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Factors that Enhance or Constrain Implementation of Team Activities in Engineering Courses*

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The Accreditation Board for Engineering and Technology in the United States strongly recommends that engineering schools add project-based team learning to the engineering curriculum. This research study provides Deans and Department Heads with information about what enhances or constrains faculty members' willingness and ability to implement team activities in their classes. Results from a grounded theory qualitative analysis and multiple logistic regression analyses confirmed that previous experience with team activities, whether successful or unsuccessful, previous training on team activities and time constraints, were all significantly related to the use of team activities by these research university professors.

INTRODUCTION: A CORPORATE GRANT FOR LEARNING EXCELLENCE

THE ACCREDITATION BOARD for Engineering and Technology in the United States strongly recommends that engineering schools add project-based team learning to the engineering curriculum to prepare students to work on multi-disciplinary project teams. Consequently, engineering administrators are currently facing the challenge of encouraging faculty to use teaching methods that incorporate team activities.

The Learning Excellence project, funded by a corporate grant and implemented by the College of Engineering at a large public research university from 1997 to 2000, provided an opportunity to explore what factors may enhance or constrain innovation in the classroom. The purpose of the 'Learning Excellence' project was to begin transforming the way engineering undergraduates learn by forming linkages among faculty and students across departmental and disciplinary boundaries, and by using innovative teaching activities to promote student learning. Twenty-two engineering and physics faculty participated in the project. To protect the anonymity of the study participants, the site of the research is being withheld.

By their participation in the project, faculty had demonstrated interest in changing their teaching methods, specifically using team activities in their classes. Faculty interested in learning about new instructional topics are likely to have a high sense of teaching efficacy and a willingness to try new teaching methods [1]. They may also be supportive of their students' academic self-directedness and intrinsic interest in learning. The Learning Excellence project, then, provided an opportunity to investigate the reasons why faculty who demonstrate motivation and have external support for change do—or do not—change their teaching methods.

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METHOD: GROUNDED THEORY PLUS LOGISTIC REGRESSION

Grounded theory was selected as the initial approach to investigate this issue because previous research has not identified the factors involved in faculty members' decisions to change classroom teaching methods, and few theories are available to explain the teaching behaviors of research university professors. The grounded theory approach follows systematic procedures specified by Glaser and Strauss [2] and Strauss and Corbin [3, 4] to inductively develop a theory grounded in the data surrounding a phenomenon. Interviews with research university engineering professors about what enhances or constrains their ability to implement team activities in their classrooms would result in a set of hypotheses or propositions that may be tested with a different or larger population. Empirically-derived propositions were subsequently tested in a survey questionnaire distributed to the entire College of Engineering to see if what was learned from the qualitative study held true for a larger population of engineering professors.

The sampling procedures, data collection, and analysis for the two parts of the study follow.

QUALITATIVE DATA COLLECTION AND ANALYSIS

Strauss and Corbin [4] suggested that a good way to begin a grounded theory study is through initial

interviewing and observations. Carefully listening to respondents or observing their actions leads to discovering the issues that are important to them or problematic in their lives. This focus on their concerns is key to where the focus of the research should be. To begin the study, the researcher decided to use qualitative methods so that the hypotheses would emerge from the evaluation of those qualitative data collection methods and be grounded in data which were representative of the thoughts and ideas of the professors being studied. Thus, the researcher began by conducting informal discussions with the participants of the Learning Excellence project and determined which issues were important to them:

- time constraints for learning about new initiatives;
- financial constraints for necessary classroom resources for teams to use;
- assistance constraints/needing someone to help them.

Additional information about these constraints and the Learning Excellence participants was collected from the project proposal, from one of the Principal Investigators of the grant, from the College of Engineering web pages, from faculty members' web pages, and from observing a Learning Excellence planning meeting. These data were recorded and summarized in field notes. This information helped the researcher to understand the context in which these faculty members worked and the issues that were important to them.

Analysis of this initial data helped to select the characteristics of the participants whom would be in the study: tenured and tenure-track full time engineering faculty who had taught college or university classes within the last five years and who had an interest in learning about using team activities in their courses. At the next Learning Excellence meeting, the faculty members who met these characteristics were asked to participate in the research study.

Faculty members' willingness to participate was an important consideration in the selection of faculty. For this study, professors were asked to attend a faculty development workshop on implementing team activities in the classroom, to allow the researcher to observe their teaching at the beginning and end of the semester, to participate in three interviews, and to respond to three questionnaires during the Fall 1997 and Spring 1998 Semesters. Thus, participation involved a large time commitment and openness to having their teaching efforts observed. The Learning Excellence project participants were asked to participate in this study because they had already committed to learning about using team activities in their classrooms. If *these* participants did not implement team activities in their classes, their perceptions of what constrains faculty innovation in the classroom would be helpful for planning future efforts to initiate teaching change.

Seven of the 15 Learning Excellence engineering professors agreed to participate. Three of the participants were tenured professors whose teaching experience ranged from 14 to 25 years. One other tenured professor had less than 10 years teaching experience, while three others were non-tenured with 4 to 11 years of teaching experience. All participants were male.

INITIAL TEACHING OBSERVATIONS AND TRAINING

To collect baseline data about teaching methods currently used by the seven engineering professors, the researcher observed each professor as he taught one class and asked each one to 'wear' a micro-cassette tape recorder in their shirt pocket while teaching in order to record their lesson. Then the seven faculty participants attended a Professional Development Workshop on using team activities in college classes. At the beginning of the Team Building Workshop, the researcher asked participants to complete a questionnaire about their past experiences using teams in their classes; their previous motivation to use teams; how they assigned students to teams; and, increases or decreases in the last five years in their use of lecture, discussion, teams, projects, audio-visual, and e-mail or web-based communication with students. From a list of twenty factors, they were also asked to check all of the ones that had contributed to positive changes in their teaching.

The results of this questionnaire showed that six of the seven professors cited the following as factors that contributed to positive changes in their teaching:

- 'Your own desire to change'.
- 'Discussions with colleagues'.
- 'Observing a colleague teach'.

OPEN CODING OF THE QUALITATIVE DATA

Next, 'open coding' of the notes from the initial interviews, document analysis, questionnaires, and classroom observations was initiated. Open coding involves 'naming and categorizing phenomena through close examination of the data' [3, p. 62]. The open coding process also involves asking questions of the data. The question 'What enhances or constrains faculty members' willingness or ability to implement teams?' led to the identification of two major conceptual categories in the data: 'personal factors' and 'organizational factors.'

At this time, the research question was refined: In what ways do personal and organizational factors affect engineering faculty members' willingness to implement team activities in their

courses? These factors were used to frame the questions asked in a second interview with each of the seven participants in December.

DETERMINING CHANGE IN TEACHING PRACTICES

During December the researcher also attended a second session of each participant's class. The purpose of this observation was to determine if any changes in teaching methods had occurred in the class since the first teaching observation during the beginning of the Fall Semester.

Throughout the next twelve months the researcher continued to meet informally with the participants to discuss their attitudes toward changing teaching methods and to explore with them the factors that enhanced or constrained their implementation of team activities in their classes. All field notes, e-mail messages, discussions, and meetings or events attended were continually coded so that the emerging theory would be thoroughly grounded in the empirical data.

EMERGENCE OF FACTORS WHICH CONTRIBUTE TO CHANGE IN TEACHING METHODS

Two personal factors that enhanced the likelihood of a faculty member implementing team activities in their classes emerged from the data. The first involved a personal history of successful experiences working on teams or guiding teamwork—knowing how to use team activities in their classes. The second personal factor involved time available to implement the team activities into their class work—few time constraints.

Two organizational factors that influenced a faculty member's implementation of team activities also emerged from the data. One involved faculty members' perceptions of resource accessibility. The second organizational factor involved faculty members' perceptions of their own employment security.

EXTENDING THE LITERATURE REVIEW TO INCLUDE EMERGING FACTORS

The initial phase of data collection concluded with structured, open-ended final interviews of each participant at the end of the Spring Semester. Analysis of these third interviews consisted of checking to see if the categories developed from previous data held up over time, if any other categories emerged, if any faculty members had changed their ideas about using teams, and if any faculty members had now added team activities to their classes.

Based on the findings from the analyses of the second and third interviews of the seven engineering faculty members in December and May, the researcher reviewed additional literature about the personal and organizational factors that emerged from the data. Because the initial findings showed faculty members' perceptions of their previous experiences working on teams or guiding teamwork as important to implementing team activities in their classroom, the next literature examined was research about the effect of capability beliefs, or task-specific efficacy beliefs, on an individual's willingness to change activities in the workplace. Then an examination of the literature on time constraints faced by university research faculty was completed, because the seven professors said implementing team activities would require extra time for teaching preparation.

Since six of the seven professors in this study reported the importance of funding for course materials and teaching assistants if they were to implement team activities in their classes, it was important to examine studies on faculty perceptions of the availability of departmental resources. Additionally, a search evolved for literature on feelings of safety or employment security and their relationship to an individual's willingness to change to a new work activity since tenured as well as tenure-track faculty indicated concern that any unsuccessful efforts to initiate team activities could hinder their success in promotion and tenure decisions.

PREVIOUS EXPERIENCE

The initial analysis of the interview and observation data showed that those professors with positive previous experiences working on teams as undergraduate and graduate students or guiding teamwork as professors were more likely to implement team activities in their classes sooner than those who did not have positive past experiences. Likewise, those professors who had training on the use of team activities prior to the Learning Excellence workshop were more likely to implement team activities sooner than those who did not have training. In this study, five of the seven engineering professors who had positive previous experience as students working on teams implemented team activities in their classes. Further, the remaining two professors who were reticent to try team activities in their classes said that after the Learning Excellence workshop and the follow-up consultations, they felt more capable of trying some team activities in their classes. Ford [5] defined capability beliefs as 'expectancies about whether one has the personal capabilities needed for effective action' (p. 45). In one study, Bandura found that capability beliefs directly affected faculty members' willingness to alter their teaching methods: faculty members were more likely to select classroom activities that they felt they could successfully accomplish, either because of previous successful experiences or training [1].

Because Bandura's concept of self-efficacy was task specific, it was suitable for exploring the reasons for the occurrence of a singular event, for example, a change in teaching method.

Self-efficacy refers to beliefs in one's capabilities to organize and execute the course of action required to produce the given attainments or goals of a particular task [1]. According to self-efficacy theory, an individual's sense of mastery will not evolve unless he or she has experienced previous successful experiences at similar tasks. A history of success is needed in order to maintain high levels of motivation in the individual and the desire to improve one's skills through training. Self-efficacy theory states that an individual's sense of self-mastery evolves through positive, previous experiences or task-specific training. During this study's interviews, the faculty members were questioned about their previous experience and training on using team activities.

Corroborating evidence from analysis of the seven faculty members' previous experiences with team activities led to the development of the following hypothesis:

Hypothesis #1: Faculty who have a personal history of successful experiences working on teams or guiding teamwork will be more likely to implement team activities in their classes than faculty who do not.

TIME CONSTRAINTS

One of the major obstacles to changing teaching methods cited by the faculty in this study was time constraints. During the interviews, they expressed concern about the amount of time that it would take them to learn about a new teaching method, implement it in their classrooms, and then evaluate its results. For the non-tenured faculty in this study, time spent on teaching change was identified as time that could have been spent on research and publication. Similarly, Fairweather [6] also found that research university faculty were discouraged by the time required for reforms and believed that time spent on research, not teaching, remained the most reliable means toward advancement. Moreover, in a study of the top rated incentives identified by university faculty to increase teaching excellence, released time and sabbatical leaves devoted to instructional development rated highest at 62 percent [7]. Time is such a precious commodity for research university professors that instructional improvement may depend upon it. Hativa [8] concluded that neither instructional development workshops nor individualized consultation were very effective for changing teaching methods unless a substantial investment of consultation time was spent with the professors. Therefore, it appeared likely that research university professors, who were so often pressed for time, would view the amount of time necessary to initiate team activities in their classrooms as interfering with completion of other tasks.

The seven professors in this study seemed genuinely concerned about the best way to teach students, yet they felt constrained by the reality of being research university professors. They felt they were expected to spend time writing grants to support research predominantly, and teaching secondarily.

Since research university professors often view the amount of time necessary to implement team activities in their classes as taking time away from their other tasks, these findings led to the development of the following hypothesis:

Hypothesis # 2: Faculty who perceive less time constraints will be more likely to implement team activities in their classes than faculty who perceive more time constraints.

RESOURCE ACCESSIBILITY

Context beliefs are 'expectancies about whether the environment will be responsive to one's goal attainment efforts' [5, p. 45]. Rewards are an important source of departmental support. Supportive environments include departments which reward increased attention to teaching by reappointments, promotion and tenure, and increased merit pay [8]. Whether faculty members see their work environment as supportive or unsupportive of their personal goals and efforts may affect their decisions about whether to introduce innovative teaching methods in their classrooms. Five of the seven professors in this study suggested that faculty would be more likely to implement team activities when they perceived their work environment provided such resources as teaching assistants, reduced class loads, and educational consulting.

Since the qualitative findings showed faculty members felt that departmental resources had to be accessible and helpful in order for them to implement team activities in their classes, the following hypothesis was developed, testable with a larger population:

Hypothesis # 3: Faculty who perceive that departmental resources (e.g. teaching assistants, reduced teaching load, instructional development consultants, released time) are available and helpful will be more likely to implement team activities in their classes than faculty who do not.

EMPLOYMENT SECURITY

Schein's [9] resistance theory of change asserted that to evoke change, a manager must first understand the reasons why a person may be opposed to the change. In later studies of individual change, Schein [10] posited that a feeling of safety or job security was necessary before an individual would attempt a change in their work behavior. Often, a period of learning would be required before the

person would be able to accept or implement the change.

The qualitative analysis and Schein's theory suggested that faculty members who felt safe to innovate perceived that their employment security would not be diminished if the innovation were not successful. Those faculty members who did not feel that employment security was a factor in their tenure or promotion status were more likely to sustain using team activities in their classes or to be 'early adopters' of team activities in their classes. In contrast, those professors who were seeking tenure or a promotion and felt that their employment decisions could be hindered by using a new teaching method were more likely to be 'late adopters' of team activities in their classes.

This qualitative analysis and Schein's theory suggested that faculty members who felt safe to innovate were the ones who perceived their employment would not be jeopardized if the innovation failed. This sense of safety was reflected in the following hypothesis:

> *Hypothesis # 4:* Faculty who have a perception of safety and security in their employment status will be more likely to implement team activities in their classes than faculty who do not.

The interviews and teaching observations of the seven professors confirmed that during the first and second semesters two professors sustained their previous use of team activities, two professors were 'early adopters' of team activities with the help of team activities training, and three professors were 'late adopters' of team activities. The three late adopting professors had self-reported in their third interviews that they had implemented team activities in their classes during the second semester of the study.

QUANTITATIVE DATA COLLECTION, ANALYSIS, AND RESULTS

To see if the views of the seven participating professors were reflected among the rest of the College of Engineering faculty, a questionnaire survey was constructed. Its purpose was to test the working hypotheses derived from the qualitative analysis with the population of faculty working in the same context as the sample. It was administered to the 330 College of Engineering professors who had full time status and had taught classes within the last five years. Seventy-seven percent of the 113 respondents reported using team activities in their classes during the Fall/Spring Semesters. The proportion of faculty who reported using teams was larger than expected. It may be that those faculty who used teams were interested in the survey and therefore more likely than faculty who had not used teams to return the survey. There is no way to verify how many of the non-respondents used teams. Thus, there may be response bias in the results. Nevertheless, some useful information can be drawn from this sample since there is sufficient variation for meaningful analysis [11].

FACTOR ANALYSIS

Many of the survey questions focused upon the four factors from the previous data analyses that were most likely to affect whether a faculty member would or would not initiate team activities in their classes. For example, in question 12 of the survey, respondents were asked to use a Likert scale ranging from Greatly Constrains, Somewhat Constrains, No Effect, Somewhat Enhances, to Greatly Enhances to describe the degree to which a list of factors enhance or constrain the likelihood of them implementing team activities in one or some of their classes.

Next, a principal components factor analysis of the items in the survey with a varimax rotation was completed to reduce the large number of variables in the survey to a smaller number of variables, or factors (Table 1). Factor analysis finds patterns among the variations in the values of several variables, resulting in clusters of highly

Table 1. List of variables included in factor analysis ($n = 84$)

Q.12 To what degree do the following factors enhance or constrain the likelihood of you implementing team activities in one or some of your classes?	Mean	Standard Deviation
Extra financial support for the additional work	3.7	0.96
Teaching a course for the first time	2.0	1.04
Having a teaching or research assistant	4.3	0.63
Promotion and/or tenure evaluation	3.4	1.06
Workshop on using team activities	3.8	0.66
One-on-one help from a team activities consultant	3.9	0.82
Research requirements	2.4	1.09
Community and committee work	2.4	0.68
Reading articles in journals on using teams	3.6	0.65
Administering and writing grants	2.3	0.98
Responsibilities to family/friends	2.6	0.64
Past success in teaching using team activities	4.1	0.62
Support from colleagues	4.0	0.64
Team activities valued by Dept. Head or Dean	4.2	0.70

1 = Greatly constrains; 2 = Somewhat constrains; 3 = No effect; 4 = Somewhat enhances 5 = Greatly enhances

intercorrelated variables as factors. Factor Analysis is frequently used in survey research to determine if a long list of questions can be grouped into shorter sets of questions which would describe several factors of the phenomenon in the study.

The factor analysis produced three of the four factors and their corresponding statements (Table 2). Loadings greater than 0.5 are underlined. The factor analysis indicated the presence of three factors in which the rotated eigenvalues were close to 2.0 and the percent of variance explained by each factor exceeded 12%. Two additional factors were extracted from the factor analysis that had eigenvalues exceeding 1.0: these two factors each explained about nine percent of the variance. A scree plot indicated a cut-off point of 12.0%.

For the factor of Time Constraints, with a Cronbach's alpha equal to 0.72, the statements included: Teaching a course for the first time; Research requirements; Community and committee work; Administering and writing grants; and, Responsibilities to family/friends.

For the factor of Previous Experience, with a Cronbach's alpha equal to 0.648, the statements included: Workshop on using team activities; Past success using team activities; and, One-on-one help from a consultant.

For the factor of Employment Security (subsequently renamed Perceived Support to better reflect the results of the factor analysis for this construct), with a Cronbach's alpha equal to 0.705, the statements included: Support from colleagues; and, Team activities valued by Dept Head or Dean.

For the factor of Resource Accessibility, the Cronbach's alpha for question 12 was too low to be acceptable; however other questions on the survey were able to be used to operationalize this factor. For example, question 9 of the survey asked respondents to rate the availability of departmental resources to them.

LOGISTIC REGRESSION

Logistic regression was used to analyze the survey data because of the dichotomous dependent variable—implemented team activities—yes or no. Logistic regression is used when a dependent variable is dichotomous and can be scored 0, 1. It is used for predicting whether something will happen or not, such as whether or not a faculty member implements team activities in a class. Independent variables may be categorical or continuous in logistic regression analysis. Data is transformed by taking their natural logarithms in order to reduce nonlinearity. Rather than using ordinary least squares methods (which can be used when the independent variables are dichotomous, but not when the dependent variable is dichotomous), logistic regression estimates parameters through maximum likelihood estimation. A logistic regression analysis yields a probability of an event occurring (e.g. faculty use of team activities) which will be depicted as an odds or the natural log of that odds, referred to as a logistic probability unit or logit.

Bivariate analyses were used to test each hypothesis independently. Bivariate logistic regression was used to test whether each of the relevant survey questions was related to the dependent variable. Then, a multiple logistic regression model produced estimates of each independent variable in the model while controlling for all others in the model. Coefficients from the bivariate logistic regression analyses were comparable to results from the multiple logistic regression model. The intercorrelations among the independent variables were estimated with Pearson r product-moment correlation coefficients.

The logistic regression model was composed of variables selected from a stepwise regression analyses. In order for the model to contain variables representing all four explanatory constructs, the perceived support index and the resource

Table 2. Results from principal components factor analysis with Varimax Rotation ($n = 84$)

Time Perc. Prev. Constr. Support Exper. Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Extra financial support for the additional work	0.052	0.041	–0.175	–0.041	0.800
Teaching a course for the first time	0.737	–0.254	0.019	0.038	0.258
Having a teaching or research assistant	0.150	0.623	–0.078	0.150	0.031
Promotion and/or tenure evaluation	0.126	0.346	0.143	–0.637	0.330
Workshop on using team activities	–0.028	0.409	0.571	0.466	–0.094
One-on-one help from a team activities consultant	0.001	0.030	0.734	0.201	–0.026
Research requirements	0.714	–0.013	0.151	–0.170	–0.321
Community and committee work	0.527	0.230	–0.048	0.024	–0.549
Reading articles in journals on using teams	0.037	0.163	0.220	0.708	0.111
Administering and writing grants	0.743	0.203	–0.036	–0.088	0.054
Responsibilities to family/friends	0.663	0.282	–0.106	0.163	–0.056
Past success in teaching using team activities	–0.014	0.096	0.794	–0.114	–0.112
Support from colleagues	0.276	0.693	0.290	–0.091	–0.052
Team activities valued by Dept. Head or Dean	–0.112	0.812	0.158	–0.108	–0.035
Eigenvalue	2.454	2.091	1.749	1.279	1.266
Percent Variance	17.5%	14.9%	12.5%	9.1%	9.0%

accessibility variable were entered into the model as well (Table 3). The model is statistically significant ($p < 0.001$).

Hypothesis # 1

Results from the logistic regressions supported Hypothesis # 1, Previous Experience: Faculty who have a personal history of successful experiences working on teams or guiding teamwork will be more likely to implement team activities in their classes than faculty who do not. These results indicate that respondents who attempted to use team activities in the past but were unsuccessful were more likely to use team activities than those who had never used team activities in the past. Those who were successful using team activities in the past were the most likely to use team activities in the Fall/Spring Semesters ($p < 0.001$). Results from a cross-tabular analysis indicated that 41% of the respondents who had not used teams in the past used them in the Fall/Spring Semesters, compared to 64% of those who had used them unsuccessfully in the past and 94% of those who had used them successfully in the past.

In addition, respondents who had received training on team activities were significantly more likely to use team activities during the Fall/Spring Semesters than those who had not received team activities training ($p < 0.05$). Results from a cross-tabular analysis indicated that 89% of those who had training used team activities compared to 67% of those who did not have training.

Hypothesis # 2

Results also supported Hypothesis # 2, Time Constraints: Faculty who perceive less time constraints will be more likely to implement team activities in their classes than faculty who perceive more time constraints. Those respondents who had higher scores on the time constraints index were significantly more likely to use team activities during the Fall/Spring Semesters than those scoring lower on the Index ($p < 0.05$). A lower score on the index indicates that respondents rated various factors as constraining the likelihood that the respondent would implement team activities in one or some of their classes. On average, those who used team activities during the Fall/Spring Semesters had a score of 2.4 on the index while those who did not implement team activities had a score of 2.0.

Hypothesis # 3

Results from the logistic regressions did not support fully, however, Hypothesis # 3, Resource Accessibility: Faculty who perceive that departmental resources (e.g. teaching assistants, reduced teaching load, instructional development consultants, released time) are available and helpful will be more likely to implement team activities in their classes than faculty who do not.

Hypothesis # 4

Results also did not support Hypothesis # 4, Employment Security (Perceived Support): Faculty who have a perception of safety and security in their employment status will be more likely to implement team activities in their classes than faculty who do not.

EFFECT OF INSTITUTIONAL CONTEXT

Although both resource accessibility and employment security (perceived support) emerged as important in the qualitative analysis, there are at least two possible reasons why these two factors did not appear as significant in the quantitative study. First, the institutional context within which this study was conducted may be unusual.

While this university is a major research university and stresses research, the College of Engineering has also made great efforts to improve the quality of its teaching and has won a national award for teaching. It may be that this college is above average in its support of teaching and may be making resources more accessible for teaching, while providing a secure atmosphere for teaching innovation. For example, the frequency distribution of background information measures showed that for Question 8 of the survey, 81.7% of the respondents cited 'Discussion with colleagues' as a

Table 3. Logistic Regression Analysis: Relationship Between Use of Team Activities During Fall '97/Spring '98 Semesters and Independent Variables Measuring Previous Experience with Team Activities, Time Constraints, Resource Accessibility, and Perceived Support ($n = 90$)

Independent Variable	Beta		Standard Error
Q2/Q2a. Tried team activities in classes prior to Fall Semester 1997 (1 = No; 2 = Yes, Unsuccessful; 3 = Yes, Successful)	1.8098	***	0.4679
Q4. Have training on team building	2.7257	*	1.0704
Q12. Time Constraints Index	1.5211	*	0.7750
Q9. Department resource(s) not available	9.1224		31.9334
Q12. Perceived Support Index	–0.1151		0.7303
Constant	–1.1448		3.4606
Model G2 = 53.676; *df* = 5; $p < .001$			

* $p < 0.05$; *** $p < 0.001$

resource that contributed to positive changes in their teaching. This data is supported by the qualitative analysis that found six of the seven professors citing this same factor as a contributor to positive changes in their teaching.

Furthermore, Question 10 asked who influenced respondents' decisions about whether or not to use team activities in classes, and the 'Department Head' was rated highest (Mean 3.6, out of 5). These data may indicate a supportive climate for change by the college and the department as they begin to implement the recommendations of ABET for accreditation and curriculum reform.

Additionally, the College of Engineering recently instituted a Continuous Quality Improvement Plan whose goals for professors included: working in teams in collaboration with colleagues; participation in training related to educational activities; encouragement of teamwork and cooperation among students; and using statistical tools to analyze the data collected to improve teaching and learning. Since 77% of the survey respondents reported using team activities, and 41% of the respondents had not used teams before Fall '97 Semester, it seems likely that team initiatives have been encouraged in the College of Engineering. For these reasons, it may be important for resource accessibility and employment security (perceived support) to be tested at other research universities, where less emphasis on teaching is being placed, before these constructs are deleted from this model.

Another reason why resource accessibility and employment security (perceived support) may not have appeared as significant in the quantitative study is because of methodology and construct validity. There was only one survey item representing resource accessibility, and it was skewed in favor of having resources. There may be other survey items that would measure resource accessibility better than those used for this study.

Finally, resource accessibility may be subsumed under the categories of employment security (perceived support) and time constraints. For example, having a teaching assistant might be viewed as a resource, and when given to a professor by a department head, might be perceived as a sense of reward or perceived support by that faculty member. Or, having a teaching assistant might be a time saver for a faculty member, thus alleviating some time constraints. Future research could be done to tease apart these issues.

CONCLUSIONS

Four conceptual categories emerged from the data: previous experience, time constraints, resource accessibility, and employment security. A substantive theory was developed that involved propositions about these four factors that affect engineering faculty members' implementation of team activities. The substantive theory was grounded in the data and provisionally verified by a larger population: Given an environment where teaching experimentation is valued and time is provided for curricular planning, research university faculty will implement team activities in their classes.

Creating an environment conducive to classroom experimentation includes providing opportunities for training, encouraging communication among colleagues about educational initiatives, arranging flexible schedules to allow faculty to observe each other teach, minimizing the number of times a professor teaches a course for the first time, and providing access to educational conferences. Previous experiences with team activities, either having participated as a team member while a student, professor, or industry worker, guiding teamwork in the classroom, or learning about how to implement team activities, are related to the use of team activities in the classroom by research university professors. Previous experience can vary from past success in teaching using team activities, participating in a workshop on using team activities, or one-on-one help from a team activities consultant.

One especially interesting finding from this study was that even unsuccessful experiences using team activities were related to future use of team activities in the classroom. It may be that research university professors are accustomed to experimenting, and trying a previously unsuccessful activity again becomes an opportunity to discover and correct what went wrong. Future research may explore the reasons why this phenomenon occurs, whether it is influenced by a personal characteristic such as persistence or resilience, for example. What we do know from this study is that attempts at using team activities in the classroom, whether successful or unsuccessful, resulted in more usage of team activities during following semesters.

The fewer the time constraints experienced by faculty, the more likely they are to implement teaching innovations, such as team activities. Time constraints may include teaching a course for the first time, research requirements, community and committee work, administering and writing grants, or responsibilities to friends and family. For research university faculty, time spent on teaching innovations may interfere with their other responsibilities. Faculty in this study reported their mean hours worked per week as 54.9 with means of 19.6 hours on teaching, 25.2 on research, and 12 on service. Fitting extra hours into their schedules to plan for teaching changes can be difficult to do for research university faculty.

Resource accessibility was often cited as important for implementing team activities by the qualitative participants in this study. Yet, in the survey of the entire College of Engineering, this factor was not significant. It may be that the Learning Excellence project participants were more aware of the

extra monies available for initiatives, such as from the Learning Excellence project's funds, than were other professors in the college.

The employment security factor, renamed the perceived support factor after the factor analysis, had a small effect on the qualitative participants, similar to the survey respondents in the college of engineering, for whom this factor was not significant.

A large proportion of tenured faculty (two-thirds) were among the respondents in this study. Did this present a bias? To see whether the results of this study would be different for tenured and untenured professors, further analyses were broken down by these two categories. These bivariate logistic regression analyses were consistent with the first set of bivariate logistic regression analyses. Prior use of team activities was a significant predictor of use of team activities during Fall '97/Spring '98 Semesters for both tenured and non-tenured respondents ($p < 0.001$ and $p < 0.05$, respectively). Similarly, prior training on team building was related to the use of team activities for both tenured and non-tenured respondents ($p < 0.07$ and $p < 0.05$, respectively). The time constraints index was significantly related to the use of team activities among tenured respondents ($p < 0.05$), with a somewhat weaker effect on non-tenured respondents. Both the resource accessibility and perceived support factors were non-significant for both groups.

Although accreditation requirements for ABET's Year 2000 state that an understanding of and ability to work well in a team is important for the future engineering workforce, some difficulties seem imminent in the incorporation of team activities in research university classes. As this study suggests, previous experience and training are important factors for the initiation of team activities in the classroom. Furthermore, the amount of extra time needed to plan and implement team activities could contra-indicate their usage, especially for professors trying to meet heavy research requirements. It seems likely that creating an environment conducive to experimentation and easing time constraints to allow for learning about new teaching activities will be helpful in furthering the use of teaching initiatives, like the use of team activities, in the research university classroom.

RECOMMENDATIONS

- *Foster conditions for faculty members to try innovations in their classrooms*. From the qualitative study, faculty members who were 'sustainers' or 'early adopters' were likely to continue using team activities in their classes. Even 'late adopters,' while more reticent to begin team activities, self-reported that they had already made plans to continue to use team activities in later semesters. In the quantitative study, those faculty members who had tried team activities in the past, whether successful or not, were significantly ($p < 0.001$) more likely to try team activities again than those faculty who had never attempted using team activities in their classes.
- *Encourage faculty members who express a desire to change teaching methods*. Both the qualitative (86%) and quantitative respondents (92.7%) cited 'Your own desire to change teaching methods' as one of the important factors that contributed to positive changes in their teaching methods.
- *Provide training on how to use a new teaching activity in their classes, using discipline specific workshops, consultants, and one-on-one follow-up activities with consultants, colleagues, and mentors*. Respondents to the survey cited their sources of learning about team activities: 50% 'Self-directed learning by reading about team activities;' 42.6% 'Colleague/mentor shared their experiences;' 42.6% 'Faculty workshop sponsored by the College of Engineering;' and 31.5% 'By observing other faculty members teach.' Faculty in this study were trying to learn more about how to implement team activities in their classes, often reverting to self-directed learning when no other training was available.
- *Help faculty members deal with the time constraints under which they must labor*. When asked, 'To what degree do the following factors enhance or constrain the likelihood of you implementing team activities in your classes?' all of the responses that dealt with constraints were time constraints factors: 'Teaching a course for the first time' (2.0 on a scale of 5 where 1 equals greatly constrains and 5 equals greatly enhances); 'Administering and writing grants' (2.3) 'Research requirements' (2.4); and 'Community and committee work' (2.4). And two of the enhancers, 'Having a teaching or research assistant' (4.3) and 'One-on-one help from a consultant' (3.9) were considered time savers by the participants in the qualitative study. Thus, Department Heads could help faculty by providing released time from some duties, assigning teaching or research assistants to them, and providing opportunities for them to work with an educational consultant.
- *Encourage faculty members to observe their colleagues teach*. This was one of the most important ways faculty learned how to use new teaching methods. In the survey, nearly a third (31.5%) of the respondents said this was how they had learned about using team activities.
- *Encourage dialogue among faculty on educational innovations*. Colleagues remain an important factor in using team activities, whether being observed in the classroom, or being engaged in conversation with each other. Survey respondents (81.7%) cited 'Discussions with colleagues'

as a factor that contributed to positive changes in their teaching.

While the evidence for the roles of resource accessibility and employment security are still out, the availability of these two factors may also determine the degree to which faculty members introduce innovations in their classrooms.

RECOMMENDATIONS FOR FUTURE RESEARCH

Since this study was conducted in a single institution, in a single college, future research is recommended with larger populations in multi-institutional settings. Similar case studies could be conducted in several institutions deliberately selected for supportive and unsupportive environments for teaching innovation.

The faculty who participated in the qualitative section of this study were male engineering professors. Additional research is recommended that will include qualitative inquiry among female professors.

The representativeness of the sample regarding rank, age, and career age was not known because these possible identifiers were excluded from the survey to reduce respondents' anxiety about responding to the survey. Future research should include these variables.

The survey questionnaire was developed for this study since no other instrument was available to measure the intended constructs. For future studies, a revised questionnaire could be developed. For example, since the survey does not touch upon employment security as a factor after tenure, additional questions could be added, such as, 'Are you hoping for a promotion in the next three years?' Hopefully, these questions would help fill out the categories delineated by the factor analysis. In this study, there were some categories with only one or a few variables in them. Additional questions might produce other variables that would measure the constructs better.

Additional ways to refine and test theory should be developed. For example, further qualitative study with a larger sample could be used to confirm or deny the results of this first study and to help develop items for subsequent surveys with improved construct validity.

Because the successfulness of team activities was self-reported in the survey, future research may want to include teaching observations of a larger population to determine if the team activities were indeed successful. Student responses to team activities and their level of learning could also be studied to determine the level of success of this teaching method.

Additionally, studies could examine the use of team activities in graduate classes from the students' perspectives, as well as the faculty's perspectives, to explore whether team activities could be used as effectively in graduate classes as in undergraduate classes. In the qualitative analyses, two of the three professors who were 'late adopters' said that they hesitated to implement team activities in their graduate classes. They gave as their reasons: language barriers of foreign students, advanced material needing more professorial explanation, and increased amounts of material to cover. They did, however, express a willingness to encourage out-of-class assignments and projects to be completed by teams of students. It is unclear what effect graduate teaching assignments may have had on this study because graduate or undergraduate classes were not differentiated in the questionnaire.

Strauss and Corbin [3] describe a substantive theory as one that 'evolves from the study of a phenomenon situated in one particular situational context' (p. 174). In contrast, a formal theory 'emerges from a study of a phenomenon examined under many different types of situations' (p. 174). In this study, a substantive theory emerged from the data: Given an environment where teaching experimentation is valued and time is provided for curricular planning, research university faculty will implement team activities in their classes. To build a substantive theory, this study examined one teaching method in one context. To develop this substantive theory further, other studies could explore the same teaching method in a different context, or different teaching methods in the same context, to arrive at a more formal theory about why faculty change their teaching methods.

REFERENCES

1. A. Bandura, *Self-efficacy: The Exercise of Control*, Freeman and Company, New York (1997).
2. B. G. Glaser and A. L. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Aldine de Gruyter, New York (1967).
3. A. L. Strauss and J. Corbin, *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*, Sage Publications, Newbury Park, CA (1990) pp. 62–174.
4. A. L. Strauss and J. Corbin, *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 2nd Ed., Sage Publications, Thousand Oaks, CA (1998).
5. M. E. Ford, *Motivating Humans: Goals, Emotions, and Personal Agency Beliefs*, Sage Publications, Newbury Park, CA (1992) p. 45.
6. J. S. Fairweather, *Faculty Work and Public Trust: Restoring the Value of Teaching and Public Service in American Academic Life*, Allyn and Bacon, Boston (1996).
7. E. P. Cook, P. Kinnetz, and N. Owen-Misner, Faculty perceptions of job rewards and instructional development activities, *Innovative Higher Education*, **14**(2), (1990).

8. N. Hativa, Improving instruction in veteran physics professors, *Research in Higher Education*, **31**(6), (1990) pp. 573–586.
9. E. H. Schein, How can organizations learn faster? *Sloan Management Review*, **34**, (1993) pp. 85–92.
10. E. H. Schein, *Kurt Lewin's Change Theory in the Field and in the Classroom: Notes toward a model of managed learning*, MIT Sloan School of Management (1997).
11. J. A. Maxwell, *Qualitative research design: An interpretive approach*, Sage Publications, Thousand Oaks, CA (1996).

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