Learning from Freshman Perspectives: A Two-Dimensional Approach to Increasing Student Satisfaction

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Abstract

Improving retention of engineering students often depends on their experiences in core mathematics and science courses during their freshman year of college. For this research, freshman students enrolled in an introductory engineering design course at a large midwestern university were asked to identify five ways in which their Calculus or Chemistry course could be redesigned. Herzberg's motivation-hygiene theory (1966) is used as an interpretive framework to examine the student's perspectives on how to improve these core courses within the engineering curriculum. The student's suggestions for course redesign were classified into motivation and hygiene factors. The results show that a majority of the suggestions involved extrinsic hygiene factors such as reducing class size, and providing more comfortable chairs and larger tables. Fewer responses were received related to intrinsic motivation factors such as course content. This finding points to the need for a two-dimensional approach to increasing student satisfaction. Although Herzberg cautions that the effects of improved hygiene are of short duration, educators should not disregard their role in student satisfaction by focusing exclusively on intrinsic motivation factors.

Introduction

Core courses in mathematics and science have a significant impact on the retention of engineering students. For students majoring in science, mathematics, and engineering, the greatest attrition occurs between the freshman and sophomore years[1]. Learning more about students' perceptions of their core courses will enable us to improve these courses, as well as positively influence the retention of engineering students. For this research, freshman students in a large introductory engineering design course were asked to identify five ways in which their Calculus, Chemistry, or Physics course could be redesigned. The question was asked as part of a regular weekly homework assignment. The students were subsequently asked to voluntarily submit their answers for research purposes. Due to the low number of responses pertaining to Physics, this course was removed from the investigation. Initial analysis of the students' suggestions for redesign revealed a strong emphasis on environmental factors that had little to do with the content of the courses or the material they were expected to learn. Based on this observation, we decided to use Herzberg's motivation-hygiene theory as an interpretive framework.

According to Herzberg[2], the determinants of job satisfaction and dissatisfaction are two distinct groups. Job satisfaction is determined by motivation factors that are intrinsic to the work and address a person's need for growth or self-actualization. These motivation factors include achievement, recognition, the work itself, responsibility, and advancement. Job dissatisfaction is determined by a second set of factors, referred to as hygiene factors, which are extrinsic to the work and relate to a person's need to avoid unpleasantness. Hygiene factors include administrative policies, supervision, interpersonal relations, and working conditions. Because humans possess two independent needs (first, to avoid pain or unpleasantness; and second, to discover, achieve, actualize, and progress), each need must be addressed individually. Meeting one of man's needs has little effect on the other. Thus, motivation factors do not influence job dissatisfaction and, hygiene factors do not contribute to job satisfaction.

Herzberg used his theory to reinterpret industrial relations phenomena. He observed that many companies only paid attention to hygiene factors. While acknowledging the importance of these factors for ensuring that employees were not unhappy, he stressed that attending to them would not "unleash positive feelings and the returns of increased creativity, productivity, lowered absenteeism and turnover" (p. 169). He suggested reorganizing the industrial relations function into two formal divisions, one for the hygiene-need system of the employee and one for the motivation needs. By doing so, companies could use human beings more effectively by treating them in terms of their complete nature.

This theory of motivation does not need to be constrained to industrial applications. In an educational setting, humans have the same two independent needs. Students wish to avoid unpleasantness in their courses and at the same time discover, achieve, actualize, and progress. For example, a student taking a course in a luxurious environment who is not challenged by the course content would have both a low level of dissatisfaction (experienced unpleasantness) and a low level of satisfaction (growth and self-actualization).

When applying motivation-hygiene theory, the key difference between academia and industry lies in the focus of attention. Whereas industry generally focuses on the hygiene needs of employees, academia tends to emphasize the motivation needs of their students. One example of this tendency is the active learning approach. Active learning can be characterized by the following strategies[3]:

- Students are involved in more than listening.
- Less emphasis is placed on transmitting information and more on developing students' skills.
- Students are involved in higher-order thinking (analysis, synthesis, evaluation).
- Students are engaged in activities (e.g., reading, discussing, writing).
- Greater emphasis is placed on students' exploration of their own attitudes and values.

Each of the strategies listed above is aimed at the motivation needs of students. While these needs are very important (and active learning is an approach that we fully believe in), the hygiene needs of students should not be ignored. Attention to both hygiene and motivation factors will best serve the needs of the students and increase our chances of retaining them in engineering by decreasing their dissatisfaction and increasing their satisfaction.

Methods

The responses for this study came from students enrolled in an introductory engineering design course during their first semester at a large midwestern university. There were approximately 225 students enrolled in the course. They were all asked to respond to the following item as part of a weekly homework assignment:

> *Most of you are in Calculus, Chemistry or Physics this semester. Generate 5 ideas to redesign or reengineer one of these courses.*

Following the homework assignment, the students were asked to voluntarily submit their answers for research purposes. Seventy-three students did so for a 32% response rate. Of the 73 responses, one was eliminated because it was the only one related to Physics, and one was eliminated because the student was not currently enrolled in one of the requested courses. For the 71 remaining participants, 43 people (61%) addressed Calculus, and 28 people (39%) addressed Chemistry. Multiple Calculus and Chemistry courses were included because the students were enrolled in different courses (for example, Calculus I or Calculus II), as well as different sections with different professors and teaching assistants. The responses were not broken down by specific courses because not all students identified the specific course they were taking.

Basic demographic data were collected to describe the group of respondents. The students ranged in age from 17 to 20 with an average of 18.2 years. Six of the students (8.3%) identified their race as something other than white/Caucasian, and ten of the respondents (14.1%) were female. Due to the small numbers of female and non-white participants, comparative analysis between demographic sub-groups was not performed.

Analysis and Results

The students' suggestions for course redesign were categorized using Herzberg's first-level factors (achievement, working conditions, etc.). Before presenting the quantitative results, it is necessary to describe more fully how Herzberg's theory was applied to an educational setting. Tables 2 and 3 give a brief definition of each first-level factor and show representative student responses that were included in each category.

Table 2. Representative Student Responses for First-Level Motivation Factors

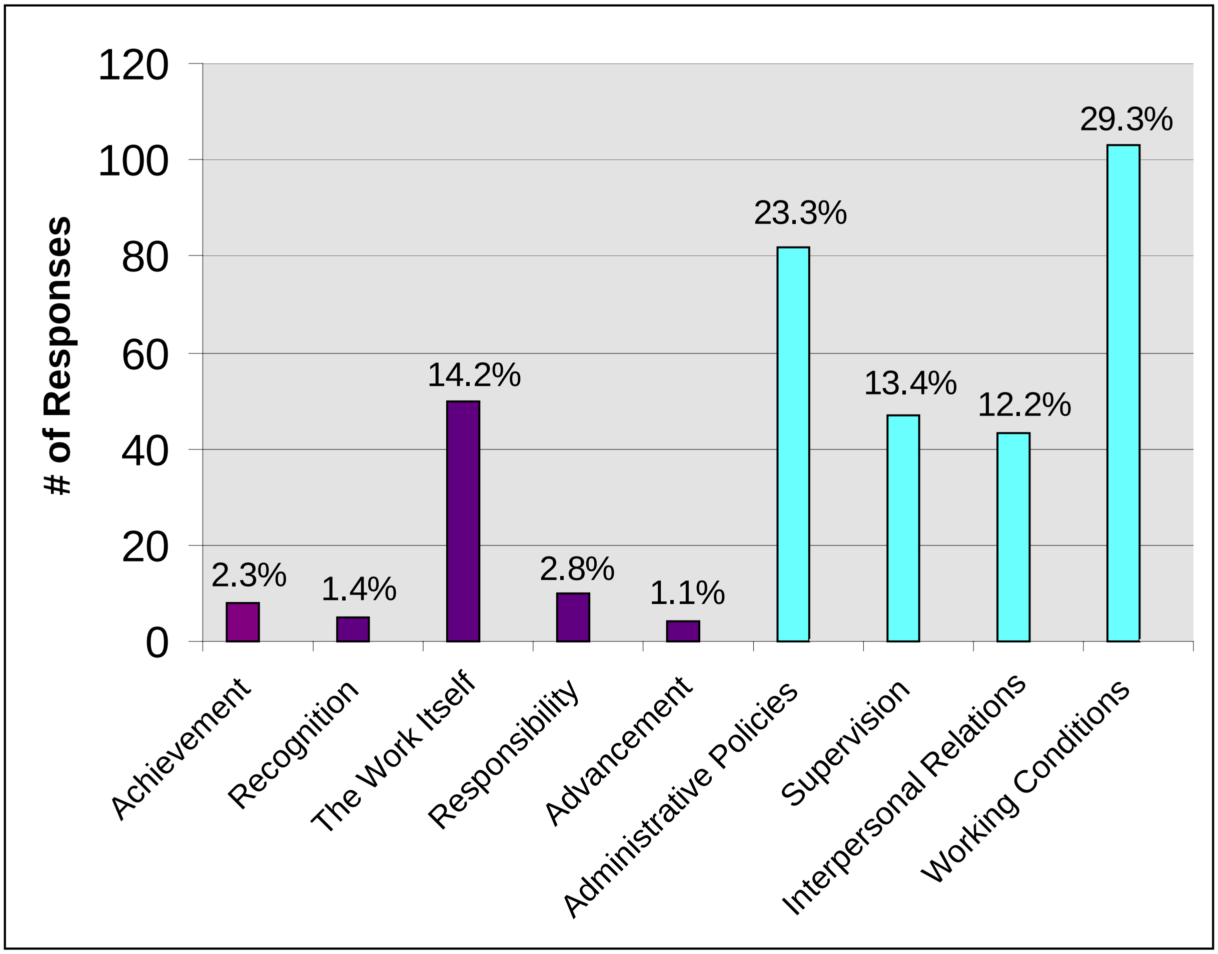
	Definition	Representative Student Responses
Achievement	Successfully completing a job, solving a problem, or seeing the results of one's work	"Assign some odd problems as homework so we can know if we got some of the answers right [Calculus]." "Generate labs that are…analytical yet not so vague that the student isn't sure if the results they are viewing are entirely off base, or right on [Chemistry]."
Recognition	Being recognized in a positive or negative way (notice, praise, criticism, or blame)	"Grade on [sic] homework…This weeds out the slackers [Calculus]." "There should be some sort of method that can be used to notify the student that there [sic] homework was received…[Chemistry]."
The Work Itself	Doing the required job tasks	"Make sure all labs have at least some practical purpose/relation to real-life [Chemistry]." "Every assignment we receive should have at least one problem dealing with an application in the REAL WORLD [Calculus]." "…spend more time teaching…the basics [Calculus]." "Eliminate the concept of limits [Calculus]." "No memorization of ions and elements and all that kind of stuff [Chemistry]."
Responsibility	Being given responsibility for one's work or being given new responsibilities	"…eliminate required homework…place the responsibility for homework entirely on the student [Calculus]." "…give out problems that require research to be done…[Calculus]." "…instead of working on a specific lab it would be interesting to do our own research [Chemistry]." "I would like my discussions to be lead by the students with a TA as a mediator [Calculus]."
Advancement	Changing status or position	"…create a discussion [section]…for people who have had it before…I could maybe do the same stuff but work on more difficult problems [Calculus]." "Make it possible for students to skip sections based on testing of FULL knowledge of material to be covered in that section [Chemistry]."

Table 3. Representative Student Responses for First-Level Hygiene Factors

	Definition	Representative Student Responses
Administrative Policies	Organization & management, company policies	"Make the classes smaller [Chemistry]." "Have more discussions [Calculus]." "Have fewer discussions and more labs [Chemistry]." "Have more exams…then each exam won't weigh so much on the grade [Calculus]." "Make it so that one quiz can be thrown out [Chemistry]." "Eliminate lecture [Calculus]." "Lengthen the lecture…twice as long or twice as often [Calculus]." "Do problems out of the book [Calculus]."
Supervision	Competence or incompetence, fairness or unfairness of the supervisor	"…I wish the Professor would tell the TA's what is expected, so all do the same stuff [Calculus]." "I would love it if my Chem TA and my professor would agree on a set of expectations [Chemistry]." "Make sure all TA's speak English (well) [Calculus]." "Hire TA's that speak English well enough to help the students [Chemistry]." "Have professor use common English terms…rather than chemistry lingo at least for the first semester [Chemistry]." "Make the class interesting…the Professor just talks and confuses us [Calculus]." "Keep the lectures interesting. This could include randomly blowing something up…This would reduce the number of people who fall asleep [Chemistry]." "TA's and Professors should be required to take special training sessions to teach [Calculus]."
Interpersonal Relations	Interaction between the worker and others (peers, supervisor, or subordinates)	"Make lectures smaller, include more interaction with the professor [Calculus]." "Smaller classes with individual instruction [Chemistry]." "…have students work together in groups on homework [Calculus]." "Make it so lectures are interactive, give students input devices to answer/ask questions [Chemistry]." "I would have 'quality buttons' that if the professor was going to [sic] fast, any of the students could push anonymously and the professor would stop and explain the material better [Calculus]." "…get professor…to introduce himself to the class [Calculus]."
Working Conditions	Physical and environmental conditions of work, amount of work, facilities available for doing the work	"Let us use CALCULATORS!!!! [Calculus]." "…more comfortable seats…It is kind of hard to pay attention when you are squirming in agony in your seat [Calculus]." "Have a microphone for the professor [Calculus]." "Build little television monitors on the back of all the chairs so that they show what the professor is projecting [Chemistry]." "Build a sound-proof booth around every student so that each…can concentrate without their neighbor distracting them [Chemistry]." "Less homework [Calculus]." "Have the professor type and hand out the notes [Calculus]." "Get professor…to slow down his writing to human readable speeds [Calculus]."

The motivation-hygiene categories defined above were used to code each of the student responses. The students were each asked to give five suggestions for course redesign. Since a few students gave more than five, and some students gave less than five suggestions, the total number of usable responses was 352 (an average of 4.96 per student). Of these, 77 responses (21.9%) were classified as motivation factors, and 275 were classified as hygiene factors (78.1%). Figure 1 shows the number of responses coded for each first-level motivation-hygiene factor.

Figure 1. Motivation-Hygiene Factor Coding for Calculus and Chemistry



The results show that over three-fourths of the student responses were related to hygiene factors rather than motivation factors. The largest group of hygiene responses was suggestions for improved working conditions. Included in this category were all responses related to student comfort and their ability to see and hear during class, the tools they were allowed to use (i.e. calculators, lecture notes, or formula sheets), the amount of homework, and the pace of the class. The second largest hygiene category, administrative policies, included responses related to reduced class size, the quantity and breakdown of classes (lecture vs. lab vs. discussion), and changes to exam and grading policies. Suggestions related to reduced class size were coded in two categories. If the student mentioned personal interaction with the professor, TA, or other students as the reason for the reduction, we put the response in Interpersonal Relations. If reduced class size was given with no explanation, we included it in Administrative Policies.

Regarding motivation factors, the largest category was "The Work Itself". This category included their suggestions for using applied "real-world" problems, changing the content of the course, and adding field trips or guest speakers.

In addition to the combined analysis, a comparison between responses for Calculus and Chemistry was completed. Table 4 shows the percentage of responses in each category for Calculus and Chemistry. The only category that had a statistically significant difference was Administrative Policies with Chemistry having a higher frequency of responses that fit in this category. Closer analysis of the data revealed that this was due to the Chemistry labs. Most of the suggestions pertaining to labs (duration, lab rules, etc.) were classified as administrative policy changes.

Table 4. Frequency Comparison for Calculus and Chemistry

	Calculus	Chemistry	
Achievement	2.8%	1.4%	
Recognition	0.9%	2.1%	
The Work Itself	12.7%	16.4%	
Responsibility	3.3%	2.1%	
Advancement	1.4%	0.7%	
Administrative Policies	19.3%	29.3%	*
Supervision	13.7%	12.9%	
Interpersonal Relations	13.2%	10.7%	
Working Conditions	32.5%	24.3%	

* Statistically significant difference based on t-test ($t = -2.17$, $p = 0.03$)

Discussion

Before discussing the research results, a caution regarding the coding scheme is in order. In many cases, it was difficult to clearly decide how to code a particular item because we lacked sufficient knowledge of the students' intent. As mentioned previously, many students suggested a reduction in class size. If the student did not provide any explanation, we included their response in Administrative Policies. However, if the student mentioned personal interaction with the professor or other students as the reason for a smaller class, we coded the response as Interpersonal Relations. Similar problems were found with other responses. For example, a request to have more discussion sessions was generally included with Administrative Policies because we could not clearly determine why the student wanted more discussions. It is likely that some of the responses coded as hygiene factors would have been included with motivation factors if greater understanding of the students' underlying meanings had been achieved.

Despite the limitations with coding, the results of this research show that a majority of the students' suggestions for course redesign were aimed at hygiene factors. The most frequent student responses were related to the lecture environment and working conditions. The students wanted comfortable chairs, larger tables, and the ability to clearly see and hear the professor. Many students also requested a reduced class size to allow for more individualized instruction and personal interaction with the professor.

It is not particularly surprising that the majority of students gave suggestions related to hygiene factors. They may have limited their responses to hygiene factors for several reasons. First, they may have felt it inappropriate for them to define the content of the courses. Second, their suggestions are based on their prior (generally limited) experience. For example, a large number of responses were received asking for more comfortable chairs. These students had experience with a large, modern lecture hall with comfortable chairs for their introductory engineering design course. Since their Calculus and Chemistry courses were held in other locations, many students found these older lecture halls to be inadequate in comparison. Finally, the students may have limited their answers to those things they felt they had a chance to influence. Most students will not feel empowered to make extensive changes to their courses.

The differences between Chemistry and Calculus were not statistically significant except for the Administrative Policies category. Students gave similar suggestions for both courses including the following: reduce the class size, make the lectures more interactive, grade homework assignments, ensure fluent English for both the professor and TA's, and ensure consistency between the TA and the professor and between different TA's. The higher number of administrative policy responses for Chemistry pertained to the labs. The students requested pre-lab information to help them prepare for lab in advance, and there was a split between those students who requested more lab time and those who wanted less.

Conclusions

The most difficult and important part of Herzberg's theory is that satisfaction and dissatisfaction are not opposite dimensions of a single scale. Improving hygiene factors will decrease the students' dissatisfaction (less unpleasantness) but not add to their satisfaction (more growth and self-actualization). Likewise, attention to motivation factors will improve their satisfaction but have no effect on the things that lead to dissatisfaction.

Applying Herzberg's theory for this research reveals two important points. First, we need to use a two-dimensional approach for increasing student satisfaction. Neither the hygiene factors, nor the motivation factors should be ignored. In industry, Herzberg was concerned that the majority of companies were focusing exclusively on hygiene factors. In education, it seems more likely that the motivation factors will be the focus as exemplified by the active learning approach, while the hygiene factors may get overlooked. Although Herzberg cautions that the effects of improved hygiene are of short duration, educators should not disregard their role in increasing student satisfaction by focusing exclusively on intrinsic motivation factors.

Second, when requesting student input related to course satisfaction, we should be careful to ask them about both the things that satisfy them and the things that dissatisfy them. Using an open-ended question such as the one used for this research will not do a good job of distinguishing between improvements that will intrinsically motivate the students and improvements needed to remove dissatisfactions, thereby limiting our ability to improve both dimensions. As mentioned above, there are several reasons why students may have limited their responses to hygiene factors when given a general question about course redesign. In essence, they were being asked what they disliked about the current course. We did not ask them what it takes to motivate them. An alternative, improved approach would be to ask the students to name a course that they do not like and then list the reasons why they are dissatisfied. Then ask the same students to identify a course that they do like and list the reasons why they are satisfied. This combination of questions is likely to do a better job of distinguishing both the important hygiene factors and motivation factors that should be addressed.

Additional research based on the motivation-hygiene framework would help to increase our understanding of student satisfaction and dissatisfaction. We believe the framework could prove to be a valuable tool in our efforts to increase engineering student retention. Future studies could build on this one by improving the data collection, coding, and analysis methods.

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