Interdisciplinary and Academic Collaboration: Integration of Engineering and Business Administration Teams

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Abstract

The Engineering Technology program at Daytona State College (DSC) includes a two semester design sequence (Senior Design I and II). The Bachelor of Applied Science (BAS) in Supervision and Management program includes a Capstone Project course. The purpose of the courses in the Engineering departments is to provide students with hands on experience in real life projects using actual concepts of product development and testing. In Business Administration, the course focuses on the integration of knowledge, skills and abilities learned in the program through a capstone project. Teams in industrial and business settings include people from cross functional areas such as marketing, finance and accounting, sales, engineering, and other departments. To ensure students have adequate hands on experience with real life projects, an academic interdisciplinary curriculum is proposed. This approach would involve having students work on the same project while in separate courses. This paper addresses the collaboration between the School of Engineering Technology and the School of Management through interdisciplinary courses. The courses serve as true organizational team experiences from initiating the idea with a client to delivering the product and closing the project. Collaborative team work includes risk and uncertainty mirroring real life projects. Measures of performance were identified and used to assess the success of this collaboration.

Keywords

Interdisciplinary, cross functional teaching, teaching collaboration, cognitive conflict

1. Introduction

Interdisciplinary collaboration is very common in research. Actually in the past two decades, it was considered as a necessity for the advancement of science [1]. Bordons stated that with the various specializations, there is a need to integrate the knowledge from different areas. More success will be achieved through the collaboration of researchers with different backgrounds. The development of knowledge and the demand of the granting institutions encouraged interdisciplinary collaboration.

There are some publications that address not only the interdisciplinary research itself, but the personal, practical, and methodological issues involved in doing it. For example, in 2005, Forman and Markus published an article that describes research collaboration between a business communication scholar and an information systems researcher [2]. The article presents their observations about the political pitfalls and personal benefits of their interdisciplinary collaboration. Before that, Israel, Schulz, Parker and Becker in 1998 published a review of community-based research that assessed partnership approaches to improve health care [3].
Few articles address interdisciplinary curriculum teaching. An article by Hunter and Matson was published in 2001, which addresses the creation of a framework that has been used to design experiential learning programs for developing teamwork and leadership skills. The framework was targeting undergraduate industrial engineering students with the goal to prepare them for different workplace scenarios [4]. Actually, in 1996 Aldridge published an article in the ASEE annual conference proceedings introducing the problems that were discovered when undergraduate engineering students worked with business and industrial design students. Aldridge used product design as a focus of team activity to prepare students from several different disciplines to work in a cross disciplinary senior design project. Seven faculty were involved in developing an introductory course to introduce students to cross disciplinary teaming and product design. Students who took that introductory course formed senior design project teams. Aldridge and his colleagues discovered that each student must have enough course work to have specialized knowledge and skills that other students don’t possess. Students had extreme differences in preparation for an experience in product design. Aldridge paper also described the tremendous effort and knowledge involved in developing the courses and the assessment process associated with these courses [5]. The effort of an interdisciplinary curriculum was confirmed in the book, Interdisciplinary Curriculum, published in 1989. Jacobs in his book stated that “interdisciplinary/cross-curricular teaching involves a conscious effort to apply knowledge, principles, and/or values to more than one academic discipline simultaneously. The disciplines may be related through a central theme, issue, problem, process, topic, or experience”. Jacobs was describing an academic unit that offers such courses for the students [6].

Others wrote about interdisciplinary courses that should be taken as electives by a variety of students. In 2002, Haynes, wrote about two interdisciplinary elective courses, Writing Across the Curriculum (WAC) and Interdisciplinary Studies (IDS). College students enrolled in these courses were from diverse tracks of engineering, business, science, and art. The purpose of the courses was to build integrative thinking and information sharing skills [7]. Most of the suggested courses were offered for freshmen or sophomores and were offered by one department. Courses were either mandatory or electives that assisted students in developing critical thinking skills and acquiring mental agility [8].

The approach in this paper addresses the collaboration and team work of students from three distinctive courses offered by two different departments within separate colleges. The courses are offered on an advanced level to students from the College of Engineering and the College of Business Administration. The difference between our approach and Aldridge approach [5] is first engineering course work and assignments were related to engineering skills, while Business Administration course work was oriented towards business and management concepts. Second, there was no interdisciplinary introductory courses involved for any of the teams, which exactly what student experience in real world work force. Although a rubric was suggested each instructor assessed their students separately. The design and development of a product by interdisciplinary teams from these different courses provide an exchange of real life experiences of knowledge and skills. The shared project provided an intensive collaborative activity that included uncertainty and risk resembling an actual work environment [9] [11-18].

2. Interdisciplinary Courses Relationship

The engineering program at Daytona State College includes a two semester design sequence (Senior Design I and II). The purpose of the courses in the Engineering department is to provide students with hands on experience in real life projects. The projects resemble new product development, new service, and/or process improvement. A recommendation report for replacing a machine, maintaining a line of production, or reducing waste can also be included. The ideas were provided by local industries, small businesses, people within the community and the students themselves. Teams worked with the stakeholders to define the project scope and constraints and to capture the client expectation of the proper solution. The purpose of Students-Client initial interaction and the team brainstorming is to develop the appropriate skills of problem solving. To initiate the project, document the requirements, and start the execution engineering students need project management skills. To complete the experience of a work environment team, additional experience will be needed, such as accounting, marketing, human resource management, operations management, etc. Those skills are provided to the bachelor degree students in the College of Business Administration. In the BAS program, students are required to complete a capstone project course that focuses on the integration of knowledge, skills and abilities learned in the program. To expose students to a full work environment experience, the proposed research idea came in place. Projects are initiated in the engineering Senior Design courses and were shared with the BAS capstone course. The engineering instructor and the BAS instructor collaborated and shared the information of these projects. Instructors participated in team meetings and
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advised students to take the proper course of action. Students from both courses worked together to provide the proper solution through knowledge and information sharing.

3. Collaborative Courses and Team Teaching Approach

Both, engineering and business administration instructors followed a team teaching approach and developed the collaborative activities and project criteria. Furthermore, the instructors assessed students’ progress over a two semester period.

The experiment started with eight groups from the engineering course Senior Design I. Four groups collaborated with teams from the capstone course offered by BAS program, while the other four groups did not use any additional help or collaboration. The purpose of the experiment is to measure the success of the interdisciplinary collaboration using the divided groups. The collaborative groups included three students from the engineering course and three from the BAS course; while the other four groups had three engineering students. Same assignment were given to both set of groups the one that collaborated with BA students and the one that did not.

For engineering, the course project was divided into three project assignments for each semester. In the first project assignment the team selected an idea and developed the project scope and constraints. Teams communicated with the client and initiated the first meeting with the client to collect project requirements. Based on the first project assignment requirements, participating teams developed the project scope, which included the goal, the objectives and the initial risk. In the scope, the team specified what will be exactly delivered by the end of the project. The scope was verified by the client in a second meeting to make sure that there are no misunderstandings in the project requirements. In the second project assignment teams developed the plan through creating a Work Breakdown Structure (WBS), Gantt chart, network diagram, duration estimation, cost estimation, Resource Breakdown Structure (RBS), and communication plan. That assignment taught students the proper skills, tools and techniques needed to manage an engineering project. Assignment activities included the initial drawing and design specifications for the suggested new product. The third project assignment requested teams to develop an execution plan including risk mitigation, change management, and reporting methods. In addition, the third assignment requested the creation of a prototype of the product, and a list of project deliverables including product documentations.

In senior design II, which is offered in the second semester, another three assignment were required. The second set of assignments addresses activities after design stage. In the first assignment Students were required to perform destructive and non-destructive product testing. In the second assignment, students were required to develop a mass production plan that will include supplier selection and the cost per unit. This assignment also included the development of continuous improvement plan. The last assignment, included the development of user manual, technical manual, bill of materials, and product brochure. During all assignment students were required to follow federal, and state regulations and guidelines.

Business Administration students were assigned to develop a business plan for the product including market research, marketing strategy and product strategy. The BA team was also responsible for resource and cost management. In addition, BA students identified supplier selection criteria, and potential suppliers. With new product idea, there was a need to identify how to introduce that product to the market.

Students had the opportunity to engage in discussions about the collected information and extracted knowledge and determined how to conceptualize the outcome. The different background mixed with project requirements and customer demand created a cognitive conflict associated with uncertainty and risk. The cognitive conflict initiated discussions and further investigation searching for the optimum solution, simulating a real life experience environment.

The project requirements presented multiple perspectives and ways of acquiring knowledge attached to the element of strong teaching and advising. The project was designed with clear and explicit interdisciplinary expectations. The purpose of the collaboration between the two colleges was explained in particulars to ensure student understanding of interdisciplinary importance. The project described the integrative structure and the interdisciplinary component needed to synthesize the diverse perspective [8].

The expected outcome of the collaboration is to develop a valuable experience for students from multiple disciplines. The collaboration also provided high quality learning with hands on experience. It ensured that students learn the
process of data collection, information sharing and knowledge extraction in a broad range of disciplines. Through the experience, the students understood the value of collaborating with people from different backgrounds.

To evaluate interdisciplinary teaching and to measure the success of the implementation students were assessed through a standard rubric that measured the advancement and project outcomes for different teams. A copy from the rubric is shown in figure 1 below.

<table>
<thead>
<tr>
<th>Grading Criteria</th>
<th>Non-performance (10 points)</th>
<th>Basic (15 points)</th>
<th>Proficient (20 points)</th>
<th>Distinguished (25 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applies relevant course concepts, theories, or materials correctly.</td>
<td>Does not explain relevant course concepts, theories, or materials</td>
<td>Explains relevant course concepts, theories, or materials</td>
<td>Applies relevant course concepts, theories, or materials correctly</td>
<td>Analyzes course concepts, theories, or materials correctly, using examples or supporting evidence</td>
</tr>
<tr>
<td>Apply Relevant interdisciplinary concepts and collaborative activities</td>
<td>Does not apply any interdisciplinary concepts, or collaborative activities</td>
<td>Applied interdisciplinary concepts, and collaborative activities, but lacks relevance</td>
<td>Applied interdisciplinary concepts, and collaborative activities</td>
<td>Applied interdisciplinary concepts, collaborative activities, and used examples supporting relevancy</td>
</tr>
<tr>
<td>Applies relevant professional, personal, or other real-world experiences.</td>
<td>Does not contribute professional, personal, or other real-world experiences</td>
<td>Contributes professional, personal, or other real-world experiences, but lacks relevance</td>
<td>Applies relevant professional, personal, or other real-world experiences</td>
<td>Applies relevant professional, personal, or other real-world experiences to extend the dialogue</td>
</tr>
<tr>
<td>Supports position with applicable academic knowledge</td>
<td>Does not establish support for relevant positions or statements</td>
<td>Establishes relevant position by making reference to general sources</td>
<td>Supports position with applicable knowledge drawn from specific sources</td>
<td>Validates position with applicable knowledge citing specific academic literature sources</td>
</tr>
</tbody>
</table>

Additionally, a pre and post survey was administrated to capture their feedback about this experience. Students were surveyed using an online quantitative instrument using a 5 point-Likert-scale. Students were informed that the surveys would be anonymous and used for instructional and academic purposes only. The survey sample consisted of eight Engineering students and eleven Business Administration students. Each student was asked ten questions about their experience with the interdisciplinary project. Questions were designed to improve face and content validity. More than one question was asked for the same variable to improve construct validity. Figure 2 below shows a sample of a survey question.

![Figure 2: Sample of the survey questions](image)
The survey results are shown in the following figures, which addresses the learning value:

As shown in the results above both Business Administration and Engineering students value the collaborative learning process. Results confirm that collaboration assists in the development of critical thinking and problem solving skills.

In addition, results measuring connection to the professional world are shown in the following figures:
From the results above Business Administration students did not see collaboration meeting market and technical requirements. But, Engineering and Business Administration agreed that collaboration gave them a real life experience.

Course assessments were used to distinguish between interdisciplinary teams and the control group. Although interdisciplinary teams gained more experience the grades did not assist in the distinction since some of the control group were nontraditional student that had technical and management experience. Instructors from both engineering and BA will be researching another performance measure to be used to assess the difference.
4. Advantages and Disadvantages of the Interdisciplinary Approach

An advantage of creating an interdisciplinary project or activity is that it will expand student understanding and achievement among all disciplines. In addition, it will enhance each student’s communication skills. The interdisciplinary approach will be the key concept to advancement of school curriculum. The interdisciplinary approach should reduce the gap between industry requirements and academic learning. It allows students to see different perspectives, work in groups and combine goals from the various disciplines [10].

Repko (2009) maintains that the interdisciplinary approach to education cultivates the cognitive ability in students [19]. Using perspectives from different fields of science, psychology, and human behavior, a program of study will also be more coherent, will promote a broader perspective of different points of view among people, and will increase the significance of the learning to the student.

It may even develop the student’s interest to a more expansive base or even change his or her interests, plus will help them think outside of their current paradigm. Students will also be able to see the different linkages among topics. The interdisciplinary approach also helps learners realize that their way may not be the only way, and that other people may have very different perspectives on the same topic. Different frameworks are essential to developing people as effective learners and more self-assured graduates. People who can look at things from different vantage points and from more skillsets can be more responsible and more valuable citizens. People often look at things only from their own vantage point and can become bitter and defensive when questions. Learners who are brought up with different standpoints are not intimidated by people who question; rather, they are very comfortable with people who ask questions to learn all sides of a problem, situation, or case. Disadvantages of using the interdisciplinary approach include the amount of extra time it usually takes to coordinate and research a topic or situation that you want your students to study. When two instructors are making time commitments to make this work, it may be difficult for instructors to maintain the stamina and time commitment that may be necessary to make this type of project succeed. If an organization is initially set up for continuous collaboration, it makes it easier to succeed.

Benson (1982) asserted that serious conceptual confusion can occur when using the interdisciplinary approach and the student does not already have a mature base in other disciplines needed for the project. He believes that bringing in other disciplines impedes development of competence in the student’s discipline. He also believed that intellectual rigor is be traded for the excitement of new information [20].

In the case of the engineering students and the business students, it was an advantage to both to use the knowledge and skills of the other group since neither group was an expert on the complete set of knowledge, skills, nor abilities needed to develop and promote the products being designed. It showed the students that it was more efficient and effective to use existing talent and complementary skills, rather than to find consultants or another means of outsourcing to find the needed information. The instructors involved have always been focused on student learning and student success, and did not mind the extra time commitment. However, the instructors realize that the amount of effort may not be sustainable throughout the organization.
5. Conclusion

The interdisciplinary approach followed in this paper integrates two courses through collaborative curriculum activities to provide lifelong learning skills, and a real life learning experience. The outcome of the interdisciplinary approach is mapped to the outcomes of the integrated disciplines. Although the development of interdisciplinary curricula is time consuming and takes collaborative team teaching, it develops skills in our students that are required by the industry and the current workforce.

Creating an interdisciplinary project or activity assisted in the expansion of student understanding and achievement among all disciplines. In addition, it enhanced student’s communication skills. The interdisciplinary approach reduced the gap between industry requirements and academic theoretical learning. It allowed students to see different perspectives, work in groups and combine goals from the various disciplines. Students learned problem solving through proper critical thinking, brain storming and constructive discussions.

To ensure successful implementation of the interdisciplinary collaboration a tremendous effort from involved instructors is required and many obstacles must be astounded. In addition, department chairs and administrator should be involved. More resources will assist in proper implementation and assessment if the interdisciplinary process.

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