts from a broad range of disciplines of engineering science and technology. These courses were such that they involved more than one faculty and therefore required some form of team teaching. In this paper, we discuss some of the merits and demerits of the team teaching concepts that have been employed in some of the ISAT courses.

1. Introduction

The call for reform in the scholarship and teaching of science and technology has been part of the public debate on improving education in general, and in particular, in the effort to attract and retain engineering students. One of the common recommendations made by the early reformers is that the academy must make a conscious effort to prepare engineering students in the "overlapping neighborhoods" of engineering disciplines. [1] The danger, Boyer and others warned, is that "specialization, without broader perspective, risks pedantry". He further argued that "no human capacity is great enough to permit a vision of the world as simple, but if the educator does not aim at the vision (of interdisciplinary education) no one else will." A lot of universities responded to this call by developing and

offering multidisciplinary courses and programs - which some even labeled, interdisciplinary.

James Madison University and the state of Virginia started a unique baccalaureate degree program in the fall of 1993 that focused on the meaning of interdisciplinary education - the emphasis was on integration of knowledge at the course-content level. [2, 3, 4] Aptly named Integrated Science and Technology (ISAT); the program is an integration of the study of science, mathematics, technology, engineering principles, and information and knowledge management. The goal of the program is to produce graduates with excellent problem-solving and communication skills, and the technical sophistication to effectively deal with the potpourri of interdisciplinary and constantly changing science, technology, and management related problems in industry. Their knowledge of science, engineering, and business management will be sufficiently broad and deep as to enable them play a central role in solving scientific and technological problems in a wide range of industries. They will have an appreciation of economic, social, political, and legal constraints that affect decision-making in industry and real life. Thus, an ISAT graduate is expected to have the following characteristics [4]: (i) technological problem-solving skills; (ii) breadth of knowledge and skills across a variety of scientific and technological disciplines; (iii) excellent problem-solving, collaborative and leadership skills; (iv) ability to use the computer as a problem-solving tool; and (v) the ability to integrate scientific and technological factors with political, social, economic and ethical considerations in problem-solving techniques.

Through the sophomore year, the ISAT program requires students to take classes that emphasize the role of science and technology in society, discrete and continuous mathematics, information systems, knowledge-based systems, statistics, organizational behavior, chemistry, physics, biology, environmental science, engineering, manufacturing and instrumentation and measurement. [4,5] These courses are designed to provide the student with the fundamental knowledge of science and engineering principles and introductory knowledge to transition into the technology sectors in the junior and senior years. The goal of the program at the foundation-building years (freshman and sophomore) is to ensure that all the courses are integrated at the highest level possible – in terms of the breadth of disciplines. In the junior and senior years, students pursue deeper study in eight strategic sectors, namely biotechnology, energy, environment, engineering and manufacturing, information and knowledge management, health systems, instrumentation and measurement, and telecommunications. Also, at the senior year a student acquires deeper understanding by selecting an emphasis or concentration area. This requires a student to take a minimum of four 4xx-level courses and six credit hours of capstone work (i.e., 18 credit hours) in a specific technology area. To broaden their undergraduate education, students, in addition to the ISAT courses, must also satisfy a required 30 credit hours of liberal studies (general education) electives. Twenty-one credit hours are available as approved electives to encourage the student to develop further in an ISAT related area of interest. The capstone of the program is a senior project, in which students work in teams of four to six members to solve an industry or government-related problem. These problems

are usually interdisciplinary in nature and usually require the student to use knowledge acquired from different disciplines within the ISAT program.

The ISAT program is driven by two major objectives. The first objective is to produce undergraduates with a solid foundation in science and its methods, and understanding of multi-faceted, interdisciplinary, practical approaches to solving technologically based business, industry, and government related problems. Accomplishing this effectively requires a paradigm shift in the educational philosophy and methodology used in teaching science, technology and engineering. It calls for a pedagogy that emphasizes student learning. The second objective of the ISAT program is to attract and retain historically underrepresented groups in science and technology such as females and minorities. This calls for an inherently nurturing program that combines scientific theory with hands-on experiences designed to motivate and stimulate interest as well as impart learning. In this paper, we attempt to review the team teaching methodologies that have been employed in the interdisciplinary courses offered particularly in the foundation courses of the program.

2. Interdisciplinary and Integrated Scholarship

Multidisciplinary scholarship appears to have moved to the center of academic scholarship, but interdisciplinary studies still remain on the edges of academic life. One of the definitions of a multidisciplinary program in the literature is "sequential presentation of topics drawn from separate disciplines and taught by teachers from different disciplines or different subdisciplines". [7] It is therefore not surprising that faculty in many academic institutions are quite eager to be part of a multidisciplinary program since this arrangement does not require the individual to move away from the comfortable areas of his/her specialization.

In contrast, Wentworth and Davis [8] define interdisciplinary work "as inquiries which critically draw upon two or more disciplines and which lead to an integration of interdisciplinary insights". Others state that interdisciplinary studies must "draw on disciplinary perspectives and integrate their insights through construction of a more comprehensive perspective". [8]

The assertion that interdisciplinary theory makes throughout literature is that interdisciplinary work is defined in terms of integration. Interdisciplinary work is therefore accomplished by "moving across the vertical plane of depth and the horizontal plane of breadth". Haynes [7] states that: (i) breadth implies a comprehensive approach that uses multiple variables and perspectives (ii) depth means that people involved in the work have competence in pertinent disciplinary, professional, and interdisciplinary approaches and that (iii) those involved synthesize and create interdisciplinary outcomes "through series of integrative actions".

If one accepts the notions that: (i) the key characteristics of an interdisciplinary course is integration, and that (ii) teaching begins with what the teacher knows, and (iii) a teacher must be well informed and knowledgeable in his/her field; one might then ask the question,

can an integrated program be accomplished without team teaching? The answer by the ISAT faculty at the inception of the program in 1993 was a resounding no - at least at the foundation level of the curriculum. There are differences of opinion on whether we have, or should even strive for integration (at the individual course level) in the junior and senior years.

3. Team Teaching within ISAT

There is support in the interdisciplinary literature to the belief that learning can become interdisciplinary when instruction is aided by team teaching. [7, 9] But what is team teaching? The general definition of team teaching would include all arrangements in which two or more faculty are involved at some level in the planning and teaching of a course. Levels of collaboration in planning and delivery among team members differentiate multidisciplinary courses from interdisciplinary courses. Therefore the "greater the level of integration desired, the higher the level of collaboration required". [9] We have experimented with the various forms of team teaching, most of which are similar to those reported in the literature. Some of these are:

- Group of faculty plan a course and instruction is carried out serially by individual members and each instructor presents his/her content area across multiple sections of a course and do not attend each other class.
- Team of faculty collaborate on planning of course content and agree on a common syllabus but then devise their own teaching methods, instructional aids, and tests with minimal coordination during the term.
- Team of faculty develop common syllabus, agree on sequence of topics, integrate their disciplinary perspectives, and take turns teaching the topics for the entire semester. All members are always present in class for all common lectures. Individual members usually will have responsibility for different sections of the course and may meet once a week separately with their sections for recitation or laboratory experience. They give common examinations and jointly grade and perform all evaluation activities.

4. Benefits and Challenges of Team Teaching in the ISAT Program

As eluded earlier, the ISAT program demanded a paradigm shift in the approach to teaching of science and technology principles. The interdisciplinary nature of the program demanded some form of team teaching. Success of the program so far has invariably depended on effective teaming of faculty. Team teaching in the ISAT program benefited both students and faculty. The extent of the benefits depended on the nature of the team teaching and the course it is employed in. Exposure of students to more than one faculty and perspective on a subject intellectually stimulated the students. Teaching of a course by more than one faculty gave the students the opportunity to see different perspectives and approaches to problem solving. Also, the students had the privilege of being taught specific topics in ISAT courses, which were typically interdisciplinary in nature, by experts and specialists in those areas. This was particularly the case in the ISAT program because of the diverse nature of the

industrial and academic backgrounds of the ISAT faculty. Team teaching gave faculty the opportunity to show students how to successfully collaborate with a peer or colleague on a common goal. This is particularly important because the ability to work in teams is emphasized in the ISAT program.

From ISAT faculty's perspective, teaming with other colleagues has provided a vehicle for exchange of ideas and learning from each other. It has resulted in the expansion of each faculty member's appreciation of other science and technology disciplines. Discussions of the merits of including or excluding certain topics and concepts from a course also made one take a more holistic approach to curriculum and course development. Team teaching also was useful for mentoring new and younger faculty members. However, some of the common complaints about team teaching by faculty are: (i) it is time-consuming, (ii) problems associated with working with colleagues who have different philosophy, (iii) inequitable distribution of work and responsibilities, and (iv) potential loss of focus in certain areas of the course.

Prior to implementation, faculty involved in the course take part in many time-consuming meetings to plan the course and agree on content and manner of delivery, common guidelines for grading and dealing with difficult students, examination formats, etc. During implementation of the course, time is also taken up by many planned and spontaneous meetings to revisit guidelines, talk about specifics of depth and breadth of topics to be covered and grading allocation. Of course, depending on the form of the team teaching, time is also spent in either delivering the course or attending the lectures of a colleague who is doing the teaching. In most faculty members' views, team teaching often tends to be more demanding on a faculty's time than teaching the same course alone. Perhaps, the greatest challenge in team teaching is the difficulty of working with a colleague who has a different philosophy and approach to the course subject. For example, some colleagues are more lenient on grading and may not demand excellence and academic rigor. Some may not believe in giving graded homework assignments. In some cases, these differences can cause significant disagreements, which can ruin collegiality in the department and may become disruptive to the course. Strangely enough, the students could also learn from the experience - the fact that significant effort is required on everybody's part to make working in a team with people with different philosophies successful. One of the issues that was mentioned in the literature was the tendency for senior and tenured faculty to leave most of the mundane aspects of the preparation, logistics, and management of the course to the junior and untenured faculty members. The extent of this problem is dependent on the form of team teaching and was not particularly a problem among ISAT faculty. Another danger with team teaching interdisciplinary courses is the tendency to lose focus during the semester, especially on topics of the course where one has limited expertise and is not primarily responsible for the teaching.

5. Conclusions

In general, application of team teaching concepts in the ISAT program has been successful

especially in the teaching of the foundation courses to freshmen and sophomores. It is reasonable to conclude that an interdisciplinary academic program like the ISAT experiment would not have survived without the willingness of the faculty to collaborate in both the development and teaching of courses in an integrated manner. The types of team teaching employed have been dictated by specific learning objectives for the different course offerings. Team teaching has made it easier for both students and faculty to integrate concepts from different disciplines. This has been more successfully done at the foundation level, but much work remains to be done at the higher-level concentration courses.

6. References

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O. GEOFFREY EGEKWU obtained his Ph.D. in Industrial & Systems Engineering from University of Nebraska, Lincoln. He is currently an Associate Professor and Assistant Head of Department of Department of Integrated Science and Technology (ISAT) at James Madison University, where he develops and teaches undergraduate and graduate courses in the manufacturing sector and concentration. He worked in industry for 11 years and joined JMU in 1993 as one of the core faculty that started the ISAT program.

PRINCE N. ANYALEBECHI obtained his Ph.D. in metallurgy from Brunel University, UK. He is an Assistant Professor in Padnos School of Engineering at Grand Valley State University where he develops and teaches undergraduate and graduate courses on materials science and engineering, manufacturing processes, and materials and process selection. He spent 12 years in industry and taught for three and half years in the ISAT program.