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The Role of Information-Gathering on Students' Satisfaction in Engineering Majors

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Abstract

This **research paper** focuses on the decision-making processes of undergraduate students in engineering. We explore how Information Gathering behaviors relate to students' academic satisfaction with their engineering major.

The Self-Regulation Model of Decision-Making (SRMDM) encompasses three phases of Generation, Evaluation, and Learning, each influenced by Moderating Factors. Our focus is on Information Gathering, which happens as a decision-maker iterates between generating ideas and evaluating them. We hypothesize that self-regulated decision-making behaviors will lead a student to be more satisfied with their Engineering major choice. A competing theory is the theory of Maximizing Tendency where the maximizer decision-maker seeks to find the best option among available information that results in being less happy compared to satisficers who just look for 'good-enough' options. This research questions the association between Information Gathering and Satisfaction in Engineering.

The sample for this study is 724 primarily first-year students in Engineering at Clemson University. Measures used include a five-item Information Gathering scale from the Multi-dimensional Inventory of Decision-making Competency (MIDC) and a five-item Academic Satisfaction scale adapted for Engineering. This finding provides support for the SRMDM-based hypothesis that Information Gathering behavior may lead to increased Satisfaction in Engineering, so advisors/institutions are encouraged to support this process.

Introduction

Daily, all individuals make decisions in different levels and various formats. This paper focuses on the decision-making processes of undergraduate students in Engineering. Becoming a self-regulated decision-maker has been studied to be one of the key outcomes of a successful college experience, but it may also be an important precursor to selecting a major, such as Engineering.

Information Gathering can be perceived as one of the key skills to becoming a self-regulated decision-maker. It extends from gathering various information from different sources, understanding, and evaluating them to make an effective decision. According to (Byrnes, 1998), to consistently make adaptive (self-regulated) choices, decision-makers must have an accurate knowledge of themselves, the context, and their strategies. Information Gathering behaviors build the student's awareness of the context and thus will help them make an informed decision about their major (specifically, Engineering).

The research question for this study is:

What is the association between Information Gathering and Satisfaction in Engineering?

Background

Academic satisfaction has been defined as the extent to which a student enjoys their academic role or experience (Lent, Singley, Sheu, Schmidt, & Schmidt, 2007). This phenomenon gains more importance when it is studied in association with students' academic fit and performance in Engineering. Schmitt et al,. (Schmitt, Oswald, Friede, Imus, & Merritt, 2008) have focused on person-environment fit in their study and have defined it as "the compatibility between an individual and a work environment that occurs when their characteristics are well matched" (p. 318). Furthermore, they have found a positive correlation between fit and satisfaction where satisfaction mediates the relationship between fit and performance outcomes such as GPA.

In other studies, researchers have examined the influence of other attributes such as students' interest (Schmitt, Oswald, Friede, Imus, & Merritt, 2008), personality (Schmitt, Oswald, Friede, Imus, & Merritt, 2008) and identity (Godwin, Potvin, Hazari, & Lock, 2016) on work satisfaction. From the interest and personality aspect, Holland's Theory of Careers has been referred to and extended to the academic domain (Schmitt, Oswald, Friede, Imus, & Merritt, 2008). Holland's theory (Holland, 1985) is based on six basic vocational interests (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional) that connect the individuals' personalities and the environment they work in.

From the identity approach, Godwin et al., (Godwin, Potvin, Hazari, & Lock, 2016) have highlighted the importance of students' self-beliefs when they choose any Engineering discipline at the beginning of college. Such beliefs can help students to explain such complex decisions which can increase the enrollment of students in Engineering. In addition, women's self-beliefs play a significant role in choosing their Engineering career. While compared to their male engineering students, women's self-perception of their performance and skills in Engineering are lower which could contribute to decreased desire in choosing and remaining in Engineering. Similarly, themes on the shared experience of Engineering identity (Huff, Smith, Jesiek, Zoltowski, & Oakes, 2019)showcase that stable career patterns are associated with higher degrees of self-efficacy. According to (Byrnes, 1998) self-efficacy beliefs directly impact decision-making behaviors in a way that college students with higher self-efficacy abilities are more prone to consider their abilities, set higher goals for themselves, gather required information, and persist in their decisions. Furthermore, research demonstrates that students who are committed to Engineering have shown growing ownership of their careers as engineers (Huff, Smith, Jesiek, Zoltowski, & Oakes, 2019). The Engineering identity ownership is also aligned with the academic fit and satisfaction in engineering as it will lead to efficient outcomes such as GPA.

Our approach in this study is to examine students' academic Satisfaction in Engineering through the lens of decision-making, based on two competing theories: The self-regulated decision-making model (SRMDM) (Byrnes, 1998) and the theory of Maximizing tendency (Polman, 2010; Dalal, Diab, Zhu, & Hwang, 2015) (both described below). We are mainly interested in the role of Information Gathering behavior as an important part of adaptive decision-making according to SRMDM (Byrnes, 1998), which leads to satisfaction with the major choice in Engineering). The theory of Maximizing Tendency, on the other hand, is closely related to the concept of rational choice theory (Simon, 1955) which assumes individuals are rational choosers (Schwartz, et al., 2002). Maximizing behavior occurs when individuals seek to achieve the best

possible outcome given their preferences and available information. Research has shown that maximizers tend to be less happy compared to satisfiers who choose the "good enough" alternative given their preference and the available information. (Polman, 2010)

Theoretical framework

In this section, we cover background theories that are principal to this work. Firstly, the primary theoretical framework to study Engineering students' satisfaction and Information Gathering is through SRMDM (Byrnes, 1998). Secondly, from a psychological perspective, maximizing tendency theory was studied to understand the decision-making rationales effectively.

Self-regulated model of decision-making (SRMDM)

Byrnes has defined self-regulation as a hybrid construct which has been adapted in different contexts such as learning, cognitive development, and social cognition (Byrnes, 1998). In addition, he refers to three assumptions associated with self-regulation. First, adaptive individuals set adaptive goals to be successful such as academic or professional achievements. Secondly, in order to be successful, an individual actively engages in behaviors that maximize their goal accomplishments. Thirdly, being successful is unintuitive and hard as humans have natural limitations and biases that can distract them from achieving their adaptive goals.

Byrnes's self-regulated model of decision-making (SRMDM) (Byrnes, 1998) includes phases of Generation, Evaluation, and Learning (Figure 1), each potentially influenced by Moderating Factors. During the Generation phase, the decision-maker generates several alternatives to work toward a particular goal. Then these choices enter the Evaluation phase for further evaluation. The Generation and Evaluation phases can be iterative. Lastly, in the Learning phase, the decision-maker will evaluate the final decision based on the success or failure of achieving the end goal. It is essential to highlight that all these phases can be influenced by Moderating Factors. Such factors can limit the decision-makers ability to decide adaptively or learn from past experiences. Environmental limitations, memory capacity, and other individual characteristics are examples of moderating factors.

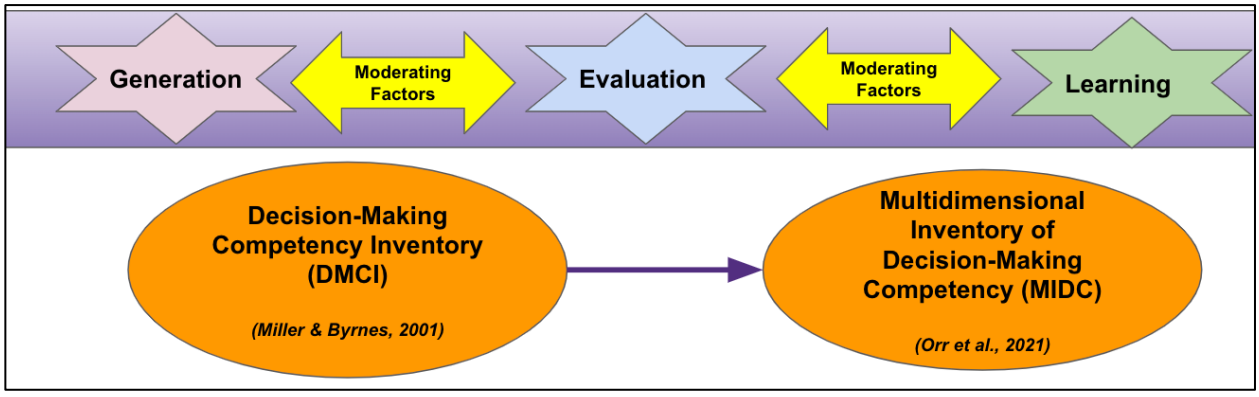

Figure 1: Self-regulation model of Decision-Making (SRMDM) and related scales

SRMDM (Byrnes, 1998) was utilized as the theoretical framework to revise the Decision-Making Competency Inventory (DMCI) (Orr, Martin, Ehlert, Brotherton, & Manning, 2021) to achieve useful subscales that associate with SRMDM. The revised instrument which was

developed through several iterations (Orr, Martin, Ehlert, Brotherton, & Manning, 2021) (Ehlert, et al., 2019) is called the Multidimensional Inventory of Decision-Making Competency (MIDC) (Ehlert, et al., 2019).

MIDC is based on four factors: Impulsivity, Avoidance, learning, and Information Gathering. Impulsivity encompasses making a decision without considering the consequences; Avoidance targets refraining from making decisions for oneself and allowing other people (i.e. parents or friends) to make decisions on their behalf; Learning focuses on reflecting on past decisions and Information Gathering, which includes collecting information, assessing strategies, and evaluating alternatives before making a decision. Furthermore, Information Gathering occurs at the Generation and Evaluation stages, Learning at the Learning stage, and Impulsivity and Avoidance occur as moderating factors. In this paper, we will focus on the Information Gathering factor of the MIDC instrument.

Theory of Maximizing Tendency

The theory of Maximizing Tendency, on the other hand, focuses on the tendency to explore alternatives and select the best option among all available choices. Schwartz (Schwartz, Self determination: The tyranny of freedom. American Psychologist, 2000) has addressed the problems associated with the increase of options within a domain of choice. Firstly, as options increase, gathering adequate information for all available options becomes problematic. Secondly, as options increase, individuals' standards for an acceptable outcome increase. Finally, with the proliferation of options, individuals could fall into the trap of believing that "any unacceptable result is their fault" (Schwartz, et al., 2002) (p.1179) and that there should be no way to have an unsatisfactory result while having many options to choose from. These problems could lead to decision-makers' unhappiness and feelings of regret.

In another work, Polman (Polman, 2010) discussed the differences between happiness levels among maximizers and satisficers. Maximizers are defined as individuals who aim to make the best decision while satisficers aim to make a good enough decision. Through this process, maximizers attempt to expand the alternatives to decide from as much as they can while satisficers attempt to do so among lesser alternatives. Taking job applications as an example, maximizers attempt to apply to as many jobs as they can while satisficers apply to fewer jobs. While maximizers may get more job offers, they also could get more job rejections compared to satisficers which could lead to unhappiness for maximizers compared to satisficers. Polman (Polman, 2010) refers to such a relationship as the "irony of maximizing" (p.179) in terms of experiencing positive and negative outcomes for maximizers simultaneously.

This paper results that the relationship between the amount of Information Gathering and Satisfaction is reversed in the academic domain. Based on SRMDM (Byrnes, 1998)framework and MIDC (Orr, Martin, Ehlert, Brotherton, & Manning, 2021) instrument, when a student gathers more information and applies self-regulation along the decision-making process (Figure 1) toward a big decision such as choosing an Engineering major, they are more satisfied with their decision (Byrnes, 1998) (Orr, Martin, Ehlert, Brotherton, & Manning, 2021). In other words, it is shown that Information Gathering has a positive correlation with academic satisfaction (Orr, Martin, Ehlert, Brotherton, & Manning, 2021). Similarly, decisions with different outcome scales demand various amounts of Information Gathering. For example, the information gathered for purchasing a different flavor of coffee involves fewer alternatives and

impacts compared to choosing a college major which would be for a lifetime. Hence, maximizing or satisficing can be rationalized based on the context of the decision.

Method

The sample for this study is 724 primarily first-year students in Engineering at Clemson University. The survey was offered at the beginning of the 2021 Fall semester for extra credit. The Fall 2021 Engineering cohort included 28% women and 15% underrepresented minorities.

Measures

The survey contained six sections with corresponding items (questions). The sections measured the following variables: Decision-Making Competency (with subsections of Information Gathering, Avoidance, Impulsivity, and Learning), Reasons for Participation in Engineering, Intent to Persist in Engineering, Fit, and Satisfaction in Engineering (separate questions for each variable), Major & Confidence in Engineering, Fit and Satisfaction in Intended Major (separate questions for each variable). The focus of this study will be on Information Gathering (as a subset of decision-making) and Satisfaction in Engineering variables to answer the research question for the current study.

Information Gathering was measured in a 5-point Likert scale (1-Not at all like me and 5-Very much like me) and Satisfaction was measured in a 5-point Likert scale (Strongly disagree to Strongly agree). Both scores were computed as the average of the scale items, allowing us to include all participants who responded to at least one item on each scale.

Information Gathering is a subscale of the MIDC which represents the generation and evaluation phases of SRMDM. The Information Gathering score (IGScore) was calculated based on the average of five items.

The Information Gathering items are:

When I have a big decision to make...

1. I try to think of all the possible options.
2. I gather the information I need.
3. I make sure that I get the facts.
4. I consider possible consequences before making any decision.
5. I take time to review my options before deciding.

Satisfaction is a five-item scale that was adapted for Engineering from Schmitt et al. [1]. By adapting Schmitt's academic satisfaction construct, satisfaction in Engineering measures the satisfaction score of the students toward their decision to choose Engineering based on various criteria including instructors, class content, and future career prospects (Orr, Martin, Ehlert, Brotherton, & Manning, 2021) .

The Satisfaction items were adapted for Engineering as follows:

1. All in all, I am satisfied with the education I can get in *engineering*.
2. I'm satisfied with the intelligence of my teachers here.

3. I'm satisfied with the extent to which my education will be useful for getting future employment.
4. I'm happy with the amount I learn in my classes.
5. I'm satisfied with the extent to which *engineering* will have a positive effect on my future career.

Descript*ive Statistics*

Descriptive statistics for both independent and dependent variables are shown in Table 1 and the distribution of the variables is shown in Figure 2.

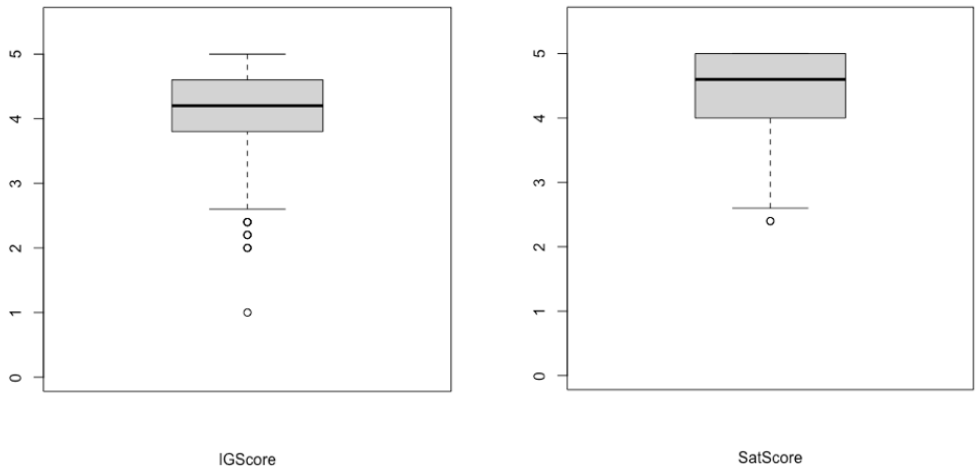

Figure 2: Boxplot with outliers for IGScore and SatScore

Table 1: Descriptive Statistics for Factor Scores

Variable	Mean	Standard Deviation	Skew	Kurtosis	Cronbach's α
Information Gathering	4.08	0.62	-0.69	0.87	0.82
Satisfaction	4.42	0.58	- 0.95	0.35	0.85

Satisfaction shows a potential ceiling effect as many students rate their Satisfaction in Engineering near the maximum value, with a mean of 4.42 out of 5 and a negative skew. In this sample, Cronbach's alpha estimate of internal consistency was 0.82 for Information Gathering and 0.85 for Satisfaction. Based on (Nunnally, 1978), an acceptable lower bound for internal consistency is 0.7, while alphas between 0.8 and 0.9 are very good.

Analysis Procedure

Simple linear regression was used with Satisfaction in Engineering (Dependent variable) and Information Gathering (Independent variable) as illustrated in Figure 6. All analyses were performed using R Statistical Software (version 4.3.2) via RStudio (2022.07.1, Build 554) (R

Core Team, 2023). The R packages that were used in the analysis include *dplyr*, *epiDisplay*, *psych*, *readxl,* and *apaTables*.

The following model was used for this study:

$$SatScore = \beta_0 + \beta_1 IGScore + \varepsilon \qquad (1)$$

SatScore is the observed value of the dependent variable, Satisfaction in Engineering,

β_0 is the intercept, the predicted value of *SatScore* when *IGScore* is *0,*

β_1 is the regression coefficient- the amount expected *SatScore* to change as *IGScore* increases,

IGScore is the independent variable, Information Gathering

ε is the error of the estimate.

Analytic strategy: Model Assumptions

The first assumption in the linear regression model is the linearity between Satisfaction and Information Gathering. To check this assumption, we will visually inspect the scatter plot of the residuals versus the predicted (fitted) values. In other words, we aim to see whether, in the residuals vs. fitted plot (Figure 3), there is a random variation above and below zero. The trendline deviates slightly for fitted values below 4.0 but is reasonably close for most values.

Secondly, through the same plot (Figure 3), we can visually inspect the constant error variance assumption. To confirm this assumption, we would inspect the residuals vs. fitted plot for a band of roughly constant width. We can say that there is not a relatively constant width which shows that there is not a constant variance. This limitation could affect the accuracy of the confidence intervals. Future work will investigate the effect of removing outliers or transforming the data.

Figure 4 demonstrates that there is a positive relationship between outcome variable (SatScore) and predictor variable (IGScore). Furthermore, we can see that as Information-Gathering score (IGScore) increases, Satisfaction in engineering (SatScore) increases.

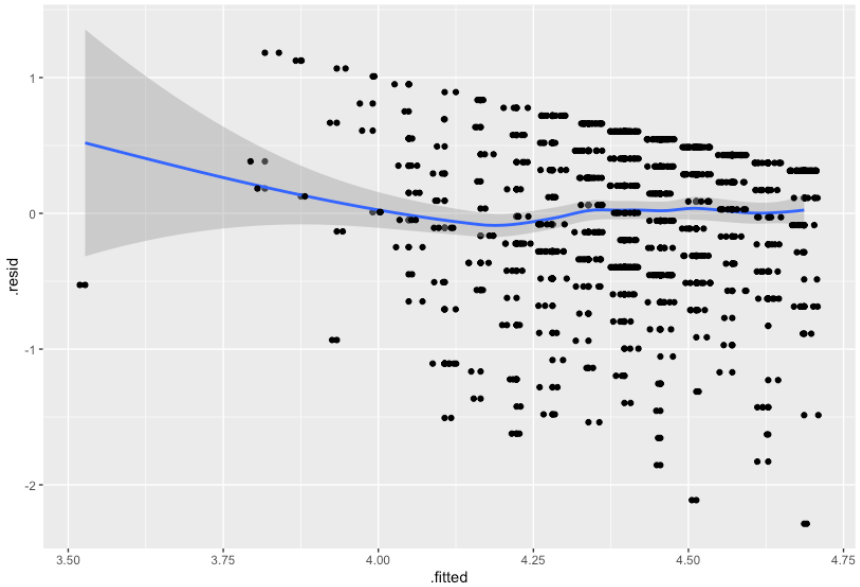

Figure 3: Residuals vs Fitted Plot

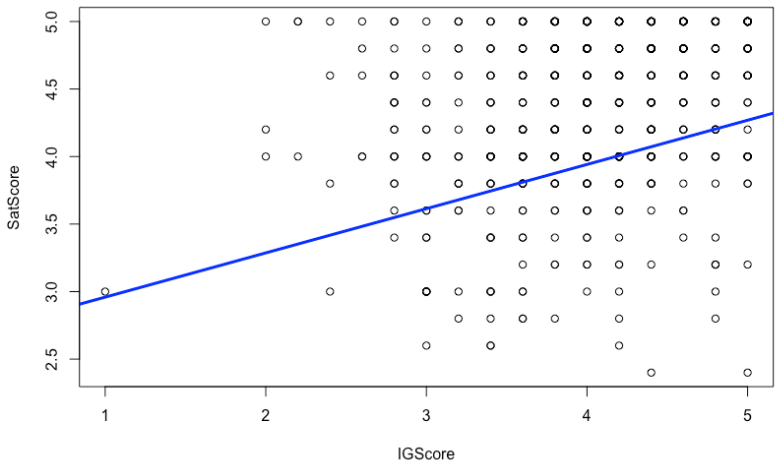

Figure 4: Correlation Plot

Results and Discussion

This section presents the results of this study for the following research question: "*What is the association between Information Gathering and Satisfaction in Engineering?"*

In order to answer this research question, regression weights and p-values were obtained. Table 2 displays the results of this regression analysis.

Table 2: Regression results using SatScore as the criterion

Predictor	*b*	95% CI (*b*)	*r*	Fit
(Intercept)	3.24**	[2.97, 3.51]		
IGScore	0.29**	[0.22, 0.36]	.31**	
				R^2 = .095**
				95% CI [.06,.14]

Note.b represents unstandardized regression weights. *r* represents the zero-order correlation.
* indicates $p < .05$. ** indicates $p < .01$.

Students' predicted Satisfaction is equal to 3.24 + 0.29 (Information Gathering) score. The results show that students' Satisfaction increased by 0.29 for each unit increase in Information Gathering. In other words, students who reported high Information Gathering in their decision-making also reported high Satisfaction in Engineering. This simple model explains 9.5% of the variance in Satisfaction.

Additionally, the Pearson correlation coefficient (*r*, Table 2) was calculated to assess the linear relationship between IGScore and SatScore. Based on the results and the correlation plot, there was a positive correlation between the variables, $r(722)=.31$, $p < 0.001$. According to (Ratner, 2009) Pearson correlation values between 0.3 and 0.7 show "a moderate positive linear relationship through a fuzzy-firm linear rule" (p.140).

The purpose of this study was to find out the impact of Information Gathering behavior on Engineering students' Satisfaction. It is important to state that two theories of SRMDM (Byrnes,

1998) and the theory of Maximization Tendency (Schwartz, et al., 2002) helped us interpret the process of decision-making (Information Gathering) and the outcome result (Satisfaction).

Analysis of the collected data showed that Information Gathering is significantly associated with Satisfaction among Engineering students. Some examples of Information Gathering skills include taking time to review possible options, making sure to get the facts, and collecting possible consequences before making decisions. Such examples have also been mentioned as indicators of students who successfully self-regulate (Byrnes, 1998). In other words, the results are aligned with the SRMDM framework and self-regulation definition (Byrnes, 1998) that adaptive decision-makers are more successful in attaining their goals. As a result, adaptive decision-makers generate options for a decision, set goals, and construct strategies. Then they evaluate different alternatives and learn from the results while being aware of moderating factors (i.e., fatigue).

It is important to highlight that the second assumption of self-regulation (Byrnes, 1998)-which states that an individual actively engages in behaviors that maximize their goal accomplishments -is aligned with the theory of Maximizing Tendency. In the academic domain, the SRMDM framework proposes that the students engage in gathering information in a self-regulated manner in order to maximize their goal accomplishment. Similarly, the theory of Maximizing Tendency claims that maximizers look for the best option before finalizing their decision. This paper shows that for important decisions such as choosing a major, students are more satisfied with their decisions when they gather more information.

Revisiting our hypothesis that self-regulated decision-making behaviors, in general, will lead a student to be more satisfied with their Engineering major choice, it can be said that the results showcase a positive association between Information Gathering and Satisfaction in Engineering students.

Conclusions and Implications

We found that Information Gathering is positively associated with Satisfaction in Engineering within our sample of 724 students in a first-year Engineering program. This research has some limitations. First, the students were offered extra credit for completing the survey which can be a cause for selection bias. Given the fact that the study was conducted in one institution, the results can only claim an association among individuals like those in this study and similar Engineering programs. Observed Satisfaction with the Engineering major was quite high, so the results may not translate to programs struggling with lower student Satisfaction. Secondly, self-report bias can be a limitation in this study, as participants' responses represent their retrospective perception of their typical Information Gathering behaviors. Further, their Satisfaction with their Engineering major could be influenced by the extra credit awarded for completing the survey or other events affecting their feelings at the time of filling the survey.

Some broad implications of this study are to develop effective tools for students to strengthen their Information Gathering skills through various resources. In other words, how a decision can be optimized with the benefit of reaching different people, using different processes and products. For example, if a student is required to decide towards selecting their majors, one idea could be to reach out to different people (advisors from university and industry) and visualizing step-by-step prospective career plans for students. Through such a holistic Information Gathering

process, advisors could be assured that students would have higher Satisfaction rates with their Engineering majors. Such direction could lead students to a more calculated decision and ultimately Satisfaction in their intended Engineering major. In addition, Satisfaction in major could lead to less absenteeism and higher GPA which can lead to students' academic success.

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