

MOTIVATION OF UNDERGRADUATE CIVIL ENGINEERING STUDENTS FOR HIGHER LEVELS OF ACADEMIC SUCCESS

Hector Martin¹, Christelle Sorhaindo² and Ferida Welch³

^{1,2} University of the West Indies, St Augustine, Trinidad

³ Tunapuna RC Girls, Tunapuna, Trinidad

It is surmised that more than half of the civil engineering students at the University of the West Indies, St. Augustine campus, fail to complete their degree in the three years prescribed for the completion of the program, suggesting there is need for an intervention strategy. Motivation though often overlooked as a measure of influencing academic success, is being revisited as the strategy to enable success, as it is the thrust behind the desire which drives an individual to achieve a goal. Before the strategy is determined a distinction between the source of motivation and the degree of its contribution must be understood. Determining the effect of intrinsic and extrinsic motivational factors and how they are linked to the academic success of engineering students can provide the basis for the choice of an intervention strategy. Intrinsic motivation was determined as the most important motivational construct towards learning. Principal component analysis determined that the main motivational factors, towards learning present in students currently pursuing an engineering undergraduate degree for all years of study were Personal, Perfectionist, Parental/Family, Job/Career and Social Acceptance. Determining what drives students to their peak performance would assist with the facilitation and design of teaching methods to capture students' interests, promoting learning and understanding as best as possible and consequently, optimizing academic performance.

Keywords: motivation, academic performance, civil engineering, undergraduate.

INTRODUCTION

In the 2012/2013 academic year at the University of the West Indies, out of fifty-seven Civil and Environmental Engineering level three students, there was a total of forty-two graduates, six with first-class honours and thirteen with upper-second class honours. However, only seventeen of these graduates completed their degrees within the three-year stipulated period. From existing statistics, on average only 30% of Civil and Environmental Engineering students complete their degree within the three-year period. This raises questions such as: Why isn't a greater number of students graduating with high honours within the requisite time; Is there a lack of motivation or drive in students to succeed, and Are the courses or grading systems too hard or strict? Whether this is the case or not universities need to make sure that the learning process is strengthened by taking professional and personal development in students into account in the design of instruction and coursework (Kudrinskia and Kubarev 2013).

¹ hector.martin@sta.uwi.edu

Academic success is influenced by a number of factors including ability, motivation and opportunity. In order to be accepted into an engineering programme at the UWI, a basic threshold level is set to filter the potential students (UWI 2013). Upon meeting this benchmark, acceptance is awarded. Therefore, it can be assumed that students at this threshold have the potential or ability and are at the required academic level with sufficient academic background to begin pursuing and completing an engineering undergraduate degree within the requisite time. While it is agreeable that academic success at university level is somewhat linked to ones' capability, this does not always differentiate high-achieving students from low-achieving students (Kitsantas 2002; Schunk and Zimmerman 2008). An alternative that can account for success is motivation which is defined as a physical, psychological or social need, which drives an individual to reach or achieve his goal, fulfil their need and finally feel satisfied owing to the achievement of their aim (Jafari and Mahadi 2012). It is this need to perform well, which translates into a desire to use knowledge and skills mastered in associated learning activities. Therefore, motivation is believed to be a facilitator of learning and academic success (Huang, Jian, Law, and Sandness 2009). Motivation must therefore play a more significant role in academic achievement.

In order to determine the motivational factors currently driving engineering students it is important to understand that since all humans are different, it is therefore expected that motivation (source, type and magnitude) is also different among individuals (Jafari and Mahadi 2012). This inconsistent and varying nature of motivation has resulted in detailed studies and the evolution of numerous motivational theories connecting and combining various types and sources of motivation. These theories include: Maslow's Hierarchy of Needs, McClelland's Need to Achieve, Expectancy Theory, Adam's Equity Theory, Achievement Goal Theory, Reinforcement Theory, the Cognitive Theory and many more.

Benson, Kirn, and Morkos (2013) placed emphasis on the Cognitive Evaluation Theory by concluding that student motivation is related to academic performance and behaviour, and is a major factor in student's progress towards critical thinking and problem solving. Law and Chuah (2009) concluded that, the cognitive ability is found to moderate the relationship between 'need for achievement' and 'performance'. The Cognitive Evaluation Theory has been previously studied regarding intrinsic and extrinsic motivation with unified conclusions that both contribute to learning. This research is therefore centred around the cognitive theory and is aimed at determining if intrinsic motivational factors were more prevalent in students with upper-second or first-class honours. The objective is therefore to determine if intrinsic motivation is the governing motivational factor contributing to their high level of academic success.

Examining students' academic performance is perhaps the most common way to gauge student success and to evaluate the effectiveness of instructional and programmatic reform and innovation. Engineering education, motivation and academic success, need to be linked in order to determine what motivates civil engineering students to perform well. This analysis was never completed for a specific branch of engineering and it will greatly help the engineering education authorities address the present challenges of low throughput. This could further attract, drive and retain students to or in the field of engineering, resulting in more educated specialists and professionals and henceforth produce a greater amount engineering professionals in the near future.

THEORITICAL FRAMEWORK

Maslow's theory called the 'Hierarchy of Needs' explains that there are at least five sets of goals or basic needs arranged in a hierarchy of prepotency, physiological, safety, love, esteem, and self-actualization (Maslow 1943; 1968). It postulates that when a need is fairly well satisfied, the next prepotent ('higher') need emerges in turn to dominate the conscious life and to serve as the centre of organization of behaviour. Therefore, it suggests that we are motivated by the desire to achieve or maintain the various conditions upon which basic satisfactions reside (Maslow 1943). Within a realistic sense students do not satisfy a need for a lower grade then work towards a higher mark. Good students strive towards the highest achievement level, as a result Maslow's (1943; 1968) Theory might not be applicable. McClelland (1966) claimed instead that motivation is driven by an innate need to achieve. This concept is supported by the Achievement Goal Theory which provides a framework to understand students' goals and motivation by highlighting various purposes or reasons and standards of evaluation that a student might have for pursuing particular academic tasks (Ciani *et al.* 2010). Benson, Kirn, and Morkos (2013) have also found that, achievement motivation, which encompasses students' attitudes about their abilities and tasks, can elucidate student choices related to persistence in engineering, solving problems, and the value of tasks encountered in an engineering environment.

The shortcomings of these previously mentioned surveys are that they seek to analyse all the existing and main motivational factors, and do not link these motivational factors to levels of academic performance (specific grade point averages 'GPA'). Frank Fox and Sonnert (2012) believe that GPA's are a key aspect of undergraduate education because, at this level, education is largely a classroom experience in which grades are the 'bottom line', and because grade point averages are widely accepted and consequential indicators of performance. Whether motivation is determined before, during or after the course of study it can be said that intrinsic motivation is a predominant motivational factor prevalent in students (Huang, Jian, Law, and Sandness 2009, Law and Chuah 2009, Haase *et al.* 2013). This study therefore aims to determine if there is a relationship between intrinsic motivational factors and high levels of academic success in engineering students. These arguments leads to the hypothesis that intrinsic motivational factors are more prevalent in civil engineering students with high academic performance levels and are the most important motivational factors contributing to their academic success. This will be tested by taking into consideration the stratification of the year group, as noted by Kudrinskia and Kubarev (2013) the main motivational factors present in a particular year of study were related to the cognitive character of the student at that particular stage/level of study. Within the engineering field this has not been investigated. Huang, Jian, Law, and Sandness (2009), have stated that there is a need to determine motivational factors because, learning will not happen without motivation and a supportive environment and if student motivation is lacking, the effectiveness of any intervention will be reduced. As suggested by Kudrinskia and Kubarev (2013), the findings from motivational studies can give insights into the development of teaching inventories and perfect the forms and methods of instruction, which can help make adjustments in the teaching and learning process. This would result in a greater understanding of exactly what impulses the students are guided by, what meanings their learning activity affords and finally promoting an increased number of true professionals who can help advance society.

METHOD

Questionnaire design

To determine the learning motivational factors of Engineering Undergraduate Students, a structured-written questionnaire formulated from studies carried out by Law and Chuah (2009)[Taiwan], Huang, Jian, Law, and Sandness (2009)[South Asia], Haase *et al.* (2013)[Denmark] and Ahearn *et al.* (2008)[Russia] was utilized, see Table 1.

Table 1: Motivational Factors Assessed Previously

Motivational Factor Assessed		Taiwan	2-South Asia	3-Denmark	4-Russia
Intrinsic	Individual Attitude	✓	✓	✓	✓
	Individual Aspirations/goals	✓	✓	✓	✓
	Clear direction	✓	✓		✓
Extrinsic	Punishment	✓	✓		
	Reward and recognition	✓	✓	✓	
	Social or group motivation	✓	✓	✓	
	Parental or Mentor motivation			✓	
	Group or social Pressure/Competition	✓	✓		

Pilot study and finalized questionnaire

Huang, Jian, Law, and Sandness (2009), and Law and Chuah (2009), suggested that for the validity and clarity of the final questionnaire, pilot studies should be employed. For this study, comments on the draft questionnaire by two (2) lecturers and three (3) current students within the Civil and Environmental Engineering Department were used to remove ambiguity from the final survey instrument.

The final questionnaire comprised of two sections. The first section, Demographic Information and Academic Level asked questions on level of study, gender, country of origin and GPA range. The second part, Motivational Attributes, enabled the identification of the positive and negative variables contributing to choice of study and current student learning motivation. There were twenty-two (22) variables (statements) assessing the various motivating factor groupings. Similar to a study carried out by Haase *et al.* (2013), a 1-5 Likert-scale scoring system was adopted starting from disagree very much to agree very much with a high score (5) representing a strong positive motivating effect on learning. The discerning point is set at 3, the middle of the scale.

Participants and data collection

A total population of 148 students, from the Faculty of Engineering at the University of the West Indies, St. Augustine campus were surveyed; 56 from Year 1, 46 from Year 2 and 46 from Year 3. The students were contacted during their class time to secure a high response rate and were invited to participate in the survey on a voluntary basis. Hair *et al.* (1998) suggested a minimum case to variable ratio of 5:1 to guarantee a reliable factor analysis. However, as noted by Costello and Osborne (2005), some researchers have worked with ratios as low as 2:1 and ratios below 5:1

have accounted for more than 40% of all studies. For this study after the removal of all unsuitable variables the ratio is positioned at 10.5:1.

Identification of positive and negative motivational variables

The mean response on the (1-5) point Likert scale was determined for each variable. It was hypothesized that the mean above 3, was a positively motivating variable towards learning. The variables with $\mu < 3$ were assumed to be demotivating factors and henceforth would not encourage students to perform well. Therefore, these variables were removed from further analyses.

Reliability of survey instrument

Similar to the study by Law and Chuah (2009), the internal reliability of the positive motivational factors was tested based on the average inter-item correlation using Cronbach alpha. The high value of alpha ($\alpha = 0.786$) attained suggests a high level of data consistency.

Validation of the motivational constructs/variables by factor analysis

Factor analysis was used to validate and group the motivating variables. The correlation matrix was examined to ensure all variables had a correlation of at least 0.3. To justify the measure of sample adequacy for the individual variables, the diagonal of the anti-imaging correlation matrix was reviewed to ensure all values were greater than 0.5, supporting their retention in the analysis. To determine sample adequacy for the group of variables, it was ensured that a Kaiser Meyer Olkin (KMO) value greater than 0.5 existed (KMO=0.803) (Das 2012). This indicates that the pattern of correlations is relatively compact and hence factor analysis should give distinct and reliable results (Field 2009). For the Barlett's test of sphericity, a significance value of 0.000 was obtained therefore indicating that the correlation matrix is not an identity matrix. These values are sufficient to justify the applicability of the Factor Analysis method to the sample (Tang and Shen 2013).

Wold, Esbensen, and Geladi (1987), explain that the principal component analysis is a least-squares method, and outliers can severely influence the model. Hence, it is essential to find and correct or eliminate outliers before the final principal component model is developed. Hoaglin and Iglewics (1987) modification of 2.2 was applied to determine the lower and upper bound and factor analysis was repeated excluding outliers. Subsequently, the removal of the outliers did not have an effect on the final solution and hence they were retained for further analysis. For brevity this further analysis is not presented here.

RESULTS

Demographics

All the respondent demographical data is shown in Table 2. The average age range (77.7%) of the Civil/Environmental engineering undergraduate students was 19–22. The amount of students with a GPA ≥ 3.00 is 27.6%, (approximately 1/4) of the entire respondent population. The majority of students are from Trinidad and Tobago 64.2%, whereas 33.8% are from other Caribbean countries and 2% are international students.

Current motivation

In order to determine what motivational factors encourage learning and academic success, it is imperative to determine what variables are currently motivating students; because it is either one or a combination of these positively motivating variables

which will inevitably encourage students to succeed. When the students were asked ‘What do you think is currently driving your desire to complete your degree?’

Table 2: Demographic details of respondents

Academic Level	#	%	Country	#	%	Age	#	%	GPA*	#	%
Year 1	56	37.8	Trinidad	95	64.2	<18	5	3.4	GPA > 3.0	40	27.6
Year 2	46	31.1	Other Caribbean Countries	51	33.8	19-20	64	43.2	GPA < 3.0	105	72.4
Year 3	46	31.1	International Students	3	2	21-22	51	34.5	Gender	#	%
Total Student Population	162		Total survey responses	148	91%	23-34	11	7.4	Male	95	64.2
						>24	17	11.5	Female	53	35.8

the highest rated responses were the two intrinsic variables; Clear Direction: ‘Studying, understanding and learning increases my knowledge and makes me feel accomplished’ and Individual attitude: ‘I don’t want to let myself down’ both with means of 4.32. Table 3 shows the means of all the variables in descending order with regard to positive motivational contribution. It is also important to note that all the negatively motivating factors ($\alpha < 3$) are all extrinsic.

In order for students to effectively apply their intellectual resources in their educational experiences, they must be motivated to do so. Educators should first understand factors in students’ development that contribute to motivation (e.g. expectations, values, goals, and attitudes) as well as their cognition and academic performance (Benson, Kirn, and Morkos 2013). Therefore, a major aim of universities should be ensuring that students’ progress well through their degree, graduate and become professionals.

It is believed that some degree of intrinsic motivation is prevalent in all students due to the fact that it’s an individual’s own decision, will or acceptance to understand, learn or retain information, as knowledge cannot be forced upon an individual. This could be the reason why the intrinsic motivational variables were found to be most important to the engineering students. The subgroup of intrinsic motivation found to be highly motivating was the individual’s self-attitude and one’s clear direction or understanding of what one wants to accomplish. Subsequent to the intrinsic motivational variables, was an extrinsic variable categorized as reward or recognition which is understandable, as it is expected that most people want to get a good job to be able to support themselves financially. It is important to note that all the variables thought to be demotivating towards learning were all extrinsic. The variable with the lowest rating of motivation was parental motivation i.e. striving to be like one’s parents. This indicates that most of the students currently pursuing civil or environmental engineering do not have parents within this field of engineering. This could lead to the reason behind parental encouragement being the 4th most important positive variable towards motivation, as parents would want their children to explore a field or career into which they did not enter.

Factor analysis

Stevens (2009), states that the total variance in the solution should be greater than 60% of the phenomena being measured. SPSS principal component factor analysis

confirmed five (5) factors containing an Eigen value greater than 1, which accounted for 66.506% of variance.

Table 3: Motivational variables and their perceived importance

Positive Variable	Mean Response
Studying, understanding and learning increases my knowledge and makes me feel accomplished	4.32
I don't want to let myself down	4.32
Completing this degree will help me get a good, well-paying and respectable job	4.25
I am keen to learn about new aspects of my subject and to explore new ideas	4.24
My parents/guardians/family encourage me	4.23
I want to accomplish my own learning goals	4.21
I want to get good grades and graduate with high honours	4.20
Studying, learning and achieving something makes my parents/family proud	4.18
I want to make a difference or contribution to engineering in the world	4.17
I get satisfaction from meeting intellectual challenges and pushing my limits	4.10
I believe that what I am learning now will be beneficial to my future job	4.05
I want to prove something to myself	3.99
I don't want to disappoint my family	3.95
I want to do well to avoid mistakes (Losing scholarship, sponsorship, failing etc.)	3.78
I enjoy working with my study group/friends and they encourage me	3.55
I want to be the top student	3.30
I just want to get a degree at the end of the day	3.23
Negative Variable	Mean Response
The lecturers are informative, encouraging and good role models	2.95
All my friends are doing well so I need to do well also	2.91
If I don't do well I will be humiliated	2.91
I want to outperform my classmates and friends	2.79
I want to be like my mother or father	2.44

The communality values for each variable were greater than 0.5 and less than 1. Table 4 illustrates the final derived solution from the factor analysis.

Factor 1 ‘*Personal Motivation*’ comprised of four (4) variables, each contributing towards intrinsic motivation. This intrinsic factor included variables supporting an individual’s clear understanding of his personal aspirations, satisfaction, accomplishments and also personal feelings towards making a valuable contribution to engineering.

Factor 2 ‘*Perfectionist Motivation*’, comprised of three (3) variables under the extrinsic motivation category. These variables indicate an individual’s desire to be the best, on top or to be idolized. This type of motivation falls under the heading of reward or recognition motivation. This motivation encompasses variables including an individual’s desire to be the top student, and to get good grades or graduate with high honours.

Table 4: Factor Analysis- Final Solution (Rotated Component Matrix)

Variables	Factor				
	1	2	3	4	5
I get satisfaction from meeting intellectual challenges and pushing my limits	0.797				
Studying, understanding and learning increases my knowledge and makes me feel accomplished	0.787				
I am keen to learn about new aspects of my subject and to explore new ideas	0.691		0.348		
I want to make a difference or contribution to engineering in the world	0.659	0.426			
I want to be the top student		0.803			
I want to get good grades and graduate with high honours		0.746			
I want to do well to avoid mistakes (losing scholarship, sponsorship, failing etc.		0.705	0.306		
My parents/guardians/family encourage me			0.747		
Studying, learning and achieving something makes my parents/family proud			0.738		
I don't want to disappoint my family			0.611	0.486	
Completing this degree will help me to get a good, well-paying and respectable job				0.770	
I believe that what I am learning will now be beneficial to my future job	0.379			0.677	
I just want to get a degree at the end of the day					0.755
I enjoy working with my study group/ friends and they encourage me					0.718

Another extrinsic motivational sub-group called 'punishment motivation' includes the variable doing well to avoid mistakes. This punishment variable provides support to the perfectionist title, as it is obvious that a perfectionist would do everything he could to avoid making errors, which inevitably involves negative consequences.

Factor 3, also a group of extrinsic factors, is titled 'Parental or Family motivation'. Under this factor there is direct encouragement by parents/family, recognition or kudos from parents/family towards the student's achievements and also student motivation to avoid parental/family disappointment and inevitably motivation of the student is centred around and driven by the family.

Factor 4 contains two (2) variables grouped into Job/Career Motivation. This extrinsic factor includes the variable indicating 'motivation to succeed and learn to obtain a well-paying and/or respectable job', which is categorized by the subgroup of extrinsic motivation called reward and recognition. The other variable in Factor 4 displays motivation to a job/career by indicating the perceived importance of learning and understanding as it will be beneficial and applicable to a future job, which is classified as motivation due to a future reward.

Factor 5 called 'Social Acceptance Motivation' is also an extrinsic factor. The variable stating 'I just want to get a degree at the end of the day' does not specify the class of degree (as previous variables did) but indicates that any class of degree will suffice. This variable can be associated with the fact that in modern society, being educated at the tertiary level is becoming the norm in most Caribbean countries and

especially in Trinidad and Tobago due to the increase in government assistance which provides free tertiary education to citizens through the Government Assisted Tertiary Education (GATE.). These universal tertiary education programmes result in employers recruiting individuals with minimum tertiary level education.

Without this level of education the 'eligibility' to be part of society therefore significantly decreases. The other variable indicates the enjoyment of encouragement due to friends or a study group. This variable demonstrates the need to be accepted by a group of people in order to be motivated, and shows the importance of social acceptance toward motivation.

CONCLUSIONS

This study arose from the question "What motivational factor(s) encourages students to do well?" Cognitive Evaluation theory was adopted to determine the positive motivational factors towards learning. Most studies utilizing the cognitive evaluation theory have concluded that intrinsic factors were the main causes of learning motivation, which is in line with the conclusion of this study. Principal component analysis revealed five factors contributing to learning: personal, perfectionist, parental/family, job/career, and social acceptance.

The recommendation that arises from this study is that faculty should use multiple motivational methods in each class setting to enhance existing intrinsic and extrinsic motivation. Since motivation and encouragement from lecturers was seen as a negative motivational variable, faculty members wishing to motivate their classes should challenge the students, provide connections to real-world applications for those students motivated by the useable content of the course, and increase compassion toward students which could inevitably change their attitude towards lecturers. Additionally, professors teaching upper level or more demanding courses should use different context-specific methods to instil a positive sense of efficacy in their students to enhance personal motivation, since this was the strongest motivational factor towards learning. Lecturers can provide examples of past projects to their current students that allow them to observe their peers' successes and encourage them to see that they can succeed. Lecturers of introductory-level classes can provide first-year students with other successful peer role models to enhance their personal beliefs to excel in their courses and enhance their job/career and perfectionist motivation. As suggested by Castiglia (2005), the recommendations for faculty members are not much different than those given countless times to managers working in business settings: avoid a one-size-fits all motivational approach and recognize that students in the classroom, like employees in a corporate setting, are individuals who are motivated by various tactics. Effective teaching, like good management, hinges upon personalizing the motivation to fit the individual.

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