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Interdisciplinary Coursework - A Systems View

ABSTRACT: Interdisciplinary education provides unique learning, problem solving and research opportunities, although at a cost. In this paper the author provides an introduction to interdisciplinary education and background on the field. This is followed by a suggested systems model for analyzing major variables that affect the design and successful delivery of such courses. Analysis focuses on the level of harmony or discontinuity displayed between the theoretic and application frameworks employed by the three primary input variables: professors, students and content of the multiple disciplines involved. The system model developed incorporates these major input variables, as well as the processes involved in delivering the course and the major outputs. Description of the efforts to correct the course deficiencies and the successful outcomes in the second year provide useful insights for developers of interdisciplinary courses. The overall conclusion of the paper is that when a single course is targeted for two very diverse groups of students, there is a serious gap between the needs and backgrounds of those two groups that must be addressed in the design and communication of the course to achieve successful delivery and enhance research potential.

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INTRODUCTION

Is there really a need for interdisciplinary courses? Is the reward for their development sufficient incentive to invest the effort to construct them? Will such development make a real contribution to the research work of an academic? A variety of viewpoints from other academics in this field will be valuable in setting the stage before we try to answer these questions.

"The modern university embodies a seemingly insurmountable paradox. On the one hand, it can survive as a social institution only by embodying a structure that affords it a degree of stability. On the other hand, the structures that are most likely to ensure its stability also inhibit its function: the function, that is, of advancing knowledge, understanding, and independent thinking both within the university and the society at large." (Novitz, 1991)

The stabilizing structure spoken of here is the departmental construct of the typical western university. In lending administrative and academic stability, this departmental structure tends to inhibit the challenge from other disciplines that may have differing world views, and therefore would question the pre-suppositions, hypothesis and theories taken for granted by those within a department. Yet it is this very challenge to the status quo that propels true discovery.

Interdisciplinary education is the attempt to surmount this paradox, facilitating student and faculty inquiry across disciplinary boundaries for the purpose of broadening understanding of the field of study. This course work is intended to stimulate the student and teacher to critically evaluate presuppositions that may be based in one of the disciplines but not in the other(s), stimulating an open-minded inquiry that might otherwise be stifled within disciplinary boundaries.

"To develop and implement new interdisciplinary programs can be rewarding, providing stimulation and renewal for faculty...and expand their own research and teaching capabilities into new areas... as well as enriching the curriculum for students." (Cohen, 1991)

"Disciplines have fragmented themselves into smaller and smaller pieces, and undergraduates find it difficult to see patterns in their courses and to relate what they learn to life...there is indeed a widely recognized need to counter such specialization and fragmentation." (Beckman, 1989)

However, the positive rewards offered by interdisciplinary courses have a considerable cost involved and substantial hurdles that must be overcome to gain the rewards. This paper presents a systems view of interdisciplinary course work including the primary variables affecting the complexity of developing and delivering a successful interdisciplinary course. Benefits and detriments arising from the mix of variables are given and suggestions for overcoming the problems that arise. Included is the experience of the author and his colleagues in overcoming some of those hurdles in the development of a systems analysis and design course.

SURVEY OF LITERATURE

Background

The very need to discuss or develop interdisciplinary concepts was largely unknown prior to the middle of the nineteenth century. This was due to the traditional role of the University as a place of learning and inquiry in the broadest sense. A 'classical' University education was not organized along rigid disciplinary boundaries but rather was intended to provide a broad base upon which to stimulate informed inquiry. This tradition was founded on earlier institutions such as Plato's Academy which, although covering a variety of 'disciplines', developed the student in a progressive, interdependent manner culminating ultimately in 'wisdom'. Thus the 'graduates' of the Academy were qualified to inquire and comment on the full range of 'research' relating to society.

However during the middle of the nineteenth century a trend began in Universities which established schools and departments as administrative units, typically along disciplinary boundaries. This trend accelerated with the proliferation of new specialty disciplines. Social Science was divided into psychology, sociology, political science, anthropology and others. Business Studies was divided into accounting, marketing, business administration, management information systems, operations research and others. This fragmentation has tended to make students 'dehumanized' in the sense of not gaining a unified view and application of subjects. (Hauseman, 1979)

Discussion of the need to develop interdisciplinary course work and include it in University education began in response to two factors: (1) the aforementioned fragmentation and dehumanization, and (2) a perceived increase in the complexity of problems facing modern society, requiring synergistic solutions that might not be discovered within the framework of fragmented disciplines.

Key Factors

There are six possible levels of interdisciplinary work, as elucidated by Heinz Heckhousen (Heckhousen, 1972). These six categories are given below together with factors that may influence the ease or difficulty of development and delivery of courses in each of the categories.

1. Indiscriminate Interdisciplinarity: the "teach them a bit of everything" approach. Given the inherent "potpourri" approach of this category, delivery of content would be relatively straightforward, simply delivering the appropriate menu of topics at the appropriate time. Sometimes also referred to as multi-disciplinarity where the multiple disciplines being covered are not integrated on any theoretical foundation. (Kockelmans, 1979)
2. Pseudo-Interdisciplinarity: the use of common analytical tools, such as mathematical models or computer simulations, across a variety of disciplines in a single course. This category would present new difficulties from an instructional standpoint. Faculty member(s) involved would need to explicate the various analytical tools in such a way that students could see the applicability and technique in relation to their particular disciplinary need.
3. Auxiliary Interdisciplinarity: the use of methods from one discipline to assist research or teaching in another discipline. For example the use of the economic order quantity (EOQ) method in both accounting and operations research, or the application of neurophysiological methods to psychology. Course delivery in this category would present few unusual challenges because the work is fundamentally single discipline in its viewpoint, but calling on methods from other disciplines. Faculty members could integrate these methods within the context of the single discipline's theoretic and application framework and there should be few new communication problems.
4. Composite Interdisciplinarity: the application of multiple disciplines to problems or goals in society. For example: application of architecture, psychology, engineering and economics to the discipline of city planning. Of the six categories presented the composite and supplementary provide the greatest challenges in terms of course development and delivery. The need to successfully incorporate the world-views, theoretic and practical applications of the various disciplines involved into an integrated problem solving system presents substantial new challenges from both the instructor and student points of view.
5. Supplementary Interdisciplinarity: the overlapping of multiple disciplines in terms of the subject matter covered, but with substantial theoretical and practical discontinuities between the disciplines concerned: e.g. computer science and MIS overlap in a number of subject matter areas. The supplementary category provides the greatest challenge to successful implementation of new course work. On the surface the substantial overlap of content between the disciplines involved would appear to indicate a greater ease of integration. However under the surface the substantial theoretic and application discontinuities present a minefield of unexpected difficulties in communication between faculty members, and with students, as well as the expectations of both groups.
6. Unifying Interdisciplinarity: the substantial overlapping of multiple disciplines in terms of the subject matter covered with increasing conformity of the underlying theoretical foundations of the respective disciplines: e.g. convergence of physics, chemistry and biology giving rise to new disciplines such as biochemistry. This category substantially reduces the difficulties of successful course delivery compared to the supplementary category. Both show considerable content overlap; however the inherent harmony in the underlying theoretic and application foundations sweep away the minefield of difficulties presented by the supplementary category.

Examples

Literature on interdisciplinary tertiary education covers a broad span of course offerings from the Humanities and Arts to the Sciences and Commerce. The following are examples arranged by Heckhousen's six categories:

• **Indiscriminate Interdisciplinarity:** Integration of computer studies into engineering curriculum in Universities in developing countries (Gorny, 1989). This appears to be largely a pseudo interdisciplinary or perhaps even indiscriminate disciplinary application.

Development of information technology courses for inclusion into an Arts degree at University of Wales, Lampeter. (Nixon, 1989) Again this appears to be largely a pseudo interdisciplinary or perhaps indiscriminate disciplinary application similar to the Gorney example given above.

• **Pseudo-Interdisciplinarity:** Provision of computer education to undergraduate medical students at the University of Lisbon, Portugal. (Oliveira, 1989) This appears to be largely a pseudo-interdisciplinary.

• **Auxiliary Interdisciplinarity:** The use of multiple criteria decision making (MCDM) as a research area and mathematical model for assisting the process of finding the most preferred decision when dealing with multiple decision criteria. This technique may find application across a range of disciplines: general management, production management, engineering management. Each discipline using the method in a way suitable for them. (Korhonen, 1992)

• **Composite Interdisciplinarity:** A course in development economics for third world countries. The course involves incorporating economics with a variety of other disciplines including sociology, psychology and history to allow the economist to learn to listen to other cultural points of view. A suggested team teaching perspective adds the "professor as learner" concept to this interdisciplinary model. (Beckman, 1989). This appears to fall into the composite disciplinary category.

• Supplementary Interdisciplinarity: An elective for undergraduate non-science majors focusing on the chemical and legal considerations of alcohol-impaired driving. (Labianca, 1990) This appears to be supplementary interdisciplinary in nature.

A series of six interdisciplinary courses developed jointly by the humanities and social sciences faculties at San Jose State University focusing on the common problems faced by all cultures, past solutions attempted, contemporary attempts to solve these problems and implications for us today. (Cohen, 1991) This appears to be supplementary interdisciplinary similar to Labianca above, but more extensive in scope.

• Unifying Interdisciplinarity: A curriculum in electronics engineering and computer engineering taking an interdisciplinary approach at the University of the Americas in Puebla, Mexico. (Baez-Lopez, 1993) Given the close engineering association between electronics and computers this would appear to be unifying interdisciplinary.

The remainder of this paper will tend to focus attention from the viewpoint of the last three categories: composite, supplementary and unifying; as these seem to present the greatest challenges and the greatest opportunities.

SUGGESTED SYSTEMS MODEL

In addition to the forgoing discussion in the literature concerning the content of interdisciplinary work it is necessary to introduce two other inputs into the development of interdisciplinary course work: faculty and student populace. All three of these variables: (1) course content, (2) teaching faculty and (3) student populace; will be discussed for their level of harmony or discontinuity in theoretic and application outlook and then a systems model will be presented inter-relating these inputs with the processes and outputs that make up a course offering.

Participating faculty members

A variety of faculty member mixes may be envisioned when considering the question of interdisciplinary course development and delivery, ranging from:

- On the one extreme, a single faculty member from one discipline delivering the entire course, integrating the material from the multiple disciplines. This offers the fewest problems of integration and communication, but also offers the least opportunity for challenge, new research and advancement of understanding that interdisciplinarity potentially offers.
- In the middle are multiple faculty members from multiple disciplines developing and delivering course work in a **turn** teaching environment and where there is considerable harmony in the theoretic and application mindset of the professors (unifying interdisciplinarity). Turn teaching has only one professor present at a time in a lecture or discussion with the student participants. Although the students may raise questions that challenge the varying viewpoints of the different faculty involved, there is little opportunity for direct faculty to faculty challenges.
- On the other extreme, is multiple professors from multiple disciplines developing and delivering course work in a **team** teaching environment and where there is considerable discontinuity in the theoretic and application mindset of the participating professors (composite or supplementary interdisciplinarity). For example there would be more discontinuity in theoretic mindset between a physics professor and one in social psychology, than between a chemist and a biology professor. Team teaching involves multiple professors presenting at each lecture, challenging each others viewpoints, with questions and challenges coming from the student participants.

Target student populace

Just as with the faculty members, we also have a range of possible compositions of the target student populace:

- On the one extreme, there is the target student populace with a high level of harmony in their theoretic and applications framework. For example where all the students are from a single departmental discipline.
- In the middle we have students from multiple disciplines, but with considerable harmony in their theoretic and applications frameworks (unifying interdisciplinarity). For example, where the target student populace consists of liberal arts students from history and philosophy, or commerce students from marketing and accounting.
- On the other extreme there is the target student populace from multiple disciplines, with substantial discontinuities between their theoretic and applications frameworks (composite or supplementary interdisciplinarity). For example, when the students are half from biochemistry and half from law.

The interaction of the three inputs under discussion (professors, students and content) combined with the processes typically used in delivering a course will produce varying levels of four major outputs described in the model shown in Figure 1.

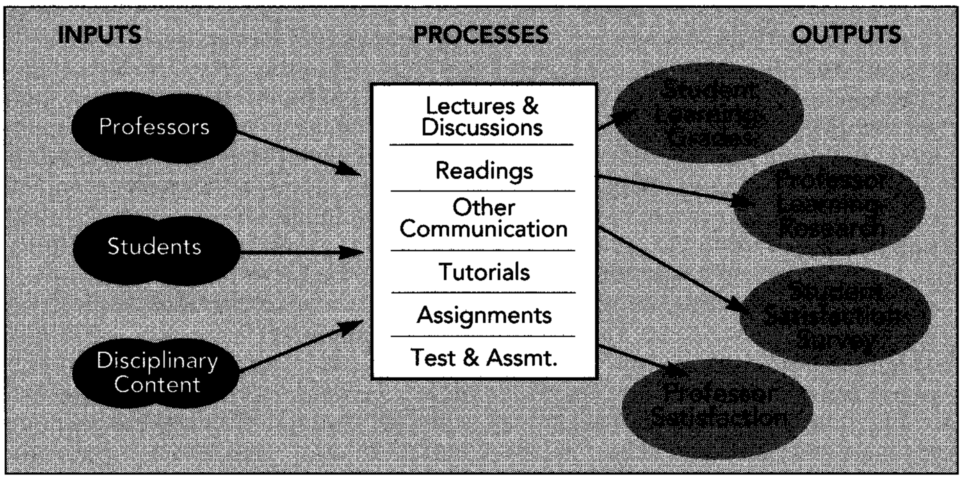
The degree of difficulty in producing satisfactory course results may vary in direct proportion to the degree of harmony or discontinuity present in the three variables under discussion. The table presented in Figure 2 gives an indication in relative terms of the increasing difficulty depending on the mix of the variables. The level of difficulty is indicated by a suggested scale of one through six, the higher the number the greater the difficulty and the greater the effort necessary to deliver a successful course. There may also be a correlation between higher numbers and greater potential rewards. The rows in the table are shown in three categories:

1. Single, where a single professor delivers the course content to a single student population.
2. Multi-Harmonious, where professors from multiple disciplines deliver the course to a mixed student populace of multiple disciplines, but the backgrounds and disciplines of the professors and students are largely harmonious.
3. Multi-Discontinuity, where professors from multiple disciplines deliver the course content to a mixed student populace of multiple disciplines, and the backgrounds and disciplines of the professors and students contain a considerable amount of discontinuity.

The six point scale proposed is established using the following two examples and assumptions at the extremes of the scale:

1. If we assume there exists a body of material from multiple disciplines with a unifying interdisciplinarity category and therefore largely harmonious theoretic and application framework, delivered by a single professor to a

Figure 1: INTERDISCIPLINARY COURSE DESIGN MODEL



student populace from a single discipline, then there will be minimum difficulty in achieving a successful result. This is indicated by the digit one in Figure 2.

2. On the other extreme, if we assume there is a body of knowledge from multiple disciplines with considerable discontinuity in the underlying framework, as may be the case with composite, or supplementary interdisciplinarity, and there is also considerable discontinuity in the theoretic and application mindset of the participating professors, and the course will be taught in a "team teaching" environment, and the student populace is from multiple disciplines with substantial discontinuities between their theoretic and applications frameworks, then there will be a maximum difficulty in achieving a successful course.

So with these assumptions it would appear that the composite and supplementary interdisciplinary categories present the most challenges, in regards to the variable mix and ease of delivery of a successful interdisciplinary course. Under these circumstances we have substantial overlap between the disciplines that are involved, but substantial discontinuities between those disciplines' view of the subject matter. These discontinuities demonstrate themselves by differences in presuppositions, theories applied, language used to describe phenomena and the predictive direction of the differing viewpoints. If we take faculty from the various departments involved, and expose students to these varying viewpoints in lectures and discussions, the anticipation and potential is that the variety of views presented will enrich the thinking students' understanding of the course content. Unfortunately, unless considerable effort and thought have been invested in overcoming the related difficulties, experience has shown that often the result is confusion on the part of the student participants, due to a lack of real integration and the challenging discussion of the various views necessary to yield a cohesive, yet broader understanding of the applicable underlying concepts and theories.

Figure 2:Difficulty of Successful Course Development

	Largely Harmonious Content	Considerable Discontinuity Of Content
Single:		
Professor	1	2
Student Populace	1	2
Multi-Harmonious		
Professors	3	4
Student Populace	3	4
Multi-Discontinuity		
Professors	5	6
Student Populace	5	6

CASE EXAMPLE

Introduction

With the foregoing as background, a more in depth case study offers an opportunity to gain additional insight into the use of the proposed model. Factors of the model that are the focus of this case study are: (1) the three major inputs (professors, students and disciplinary content), (2) The course delivery processes and (3) Some of the outputs including the student satisfaction survey and professor learning/research. The other outputs will be discussed under the heading of "Further Research" at the end of the paper. Using the author's experience, additional light is shed on the process of developing and delivering an interdisciplinary course. Insights gained in developing and delivering the course with colleagues are largely a result of hindsight, as much of the work on interdisciplinarity was unknown to the author during the course development period as described. The environment in which the course was delivered, using the variables discussed above, could be described as: supplementary interdisciplinary with substantial discontinuities present in the professors, students and content frameworks. The course has not been team taught, but rather turn taught, which eased some of the problems, at the same time removing some of the opportunities for idea exchange, challenge and maturation.

Overview

In 1990 the Accountancy Department and the Computer Science Department at the University of Canterbury in Christchurch, New Zealand delivered a new interdisciplinary course in systems analysis and design entitled "Information Systems Development", course number CMIS 223. The course struck some very rocky ground in the first year of offering, causing the lecturing staff involved to restructure the course.

After considerable consultation and modification of the delivery variables of the course, the 1991 version showed a marked improvement in both student and professor satisfaction. Innovative instructional techniques together with appropriate use of modern information technology turned an interdisciplinary disaster into a successful course offering.

Background

In 1989 during discussions between the Accountancy Department staff, who offer the commercial computing courses, and the Computer Science staff it was discovered that two very similar courses were being offered by the individual departments. The two courses were in Systems Analysis and Design, emphasizing CASE (Computer Aided Systems Engineering) technology and software engineering. From those discussions developed the concept of a jointly taught course covering the same material. It was thought that such rationalization would reduce the pressure on each department's resources and bring considerable synergism to students and professors of the departments. The expected interdisciplinary stimulation was expected to more than compensate for the effort involved in developing a new course. Further influencing the need to develop the course were the comments local industry employers had made over a period of years clearly indicating that they needed computer science graduates with a greater understanding of the commercial environment. It was felt by some of the computer science staff involved in this project that the new course could go a long way to addressing this concern.

The course structure was to include:

- Three continuing case studies:
  a. A continuing lecture case that would act as the commercial background throughout the year.
  b. A continuing tutorial case that would act as the commercial and factual background on which tutorial assignments (CASE tool usage, analysis, design and implementation) would be based.
  c. A case that would account for 10% of students course grade. This analysis and design case would involve students in groups of three working through a hypothetical case using the entire systems development process from planning and analysis to logical and physical design, concluding with construction and implementation.
- A data centred, Information Engineering approach to systems analysis and design.
- Demonstration and incorporation of automated structured development support using CASE tools.
- Emphasis on the strategic position of information systems from a management point of view.
- Coverage of the entire systems development cycle from planning to implementation.
- Assessment consisting of a mid-year test (30%), case project (10%) and final exam (60%).
- A weekly two hour lecture of about 200 students coupled with weekly one hour tutorials of about 20 students held in a computer lab consisting of networked PCs.

First Year Experience

The course, CMIS 223, entitled "Information Systems Development" was first offered in 1990. This year long course with two hours of lecture and one hour of tutorial per week, as is typical at the University of Canterbury, covers three terms: 1st term of ten weeks, 2nd term of ten weeks and 3rd term of five weeks. Of this period, half (12 weeks) would be taken by the Accountancy Department with the author as lecturer, and half would be taken by the Computer Science Department professors. The remaining week would be used for review. Students would organize themselves into groups for the analysis and design case study that was part of their assessment. There was no attempt to integrate students from the two disciplines into joint tutorials.

Considerable difficulties were encountered from the beginning including the following:

1. Even though the departments involved in the new course agreed that there was as much as 80% overlap in the content being covered, the viewpoints, presuppositions and underlying theoretic framework of the two disciplines (computer science and management information systems) had considerable discontinuities.
2. No allowance was made for the diversity of background and lecturing styles of the professors from accountancy and computer science. The accountancy/management information systems professor (the author) had concentrated his education, teaching and research on business related systems development, whereas the computer science professors had come up through a hard science and mathematical background. This serious discontinuity in underlying theoretic and application frameworks created many misunderstandings between professors, and in presentations to students.
3. No allowance was made for the considerable difference in backgrounds of the students attending the course, approximately 75% were accountancy students and 25% were computer science students. The accountancy students had emphasized a commercial, non-technical viewpoint throughout their high school and early university studies. These students will typically have taken first year courses such as Commercial Law, Introductory Accounting, Economics, Introduction to Management, and Statistics with the average age of approximately 20 years old. On the other hand the computer science students had emphasized science and technical views with first year courses typically consisting of

Figure 3: SUMMARY OF STUDENT SURVEY RESULTS-1990

Question	Mean	Std. Dev.
1. As a result of this course my interest in this subject has: (decreased/increased)	2.2	1.08
2. Have you enjoyed learning about this subject? (not at all/very much)	2.1	0.91
3. How much has this course challenged you to think? (very little/a great deal)	2.9	1.15
4. The amount of feedback during the course has been: (inadequate/adequate)	2.4	0.96
5. What overall grade would you give to this course? (very poor/well organized)	2.2	1.05

Figure 4: SUMMARY OF STUDENT WRITTEN COMMENTS-1990

Comment	Number of Occurrences
1. This course is very boring	32
2. Lack of common perspective & terminology across Accountancy & Computer Science professors/students	24
3. Group case project too much work for percent of grade (10%)	21
4. Tutorials are a valuable inclusion in the course	16
5. Two hour lectures are too long	14
6. End of year final too high percent of year grade (60%)	6
7. Poor textbook	6
8. Group project case a valuable inclusion in course	4

Math, Science and Computer Programming. This background was of course similar to that of the professors involved.

4. Insufficient and slow feedback to students on their group case study covering the entire year's work. There was also student dissatisfaction on the high level of work required for this group case study compared to the percentage of the year's grade (10%) allocated for the work.
5. Poor general communications between the professors and students, in large part due to the involvement of two separate departments that normally had only a low level of contact.

Throughout the first year professor dissatisfaction was noticeable, spurred on by the continuous high level of complaints from students over the issues mentioned above. The year end survey of student opinion conducted by the course supervisor (the author) yielded a very unfavorable score for the course, as well as an extraordinary level of negative written comments on the surveys. A summary of the results is seen in Figure 3. The most common written comments for 1990 are summarized in Figure 4. Students were asked to respond to all questions on a scale from 1 (most negative response) to 5 (most positive response). A total of 98 questionnaires were received out of a total class size of 152. This relatively low response rate (64.5%) on the survey was taken to be an additional measure of the high level of dissatisfaction and hopelessness over the state of the course. The student association conducts its own student surveys, and the results of this survey confirmed the results of the course supervisors' survey.

The author and other professors met to discuss the results of the year, and to decide the future of the course. Early in the discussion it became evident that all were agreed that the offering had been disastrous in many areas, and although we had tried a number of quick fixes, they had been insufficient to correct the underlying problems mentioned above. It was also generally agreed that we would not quit too quickly, and that we should attempt to fix the underlying problems. So we embarked on a plan to "rescue" CMIS 223.

Second Year Experience

Over the remainder of 1990 solutions were discussed and prepared that offered opportunities to overcome the major problems previously discussed. These changes included:

Figure 5: STUDENT SURVEY RESULTS - COMPARATIVE

Question	Mean 1991	Mean 1990	Incr.
1. As a result of this course my interest in this subject: has (decreased/increased)	2.9	2.2	0.7
2. Have you enjoyed learning about this subject? (not at all/very much)	2.7	2.1	0.6
3. How much has this course challenged you to think?: (very little/a great deal)	3.0	2.9	0.1
4. The amount of feedback on my progress during the course has been: (inadequate/adequate)	2.5	2.4	0.1
5. What overall grade would you give to this course? (very poor/well organized)	3.3	2.2	1.1

Figure 6: SUMMARY OF STUDENT WRITTEN COMMENTS-1991

Comment	Number of Occurrences
1. This course is very boring	4
2. Lack of common perspective & terminology across Accountancy and Computer Science professors & students	6
3. Group case project too much work for percent of grade (10%)	28
4. Tutorials are a valuable inclusion in the course	9
5. End of year final too high percent of year grade (60%)	5
6. Poor textbook	19
7. Group project case a valuable inclusion in course	7
8. Electronic mail and bulletin board valuable	4
9. Course well organized	2

- The author completed a *Computer & Commerce Dictionary* which computer science students could use for relevant commercial terms and examples; and accountancy students could use for computer terms and examples. It was anticipated that this would help in resolving the lack of common terminology between the two disciplines.
- It was agreed that the mandatory makeup of the group case study teams would consist of 2 or 3 accountancy students and one computer science student. This was to increase communication between these two disciplinary groups and encourage them to employ each other's strengths to overcome weaknesses in self tutoring groups.
- Professors agreed to sit in on each other's lectures in order to develop a more cohesive presentation of the course, as well as enhance the teaching style of the computer science professors.
- The group case study would have a "preliminary submission", which would not be graded in the traditional sense, but would be marked and heavily commented by the marker to provide early feedback on progress and understanding of the key techniques covered in the case.
- Introduction of electronic mail between the students, professors and each other. Also the introduction of an electronic bulletin board. Both of these were intended to help facilitate general course communication.

The general outcomes of the 1991 implementation of the course could be seen very early in the year with a much lower level of student complaint, and greater enthusiasm on the part of professors. The e-mail and bulletin board were used instead of other types of notices in order to get students into the habit of reading their mail and the bulletin board. Strong pressure was required to enforce the group case study team composition of 2 or 3 accountancy students to one computer science student. But the natural reticence of the two disciplinary groups to mix was overcome, with considerable instructional enhancement as internal self tutoring developed within the groups.

A year end survey was again done with the students. The improvement in overall evaluation was substantial, although there were a number of areas in which students suggested further improvements. The results of the 1991 survey and a comparison to the 1990 results are seen in Figure 5.

A total of 155 questionnaires were received out of a total class size of 190. This increase in student participation in the survey, 81.5% in 1991 versus 64.5% in 1990 was taken as a sign of greater satisfaction, and hope for improvement.

As can be seen from these 1991 results, the course as perceived by students showed improvements in every category, with substantial improvements in three out of the five questions and the largest improvement of all in the overall question.

The most common written comments for 1991 are summarized in Figure 6. The occurrence of positive comments on the survey were also a noted and encouraging change from the prior year. However it was also evident that there was still room for improvement. Among the changes proposed for the 1992 offering are increase in the value of the group case projects from 10% to 20% and a corresponding reduction of the final exam value from 60% to 50%. In addition the selection of a new textbook for 1992 is expected to address student comments in that area.

RECOMMENDATIONS FOR INTERDISCIPLINARY COURSES AND SUGGESTIONS FOR FURTHER RESEARCH

The overall conclusion of our experience to date is that when a single course is targeted for two very diverse groups of students, there is a serious gap between the needs and backgrounds of those two groups that must be addressed in the design of the course. The challenges presented by this supplementary or composite category of interdisciplinary course can be successfully bridged, but not without considerable effort.

As noted at the beginning of this paper, interdisciplinary courses can stimulate research across disciplines as well. This has proved true for the author and one of his computer science colleagues as we have embarked on a joint research project involving the application of Information Technology to increase the effectiveness, efficiency and competitive advantage of commercial organizations. The author's interest and experience in business and commercial computing together with the strong telecommunications background of the computer science colleague has proved both synergistic and highly stimulating. The prospect of a substantial stream of research benefiting both academic streams as well as the interests of the authors is very promising.

Given the rapid rate of change in the developmental sciences, and the speed of change in economic and competitive spheres, the need to offer more interdisciplinary courses which will better equip students and faculty to maintain a life-long learning attitude, as well as make useful contributions to emerging disciplines, suggest the need for more of this type of course.

Further comparative and time series research into the impact of Heckhousen's six categories of interdisciplinary courses as they relate to various disciplines would be most beneficial. Correlations between the components of the model described in this paper could provide both insight and direction for further successful course innovation including various input and process mixes on the final outputs of student and professor learning, research and participant satisfaction.

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AUTHOR'S BIOGRAPHY

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