Rediscovering Learning: A Survey of Factors that Affect Student Learning in Engineering Education

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Abstract

Innovations in technology, curriculum, and programs in engineering education are all directed toward the improvement of learning for engineering and technology students. In the pursuit of these beneficial tools as a support to learning, the basics of learning, as the student sees them and proven by experience and research, must not be forgotten.

Extensive surveying has been done in the College of Engineering and Technology at Brigham Young University to identify factors that promote and learning. Over one-thousand students and alumni in the College were surveyed to identify the key facilitators of learning. Results show an interesting shift of some factors important to active students but not as important to alumni, while other factors maintain strong position regardless of the level of student or time in field for alumni. Some of these factors include faculty knowledge and interest in teaching, grades and grading methods, hands-on experience, and type of homework.

A report will also be given of a survey of students who had participated in classes which uses a teaching method in which students are given full control over their grade. The intent of this method is to oblige students to accept responsibility for learning and be more interested in understanding and applying the course material than competing for a grade.

Motivation for the Survey

This effort was prompted by an exercise which used questions about learning to teach the use of an affinity diagram in a quality assurance class in summer of 1995. The results proved enlightening and prompted further study. Additional surveys were given in a few other classes with a simple form similar to the one described below. Approximately a hundred Manufacturing Engineering and Engineering Technology students were surveyed in the first effort and provided the basis for subsequent surveys. A high number of students indicated grades and grading as a impediment to learning. It was thought this was in large part due to the fact that most of the students surveyed had participated in a class from the author who does not use grades and grading as a motivation for learning or performance. In order to determine if this concern about grades would be true across a broader population further surveying was conducted.

Survey Format and Method

The surveys to determine the factors that promoted and impeded students learning was completed in three phases, two for the students, and one phase for alumni. The first phase consisted of providing students with a half page sheet which asked the following questions:

1) List three things that occur in the educational process at BYU that promote learning from your perspective.

2) List three things that occur in the educational process at BYU that impede learning from your perspective.

Each question was followed by three blank lines where the student could write in their responses. This survey was given to two hundred and seventy-five students, primarily junior, senior and graduate student level. It covered eight different classes in manufacturing engineering, engineering technology, mechanical engineering, civil engineering and chemical engineering. This same survey, with changes to past tense on the words occur , promote , and impede , was sent with a Christmas greeting to eight hundred alumni. Just under three hundred responses were received from the mailing.

The first student survey was followed with a second survey using a menu format. The items listed were the top 16-20 items listed from the previous fill-in-the-blank survey, arranged in random order. The students were then asked to check the top three items for both questions asked previously regarding learning. A comment line was left open for students to list a factor

not included in the table. When taking the survey students were asked to consider their entire educational experience. Just over two hundred fifty of surveys were completed from the following areas: Electrical and Computer Engineering, Mechanical Engineering, Civil and Environmental Engineering, Chemical Engineering, and Manufacturing Engineering and Engineering Technology.

The first survey (the fill-in-the-blank) was administered to determine what current students felt were the most critical factors in promoting and impeding learning. The alumni survey was administered to determine how those who had graduated 3-8 years earlier felt about their experience and what factors they deemed critical. The menu survey was used to corroborate the results of the first two surveys by determining what factors (limited to 3) current students would select from a given list. Factors selected by all three groups would be judged as most important.

Results

One of the most interesting parts of this project was to compare factors that shifted and those that remained stable as the audience and survey type varied. For example, in Table 1 (promote factors) there is good consistency between the initial (fill-in-the-blank) survey and the Alumni survey of the same format. Some rearranging of factors occurred, however, 6 of the top 7 student items were also listed by the alumni, and 5 of the 7 factors were rated in the top 7 by all three groups. The impede factors were not as conclusive. Only 2 of the factors were rated in the top 7 by all three groups (poor professor and focus on grades), and nearly two times as many total factors were required to include the top 7 of each survey. This was also reflective in the impede surveys, in which the answers were written, both having a much greater number of factors listed than the promote factors. Also, about 20% of the alumni surveys left the impede portion blank, stating they were very pleased with their education and could not think of any negative aspects.

The top two promote factors universally indicated by students are good professor and hands-on experience. At least one of these items was selected by nearly 80% of the respondents. These items ran neck and neck in terms of total count and were significantly ahead of the other factors. Three of the remaining five factors, group work, having good and available resources, and having the teacher available to help and answer questions, ranked in the top 7 of all three surveys. Students defined good professor as having the following characteristics: respects students, is friendly and good natured, motivates students to want to learn, cares about the students, trusts students, guides students in the learning process, promotes a learning atmosphere, loves the subject, and is approachable. Students indicated that this did not mean the professor was a pushover. They indicated that some of the best pushed them very hard, but they knew the professor cared about them and was willing to listen when students needed to express concerns and make suggestions. They contrasted this with someone who pushed them by being rude, condescending, and treating them like third class citizens.

As shown in Table 2 only two impede factors, Poor professor and Focus on grades with poor professor being 1 or 2 in each survey, were common in all three surveys. Students defined a poor professor as having the following characteristics: tries to force learning, is arrogant and condescending, monotonous, wants students to memorize not learn, more concerned about the class GPA than what students learn, doesn t trust students, tries to judge what students have learned, rude, does not want to teach and lacks excitement and knowledge about the subject. The focus on grades is a key point of impedance for students. In discussions with students and faculty it often stated that one of the reasons for grades is to motivate students to learn, but this did not show up as a factor for promoting learning. In fact of nine hundred total surveys received grades were indicated by only 6 students as a factor promoting learning. Of particular dislike is the forced curve distribution grading method. This method promotes intense competition, causes feelings of hopelessness and high frustration for most students. None of these promote learning.

If lack of time , the top pick in the menu survey, was combined with course-work overload it would be near the top for the student surveys but did not show in the top 7 in the alumni survey. When asked about the number one ranking of lack of time , many students basically dismissed it as a cop-out because it was an easy first pick on the list. Others acknowledged they were very busy but knew it was a part of life and actually felt it would teach them to set priorities and learn good time management. Skills that would be of benefit later in life. This may be, in part why lack of time did not show up in the alumni survey. When asked if course work overload and lack of time were the same thing, most said they were not (thus the reason they are listed separately). Course work overload was defined as simply too much work for the course s credit hours. Comparatively lack of time referred to jobs, family responsibilities (the majority of students in the upper division classes at BYU are married), and church or other volunteer responsibilities. One high scoring point from the alumni survey was the factor of insufficient

counseling. This factor, along with others, will be addressed in more detail in a follow-up survey in fall 96.

Table 1

FACTORS THAT PROMOTE LEARNING

Item	Initial Survey	Alumni Survey	Menu Survey
Hands-on activities/projects	1	1	2
Good Professor	2	2	1
Group Work	3	6	4
Available resources (equip. and labs)	4	3	7
BYU Environment	5	5	
Teachers is available	6	4	6
Class useful	7	8	9
Co-op experience		7	
Examples in class			3
Well-written text			5

Table 2

FACTORS THAT IMPEDE LEARNING

Item	Initial Survey	Alumni Survey	Menu Survey
Poor professor	1	1	2
Poor tests, etc.	2		
Focus on grades	3	4	6
Course work overload	4		5
Lack of hands-on work	5		8
Poor lectures	6		
Poor/lack of equip	7	3	
Busywork	8		4
Gen. Ed courses	9	5	
Large classes	10	8	7
Insuff. counseling		2	
Myself/personal		6	9
Inflexible program		7	
Lack of time			1
Poor text			3

A Survey on Learning Without Grades

A second survey conducted through BYU's Faculty Development Center and completed in early 96 evaluated the effectiveness of a approach to learning which concentrates on the student accepting responsibility for learning. This method, which is used in various ways by faculty at other institutions, does not use grades as a motivation or requirement in the class. The first day of class students are told they have control over their own grade. The course syllabus identifies a significant number of expectations including homework assignments, chapter reviews of the text, tests, a major project, lab reports etc.

The intent of the grading (or lack of) policy, which is clearly explained to the students, is to eliminate most or all of the inclination students have to figure out what the professor wants , or to only do what is necessary for a certain grade. Instead students are encouraged to concentrate on learning concepts and tools, and even to learn about themselves and how they work.

This method has been used in classes taught by the author over the last two years including a junior level Quality Assurance class, senior level Production Planning class and Engineering Ethics class, and a graduate level Technical Management course. Every student who has been in a class where this method has been used over the previous two years was sent a survey with the questions listed in Table 3. Class sizes ranged from 8 to 50. Of one-hundred and ninety-five surveys sent, one hundred eighteen responses were received yielding just over a 60% return. Of these responses, 82 added detailed comments identifying particular points and advantages of the learning method. The high response rate and the nature and type of comments can be attributed to the strong feelings students had about the method and its effectiveness. This survey was administered by the Faculty Development Center, which is independent of academic departments. This was done in order to solicit unbiased responses from the students.

Common themes of the comments were:

1) the increased deep learning that occurred

2) the high incidence of students who were excited to accept responsibility for their own learning

3) the motivation to learn changed from the grade to self-improvement and real interest in the subject.

These common themes of motivation (deep and thoughtful learning, and acceptance of responsibility) are critical elements in an effective learning process.

There are important assumptions that must be clear to the teacher in order for this kind of a method to work. These include:

1) Students can be trusted.

2) Students want to learn and be challenged.

3) The teacher must be willing to have an open class and admit he does not have an answer to every question.

4) More work and preparation required by the teacher.

5) Students must be able to trust the teacher.

6) Students, and their ideas must be respected.

7) Students learn in different ways and at varying paces.

There are also important expectations on the part of the student. These include:

1) Students must be honest with themselves and others.
2) Students may propose different assignments and expectations, these should be discussed with the teacher.
3) The students will complete and turn-in a portfolio containing all work completed during the semester.
4) The student will give honest an effort to understand the purpose of assignments and expectations.
5) Students must be willing to evaluate their growth and assign the grade or at least participate in the assignment of the grade at the end of the semester.

The activities and tools for evaluation in the classes are still much the same as before. The motivation for using them has changed. For example, tests and quizzes are still used regularly including mid-term and final exams. Before any test or activity the key question is, how can this test (assignment, paper, etc.) help the student understand where they are and learn more than they did before. These same instruments are also used to determine the level of the students understanding. This is important in order to clear up any misunderstandings and ensure all students know the requisite material.

Conclusions

Research on learning is prolific. Factors that promote and impede learning are a significant part of the research and studies in education. Linskie [1] describes that basic needs that must be met for learning to occur. These are: first physical needs, such as the physical state of the student and the physical environment of the classroom. Second the students emotional needs that can usually be met by the teacher showing respect for the student. Third is social needs. The student must have a feeling of self-worth and belonging. Learning accelerates in classes where the environment allows the student to identify with the class curriculum and the other students in the class. If they know they are missed when they are absent, they will be more a part of the learning process.

Linskie also states motivation is a process which leads students into experiences in which they can learn. [1] There is no one way to motivate. Motivation to learn is as varied as the ways people learn. Two things are clear about motivation. First, intense competition, caused by grading or other such methods, ignores individual differences and allows for little flexibility. Therefore competition becomes an impediment rather than a promoter to learning. The good professor reflects the respect for the student and the flexibility necessary for students to learn. In Practical Points for University Teachers, Cox [2] describes the effective learning environment as 1) having good communication, 2) good human relationships, and 3) correct motivation. Good professors foster these things. Cox also describes 3 approaches to learning used by students. Surface learning is when the students primary concern is to complete the course, memorize facts and equations. This results in superficial learning. A second approach is the strategic level. Students are motivated by a need to compete and play the system. The third level is deep learning. Here the motivation for the student is a desire to learn about the subject and gain a deep understanding of it.

Table 3

Questions from the Hawks Class Survey
Key 5=Strongly Agree, 4=Agree, 3=No difference, 2= Disagree, 1=Strongly Disagree
As a result of Professor Hawks grading policy and course structure:

The survey of the Engineering and Technology students reflect the statement of basic principles of learning described by Cox s and Linskie s research. Good professors are critical for students to experience effective learning as they provide an environment where deep learning occurs and talents can flourish. Activities provided in the class by the teacher then serve to accommodate learning styles, provide flexibility, meet social needs that foster learning, and provide thoughtful experiences. Some traditionally accepted methods such as grading, particularly forced curve distributions severely damage deep and thoughtful learning by the student. Too many professors, in an effort to curb the perceived grade inflation problem use this method. Students will respond better when they are trusted, challenged, and given opportunity to grow. Learning is much greater for the student and the teaching and teaching is more rewarding.

References

1. Linskie, Rosella. The Learning Process: Theory and Practice, New York, VanNostrand, 1977
2. Cox, Bill. Practical Pointers for University Teachers, Philadephia, Kogan Page, 1994

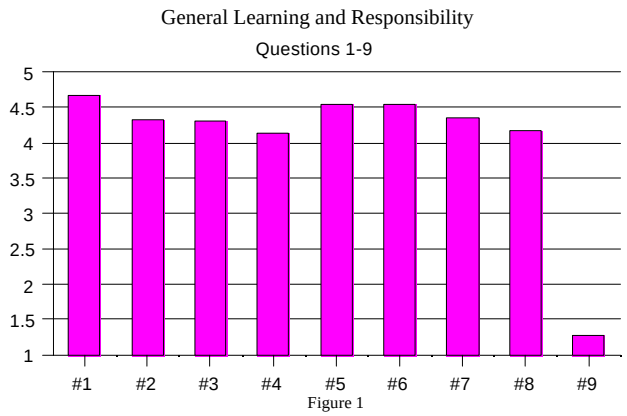

Figure 1

#1 I felt increased responsibility for my learning.
#2 I worked harder on assignments and readings
#3 I tried harder to understand material.
#4 I attended class more frequently.
#5 I finished the course with a better understanding of the material.
#6 I felt more motivated to learn.
#7 I felt more willing to try different ways of learning.
#8 I shared/discussed more of the material with other outside of class than I otherwise would have done.
#9 I felt the instructor was not fulfilling his duty as a teacher.

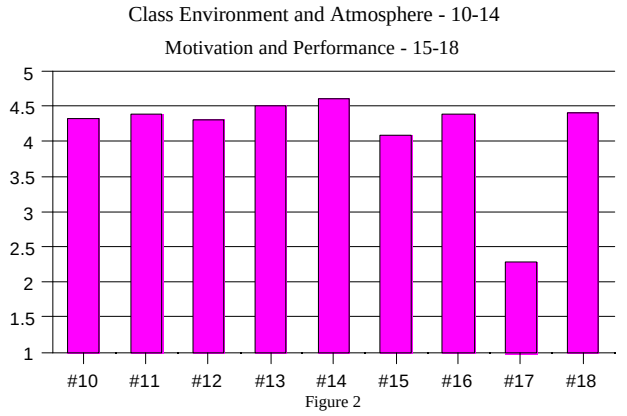

Figure 2

#10 had a positive effect on my openness in class.
#11 had a positive effect on the openness of students in class.
#12 had a positive effect on the instructor s openness in class.
#13 allowed for more open discussion in class.
#14 made it more enjoyable to come to class.
#15 increased my performance on assignments that would normally be graded (test, homework, etc.)
#16 increased the quality and thoughtfulness of performance on assignments (IE reports, papers, etc.)
#17 caused me to submit assignments later than I usually do because of the lack of enforced deadlines.
#18 motivated me to want to learn more about the subject even after the class was over.