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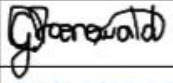
Handtekening **Signature**	
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BPJ 420 FINAL PROJECT REPORT

Statistical Analysis, Reliability Evaluation, and Prioritisation Modelling of Students Intellectual Dynamics and Learning Maturity in an Ascending Knowledge Acquisition System.

Carla Groenewald

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Executive Summary

This project aims at creating surveys that will be given to the consumer (students in university) to conduct data analysis and modelling based on the intellectual dynamics of the students as they advance from one learning level to another. The expectation for this project is to determine what the causes and remedies are of the intellectual dynamics of students as they mature intellectually during their studies. For example, are the second-year students' intellectual maturity at the same level as it should be in your second year, or do they still have the intellectual maturity of that of a first-year? The objectives of this project will include, carrying out investigative surveys on the causes and remedies that negatively impacts the intellectual dynamics and learning maturity in higher institutions of learning, carrying out statistical and reliability analysis on the responses of the investigative surveys, and developing a prioritisation model of the identified causative factors to carry out criticality analysis on the level with which they influence the intellectual dynamics and learning maturity. The deliverables of this preliminary project report, when successfully completed, are to do a detailed literature review on human learning behavioural studies, data and reliability analysis of survey research, and the application of a prioritisation model on causative factors influencing student's intellectual dynamics and learning maturity. The deliverables will be in the form of an academic report and it will be discussed during an oral video presentation. Thus, the aim is to develop a prioritisation model that can be applied in the learning domain to establish the criticality level of which the identified causative factors influence student success. Based on this, future recommendations can be made to propose control levels that can be used to minimise these challenges present in higher educational systems.

Extraction of the identified causative factors can be found in the academic report along with the ratio of validity on each of the questions the factors got extracted from. A result found from the investigative surveys of this study shows evidence that students from the Industrial Engineering department on average fails 3.82 industrial engineering modules during their academic time span. This raised the question: Why do students fail and occasionally drop out of the faculty of engineering? All-encompassing data, analysis, and discussions on the factors that influences the academic success and retention of students in higher educational systems are present in the section throughout this project report.

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Introduction

1.0 Background to the Study:

In most formal education setups, it is evident that mental awareness and intellectualism are the valued gems in a world of knowledge and acquisition. Higher institutions of learning are specifically an interest in this study. The sustainability and progression of intellectualism often called "intellectual dynamics" seems to be the state of customs when a student needs to make substantial improvements within a specified amount of time. The development, use, and training of the intellect and mind define intellectualism. According to Mazrui, an intellectual person is a person with the ability to be captivated by ideas, who gained the skill to handle some of these ideas effectively (Mazrui, 2003) . Higher educational systems are becoming progressively geared to guarantee that each student will acquire a certain standard of knowledge and degree of success but fails when it comes to the growth and development of intellectual maturity of each individual student. Do higher educational systems such as universities also have the responsibility of providing the context in which the students can grow in terms of their intellectual dynamics? What influences in higher educational systems, if any, determine the growth of the student mind, and what is it about university life that transforms intellectually immature first years into intellectually mature graduates?

Another question arises whether there is sufficient attention given to the intellectual development of university students as they progress during their studies? More specifically, are students being equipped to develop a combined high level of good judgment and wisdom in each learning level from first year to graduation? Over time it is brought to the attention of universities that there is a group of students that have lower reasoning skills than their peers. Their lower reasoning skills cause them to perform poorly in academic-related exercises. Poor performance results in students struggling with their modules and ends up deregistering their modules or worse drop out of college out of fear to fail. This leads one to wonder why these students are struggling with the intellectual challenges of their academic careers. Can it be solely blamed on personal issues, system-driven issues i.e. student-teacher interaction, the university set up at large, etc., or can it be that some modules are more intellectually demanding than others? Whatever the case may be, it is found that these students tend to perform averagely well in particular modules and the need, for these crop of students, to improve their intellectual capacity to an equal level as the present year of academic exercise are of utmost importance.

Furthermore, there could have been possibilities that some of these students were top achievers during their high school years, but now found themselves amongst the crop of struggling students. This highlights the reasons to asks the "Why? What? and How? "questions i.e. Why is it that students struggle to keep up with the intellectual demands of higher educational systems? What are the causes and remedies thereof? How can this matter be improved to enable all students to achieve success? These scenarios justify the need to focus more on the intellectual dynamics of students in higher education to guarantee student success in every module during each academic year. Addressing factors to the above mentioned statements will include the driving forces behind the intellectual dynamics of students. Factors such as the lecturer, the learner, the learning content, and the learning materials will be inspected in each learning level throughout the research of this project.

1.1 Problem Statement

There is a need to address if the students, in higher institutions of learning, are intellectually matured enough in each learning level. If their intellectual maturity is not on the same level as their learning maturity, they may lack the ability of necessary wisdom and a good understanding of the following learning levels during their studies. It is not known if the intellectual dynamics of students in higher education is on the same level as their learning maturity when they advance from one learning level to another. The problem with this is that it leads to students performing poorly in academic-related exercises. A result of this would be that students end up deregistering their modules or change between faculties or worse drop out of university.

A case study done by Pocock in 2012, provide concrete figures presenting the reasons why students, from the Faculty of Engineering at the University of Kwazulu-Natal, left the faculty of Engineering and did not complete their original degree choice. In **Figure 1** it is evident that 15% of the reasons reported by the students who left the faculty were because there is a lack of student-lecturer interaction and the attitude of the lecturer. Several students also reported that they found it difficult to understand the accent of the lecturer and that that was the reason for their failure to complete the course. A big reason for the dropout of students was the fact that they found that the learning material covered in Engineering was too difficult.

Thus, without addressing the teaching methods, the student-lecturer interaction, and the development of the intellectual maturity of the students to bridge the learning readiness between school and university studies, there will not be a significant reduction in the rate of students dropping out of the faculty of engineering. (Pocock, 2012)

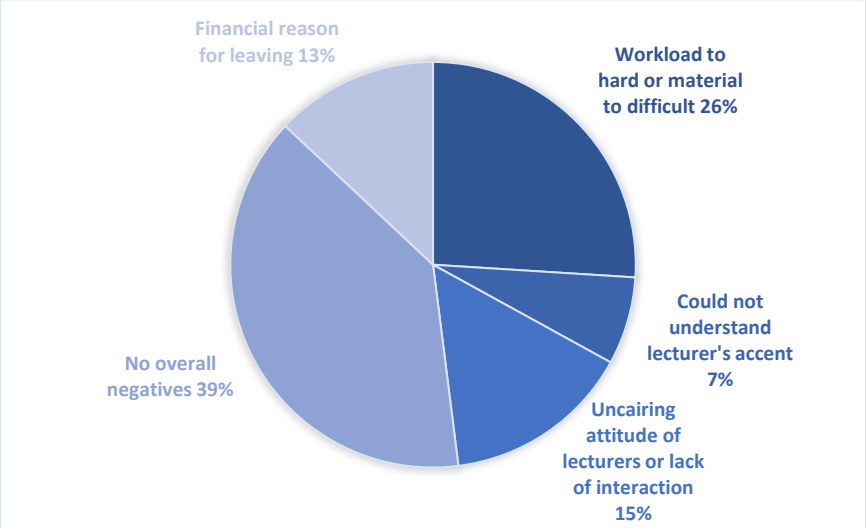


Figure 1-Reasons are given for leaving the Faculty of Engineering of the University

A study shows that intellectual maturity matters and that it has a significant role to play in the learning ability of a student. Social and cognitive maturity will affect the success of learners. Teachers need to know how the development of the brain influences brain maturity and in effect the students learning readiness for them to be able to use the correct instructional strategies when they create their lessons. (Anon., 2016)

In a previous study, by Pettis, it showed that there is a correlation between the relationship that exists in each domain of teacher-student interaction and student course engagement of technical college students. This study's findings indicated the importance of teacher-student interaction and student course engagement in higher education. (Pettis, 2017) But it is not known how lecturer-student interaction influences the student in becoming intellectually matured. Students may not be as ready and prepared to deal with challenging topics as the lecturers hoped them to be. This is because university students are still in the developing stages of their intellectual and social maturity and still figuring out how to deal with complex issues. (Anon., 2020)

Thus, research on the level of intellectual maturity of students and how it impacts their learning ability is a critical factor to address to ensure the success of students in each learning phase during their studies.

1.2 Research Questions (RQ):

i) Is the intellectual maturity of the students in higher education systems on the same level as their learning maturity?

ii) What are the causes and remedies of intellectual dynamics and the influences thereof on the success of students in higher education?

iii) How can the intellectual maturity of students in universities be improved to match their learning maturity at each learning level during their studies?

iv) How reliable and valid are the data gathered, by the researcher, from the investigative surveys of the causes and remedies on intellectual dynamics and the influences they have on intellectual maturity.

1.3 Aim/Research Objectives:

1.3.1 Aim

The deliverables and aim for this project will be to determine if the intellectual maturity of students, in higher educational systems, is on the same level as their learning ability. And to highlight the need to improve the learning maturity of the students to avoid them deregistering their modules and help them to have good judgement combined with wisdom in each learning level in an ascending acquisition system.

1.3.2 Research Objectives

The objectives of this research report are to:

i. Carry out an investigative survey on the causes and remedies of negatively impacted intellectual dynamics and learning maturity in higher institutions of learning.

ii. Carry out statistical and reliability analysis and evaluation of the responses in (i).

iii. Develop a prioritisation model of the identified causative factors in (i) to carry out criticality analysis of the level with which they influence intellectual dynamics and learning maturity.

1.3 Project Rationale:

Currently, it is not known how students are developing intellectually during different stages of their studies in higher educational institutes. This is a concerning factor to universities because students that have lower reasoning skills than their peers tend to perform poorly in academic-related exercises resulting in the students deregistering their modules, change departments (not because they had a different career view, but rather out of the fear of failing) or worse drop out of the university system as a whole. By improving the intellectual maturity of the students, it will help them to be more motivated to learn and ensure that the students have the necessary understanding combined with wisdom in each learning level necessary for the student's success in an ascending acquisition system.

1.4 Motivation:

Over some time, universities recognized that there are a group of learners who have lower reasoning skills than those of their peers, even though some of them were top achievers during their school years. This led them to wonder why students who are physically fit, economically privileged, and thrives socially are now struggling to cope with the intellectual demands of their academic pursuits.

1.5 Scope of the Research

The focus of this study will be on the intellectual dynamics of students as they advance from one learning level to another in an ascending acquisition system. Data analysis will be done based on the intellectual dynamics of students to establish if there is a difference in the level of intellectual maturity and learning maturity of students. This research will determine what the driving force(s) are behind the intellectual maturity of the students and how their intellectual maturity will influence the student's success. Also, the research will determine if there is a correlation between the intellectual maturity of students and their learning maturity. Addressing factors such as why students are failing some of their modules and the Lecturer-student technical interactions influencing the student's intellectual maturity will be looked into. Therefore, responses from the surveys will be analysed and based on the results gathered, the researcher will aim to proffer technical solutions and discuss the degree of these solutions. A reliability and validity analysis will be done on the causative factors on students' intellectual dynamics to be able to improve their

learning maturity during their studies. Lastly, this project will focus on developing a prioritisation model on the identified factors to establish a criticality level with which they influence intellectual and learning capacity. Based on this, the researcher will propose control measures that the university can use by which these challenges can be minimised.

1.6 Limitation of the Research

This research is limited to gather dynamic data in the Industrial Engineering Department of the University of Pretoria (UP). The surveys will be distributed to the students, in different learning levels, who are studying Industrial Engineering at the University of Pretoria.

1.7 Delimitation of the Research/Project

i) Surveys will exclude students who are not from the University of Pretoria.

ii) Modelling the dynamical increment within the space of growth in intellectualism will not form part of this project.

1.8 Organization of the Project

Chapter one of this document contains the Background information of the study, the problem statement, and the objectives that the researcher wants to achieve. It also expands on the questions the researcher wants to address, the motivation behind this study and the limitations and delimitations of this project. Chapter two contains a comprehensive literature study. The sub-sections in the literature review will address the improvement, previous solutions to similar problems and all-encompassing research to the problem sphere. In the third chapter of this project, you will find the research approach that the researcher chose to use in solving the problem at hand. The conceptual framework, theoretical framework, plans for data collection, and data presentation and analysis of the overview of the survey questions sections are briefly discussed in this chapter. Chapter four gives a presentation of the data. Validation of the survey questionnaire will also be present in chapter four. In chapter five, is a discussion and analysis of the results gathered through the data. Chapter six is the concluding chapter where the researcher will conclude this report and present the research findings as well as future recommendations for the proposed solutions. The

deliverables of the project are present in chapter seven of the project study. Chapter eight of this project report shows the project plan of the researcher where the work breakdown structure of BPJ 420 appears. Lastly, in chapter nine, the researcher will present all the references relevant to this project. At the end of the project, the researcher will come across the appendices which will include the researcher's time-line, supporting documents of the approval granted for this project, and the raw data of the survey responses.

Literature Review

2.0 Introduction

In this chapter the reader will be exposed to information the researcher used to understand the problem better, to gain knowledge on similar problems and their solutions as well as how this research will help the researcher in achieving the project objectives. Information on the reliability evaluation of student's methods and lecture-student technical interaction will be discussed in some of the sub-headings in the literature review. The researcher will look into the learning curve and the learning rate of students. Another sub-heading is about the Intellectual dynamics in the learning space. Learning maturity is an important factor when one wants to gain knowledge on the intellectual dynamics of students and what the developing stages are in becoming mature. Lastly, the researcher collected information on the progression in learning, the reliability of the sampled dataset, and the prioritisation model to improve the intellectual maturity of a student.

2.1 Review

2.1.1 Statistical Analysis of Student Learning curve

The skill of gathering data and discovering patterns and trends are used to describe statistical analysis. Statistical analysis is just another way of saying "statistics". After data is gathered one can analyse the data and convert the data so that it can be useful (Anon., 2014). The dictionary describes the learning curve as the tempo at which a person's progress in learning a new skill or gaining experience (Oxford, 2020). The study, Positive Impact on Learning Curves of Students by Introducing Information Communication Technology in Teaching Methodologies, shows remarkable results and compelling proof that Information and Communication Technology (ICT) tools that are used in the methodology of teaching improve the learning curve of students. Evidence shows that the concentration of the students significantly increased and their readiness for learning also initiates. It also shows that learning abstract concepts, which require a good cognitive approach from the learner's side, get enhanced when ICT is used in the teaching methods especially in higher levels of education (Varghese, 2015).

In a paper done by Pavlik Jr, Cen, and Koedinger they defined a new method to create a quantitative model using learning curves of an educational content domain of related practice item-types. To acquire the relationship between the learning curves and these item-types they made use of a

pairwise test. They showed how the results of the test in a set of pairwise transfer relationships could be articulated in a Q-matrix domain model. The newly developed domain model consistently resulted in better learning curve fits, showed by using cross validation. Also, the produced Q-matrices can be used by curriculum designers as well as educators to acquire well rich and more integrated perceptions on concepts in the educational domain. A positive implication of this model is that students' knowledge can be traced more effectively. What makes this domain model stand above the rest of the automatically determined domain models is that not only does it determine the performance dependencies that might be used for ordering practices, it also explicitly tracks the learning of a student. This model with the added learning domain creates the potential not only to answer questions related to what item-type is best to use next, but it also answers the question of how much more should the item-type be practiced (Pavlik Jr, et al., 2009).

2.1.2 Statistical Analysis of Student Learning rate

The aptitude for learning is described in terms of the time required for a student to master a fixed amount of material. This was described by Carroll in 1963 by proposing a model of learning. This model indicates that all students have the ability to learn the material that has been taught to them, but they may learn this material at different rates. Based on the study, The Effects of Grouping and Pacing on Learning Rate, Attitude, And Retention in ISCS Classrooms, it is evident that students with high mental ability will learn at a faster rate than students with low mental ability. Also, students with higher mental abilities will remember more of what they have learned than students with lower mental abilities. The study also shows that some chapters are learned at a faster rate than others. The reason for this is regardless of the learning ability of the students, but rather because some chapters are more difficult than others and are better taught by the teacher (Gabel & Herron, 1977).

The statistical analysis approach, ANOVA- analysis of variance, is used to test research hypotheses. In the article done by Buckless and Ravenscroft, they propose that researchers should employ contrast coding to test hypotheses, because one limitation found of ANOVA is that it only detects large differences between cell means and not the functional form of the relationship between cell means. They called this contrast coding, a refinement of ANOVA. The researcher will be required to specify the functional form of the relationship between cell means. It is demonstrated that contrast coding will result in better statistical power than the standard ANOVA (Buckless & Ravenscroft, 1990).

In the book, Encyclopedia of Research Design Chapter Title: Analysis of Variance (ANOVA), ANOVA can be distinguished into one-way ANOVA or two-way ANOVA. The effect of a single factor on a single

response variable can be assessed by using one-way ANOVA. Fixed-effects one-way ANOVA is when the factor is a fixed factor whose levels are the only ones of interest. Random-effects one-way ANOVA is when the factor is a random factor whose levels can be considered as a sample from the population of levels. To answer the question of whether the population means are equal or not, one can use the application of fixed-effects one-way ANOVA. The effects of two factors and their interaction on a single response variable are called two-way ANOVA. The fixed-effects, the random-effects, and the mixed-effects are the three cases to be considered here. The fixed-effect is when both factors are fixed. The random-effects is when both factors are random. The mixed-effects is when one factor is fixed and the other factor is random. To answer the questions of whether Factor A has a significant effect on the responses adjusted for Factor B, whether Factor B has a significant effect on the responses adjusted for Factor A, or whether there is an interaction effect between Factor A and B, one can use the application of two-way ANOVA (Salkind, 2010).

Sharpe stated in his article that the chi-square tests, was the choice of applied researcher for more than hundreds of years and it is still a popular statistical analysis tool today. He stated in his article that a survey was done by Bakker and Wicherts in 2011, they selected six random journals for 2008 and found that 642 chi-square tests were reported in these journals. It is evident that the chi-square test is a very popular statistical analysis tool. In this journal, Sharpe addresses the question of how researchers should follow a statistically significant chi-square test result to be able to establish the source of the obtained result (Sharpe, 2015). The chi-square test is also called a “goodness of fit” statistic, this is due to the fact that the chi-square test is used to test what the likelihood is that the observed distribution of data is due to chance. In other words, it measures if the observed distribution of data fits the expected distribution if the variables tested are independent. In the report written by Onchiri in 2013, he identified what shortfalls exist in the literature and application of the chi-square test and developed a model that can be adopted by researchers to ensure the chi-square test is applied correctly to their data (Onchiri, 2013).

2.1.3 Student retention in higher education.

Student retention is one of the largest challenges that higher educational institutions face. In 2010, Zang, Oussena, Clark, and Kim, did a case study on using data mining to advance Student retention in higher educational establishments. Data mining is used to obtain knowledge and discover a combination of machine learning, statistics, and visualization techniques. Their project was based on using normal language processing technologies combined with data mining to enable the institutions to observe students, analyse student academic performance, and offer a basis for effective intervention strategies. The end goal of this study was to identify potential problems in the earliest

stages possible and to follow up with intervention options to improve student retention. Universities could use data mining to make the education more personal, to ensure maximum educational system efficiency, and to lower the educational process cost. Data mining may lead to an increase in the rate of student retention, a higher educational improvement ratio, and an increase in the learning outcome and success of the students (Zhang, et al., 2010).

Glenda, Heagney, and Thomas wrote an article on student retention from a teaching and learning perspective. It is found that there are teaching and learning approaches that will impact a student's decision to continue with or withdraw from their studies. A discussion on how to facilitate the interaction of student course engagement through teaching and learning programmes in higher education systems is given in the article. A way to increases quality in student retention is to engage with students during their studies. Analysis of various learning and teaching approaches, that will increase the engagement of students between their studies as well as their institution was done in the article. The advantage of using learning, teaching, and curricular development in addressing student retention, will not only increase the student retention but also meet all the needs of the students in a university (Crosling, et al., 2009).

In 2012, Pocock did a case study on the reasons why students, from the University of Kwazulu-Natal, left the faculty of Engineering and fail to complete their original degree of choice. It is stated that student retention has become a problem that worries the academics and administrators worldwide in higher educational systems. The University of KwaZulu-Natal (UKZN) split the issue of student retention into three causes. Firstly, students that show minimum academic progress gets excluded from the faculty, more known as 'academic exclusion'. Secondly, the group of students that choose to leave the university before the completion of their degree, irrespective of their progress. Pocock named the second cause 'walking away'. Thirdly, are the crop of students that leave the university because of the inability to finance their studies, also known as 'financial leavers'. It is not easy to separate each cause from literature and retention rates alone and thus the aim of this study was to put the reasons why students leave the Faculty of Engineering, of the UKZN, in categories, more specifically to quantify the scale of students 'walking away' and 'financial leavers' for leaving the university. To fully grasp the leaving rates within the Engineering faculty of the UKZN, Pocock studied two types of data sets. The first data set was a year-on-year cohort registration analysis. In **Table 1** is the results obtained by the year-on-year cohort analysis which provides an indication of the overall leaving rate from the university as well as the time period of when the retention took place. The second type of data set used was a population balance across the faculty registrations in total. It resulted in a 1-year snapshot of the progression and retention of students. This gave the loss

rate of 1-year and allowed Pocock to identify the group of students to be interviewed to determine their reasons for leaving the faculty (Pocock, 2012).

Table 1- The Faculty of Engineering of the UKZN's cohort departure rates (%).

Year	Leaving Rate (After 1st Year)	Leaving Rate (After 2nd Year)	Leaving Rate (After 3rd Year)
2004	17.9	38.2	49.1
2005	22.3	35.6	43.8
2006	16.9	28.1	36.2
2007	14.8	29.8	41.2
2008	13.8	28.8	-
2009	17.1	-	-

2.1.4 Progression in Learning

Learning progression is defined as the purposeful categorisation of teaching and learning prospects across numerous developmental stages, ages, and grade levels. This term is mostly used when referring to the learning standards and clearly expressed descriptions of what the students should be able to know and do at a certain stage during their education (Anon., 2013). In a blog, by Helyn Kim and Esther Care, it is stated that there is little knowledge on the progress of 21st-century skills. Therefore, there are no outlined guidelines available for teachers in what the expectations are for the different skills the learners should acquire, necessary to be able to contribute to a changing and developing world. One can say there is a need to deliberately design new teaching approaches to ensure that the students of the 21st century develop the necessary skills (Kim & Care, 2018).

Wilson describes in his article, Measuring Progression: Assessment Structure Underlying a Learning Progression, how he used fundamental conceptualizations in the work of the BEAR Center towards the development of learning progression. The heart of the development of learning progression is all built on the construct map, which is the base building blocks of the BEAR Assessment System (BAS). The concept of learning progression was described as the idea that learning progression undergoes rapid development at a certain time. Planning the means of measuring the student's position alongside a learning progression is one of the key steps when one wants to advance the scientific study of learning progression. This also helps in finding valuable educational applications of this idea. Decent assessment addresses the need for comprehensive measurements and there are four principles on which the BAS is based on. The first principle is a development perspective, the second is a match between instruction and assessment. Thirdly is the principle of generating quality

evidence and lastly is the principle of management by instructors to allow appropriate feedback, the way forward, and follow-ups. These four principles can be seen in **Figure 2**. This article also describes a sequence of various ways one can see the relationship between the idea of a construct map and learning progression which is better known in the article as "assessment structure". Thelatest BEAR project examples are also illustrated in this article. Lastly, this article gives a comprehensive discussion of the strengths and limitations of these conceptualizations that focus on both educational and measurement concerns (Wilson, 2009).

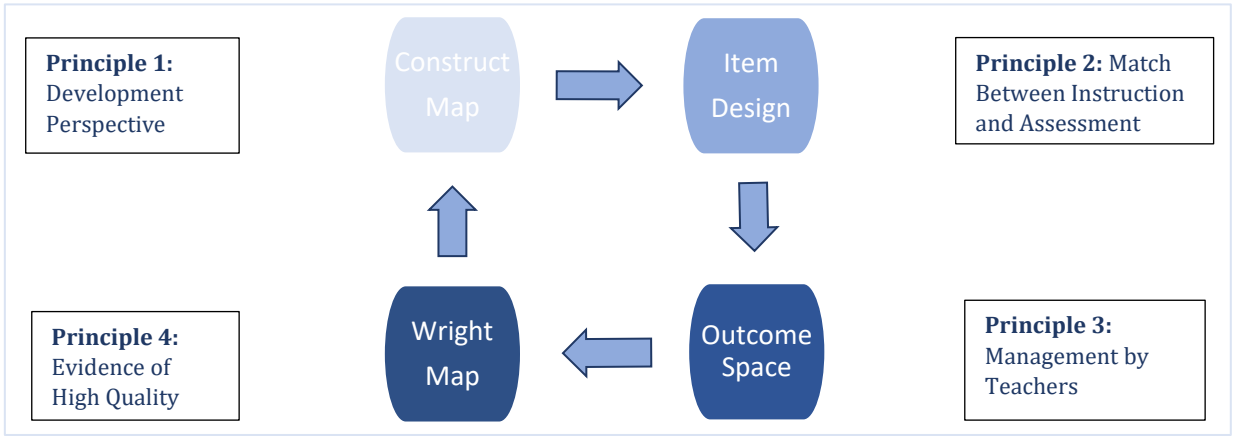


Figure 2-The BEAR Assessment System's Building blocks and Principles.

2.1.5 Reliability Evaluation of Lecturer-Student Technical Interaction

In the report, The Relationship Between Teacher-Student Interactions and Student Course Engagement from a Student Perspective, it states that teacher-student interactions, personality, motivation, institutional and non-institutional support, active citizenship, and achievements are all factors that influence the student course engagement in higher education. There are four domains of teacher-student interactions namely: Dominant teacher-student interaction, Cooperative teacher-student interaction, Submissive teacher-student interaction, and Oppositional teacher-student interaction. In the four scatter plots shown below in **figure 3**, one can see the relationship between student course engagement and each domain of lecturer-student interactions. It is evident, that Cooperative teacher-student interaction has the most positive influence on the student course engagement. The reason for this result is that teachers who are caring and display characteristics of warmth will have students who enjoy learning and are actively engaged in their courses. Overall, this study shows the constant role of teacher-student interaction and the impact it has on the student course engagement in higher education (Pettis, 2017).

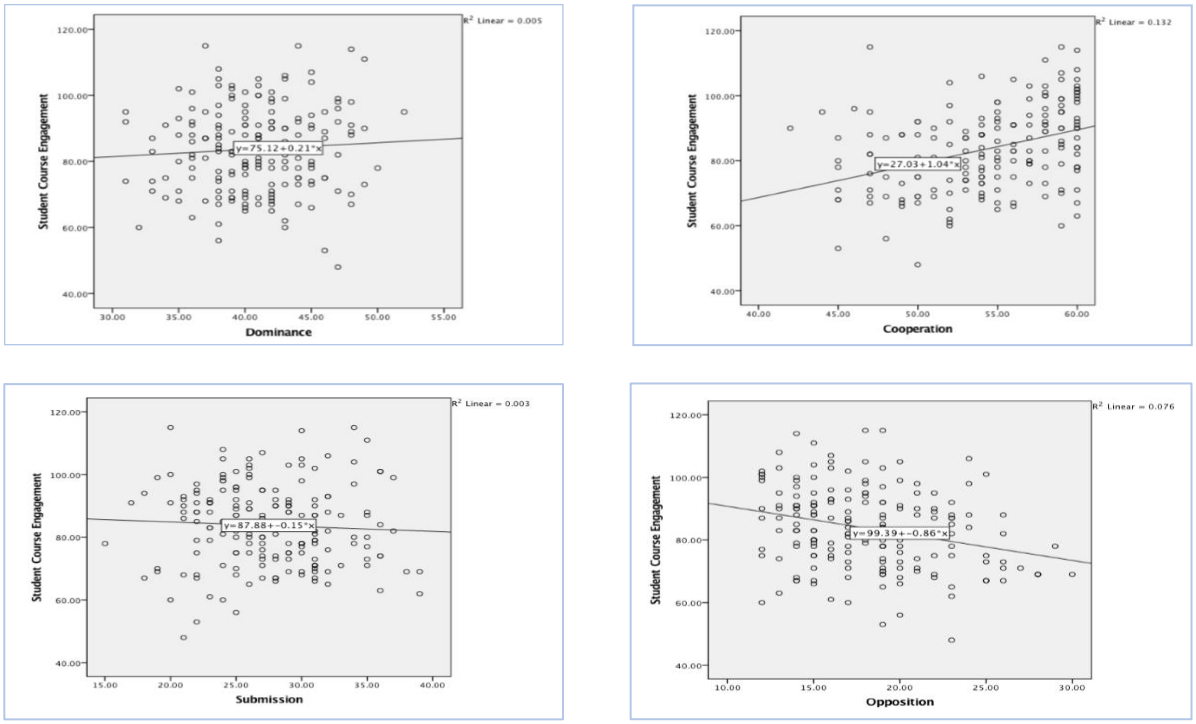


Figure 3-Scatter plots of the relationship between student course engagement and each domain of lecturer-student interaction.

2.1.6 Learning Maturity

William Perry hypothesized over research studies for ten years on the intellectual and ethical development of students. It appeared to him that students move through four levels of maturity as learners. His studies have implications on students from pre-school up to university. In ***Table 2*** below, one can see the four stages of maturity as Perry described it. The four stages seen in ***Table 2*** are equally related to the way we teach and provide media services.

Table 2-Perry's Four stages of Learning

Name	Description
Dualism	• Wants the answer • Knowledge equals facts • Avoids ambiguity • Authorities have answers • Memorize by hard work
Multiplicity	• Wants more answers • Ambiguity grudgingly acknowledged • Everyone has right to own opinion • Permissive regarding diversity • No one is wrong
Relativism	• Context determines inquiry • Ambiguity is fact of life • Knowledge is constructed • Reasonable people can disagree • Knowledge is qualitative
Commitment	• Contextual relativism assumed • Open to alternatives • An ongoing, unfolding activity • Decisions based on reasoning • Explores issues responsibly

The teaching stages of Perry's model can be seen in ***Table 3***. These stages are seen as the approaching styles that work together with the learning stages and serve to reinforce each level of learning.

Table 3-Perry's Teaching Stages

Stage	Description
Teacher Dominated	• Teaching is telling • One-way communication • Questions and answers • Subject matter acquisition is basic • Evaluates testing on recall
Subject Centred	• Teaching is telling plus media • One-way communication — some ambiguity • Multiple authorities are cited • Student expected to be active learner • Evaluation on recall and applications
Task Oriented	• Teaching includes group and individual work • Needs assessed — alternative methods • Different authorities recognized — ambiguity accepted • Two-way communication for mastery • Evaluate on recall applications, implication
Inquiry Centred	• Courses based on readiness levels • Critical inquiry encouraged • Creativity is supported • Collaborative problem solving by teacher and student • Evaluation based on mastery criteria

Lastly, in ***Table 4*** one can see a phased structure of the responses done by media library specialists. This phased structure runs parallel with the educational stages mentioned above.

Table 4-Perry's stages of Media Services

Stage	Description
Basic Library	• Gives simple answer • Tells student about centre • Worksheets on organization • Encyclopaedia basic reference • Provides lists, guide sheets
Media Centre	• Card catalogue with slides • Teaches media use • Refers to several sources • Games on centre organization • Includes teacher in selection
Learning Resources Centre	• Guidance re problem identification • Examines quality of alternatives • Encourages variety media and processes • Strategies for learning styles • Helps student express ideas in different ways
Instructional Development and Media Services	• Reviews curriculum needs with teacher and student • Encourages exploration with computers • Looks beyond standard references • Collaborates on systematic and multidisciplinary approach • Develops evaluative procedures

Ronald J. McBeath explained all the stages listed in the tables above and conclude in his article, that when education advances to the last stage of maturity, the lecturers would need help with the proses of identifying the students' level of readiness for them to have a realistic and meaningful study programmes. Alternative methods for learning should be introduced as the replacement of traditional measures. Instructional technology and learning resources play a large role in the development of the stages and help the teachers and learners to move from one stage to another. To

succeed in all this, it is necessary to make use of media library specialists to work in alliance with the students, teachers, curriculum specialists, and administrators to create curriculums intertwined with media support (McBeath, 1987).

The initial work that was done with the aim in developing a model for the learning process maturity is described by Thompson in 2004. This model was based on the concept of the Capability Maturity Model. Thompson studied the Capability Maturity Model and after more knowledge was gained a mapping to a learning maturity model was developed. The Capability Maturity Model is a tool used for assessing to which extend an establishment has to determine the process to continuously develop a high class software to the consumer's conditions while staying within a certain budget and time. By using this model, it enables the establishment to be assessed and the course for improvement can be developed. Once the highest level of assessment is achieved in the model, the establishment will have everything in place for the ongoing tools for self-assessment and development. For an establishment to reach its fullest potential in software development, they have to use the Capability Maturity Model to define the levels of maturity and the processes that need to be set in place. Thompson took the concept of the Capability Maturity Model and experimented if it could be transferred to the learning concept. He wondered if there were a way of applying the principles of the Capability Maturity Model in such a way that it would enable the student to identify the problems they face, to help them improve their learning. The model that Thompson developed was the first step towards developing a learning process maturity model that can be applied repeatedly in the learning context. This model will enable the student to identify their strengths and weaknesses when they are learning and how to better their learning by selecting different learning strategies (Thompson, 2004).

2.1.7 Determining Reliability of Sampled Dataset

To obtain an extremely effective method of measurement in research, more specifically, social, and behavioural sciences, it is found that survey research is the way to go. Survey research became very flexible because of the endless amount of available options for tools and the collection of data. We can give credit to the web and email for being the new primary vehicle for distributing questionnaires and collecting data. Do not mistake surveys for only being questionnaires, no, surveys rely on proper design, representative sampling, and suitable and effective questionnaire administration. Surveys have become widespread in the modern Western world and can be seen as a key research tool in the academic world (Ruel, et al., 2018).

After the framework of a survey has been created and all the relevant questions are in place, one must start to validate the instrument and the measurements thereof. In social and behavioural sciences this is a much more complex job than in the biological and physical sciences. The reason for this is stated in the book, The Practice of Survey Research: Theory and Applications, that social science concepts are usually abstract, intangible, or otherwise not easily detected. Also, to ensure an accurate survey, the research measurements need to be stable and specific. In the book, they described validity as the measurement that is a true representative of the concept being studied and reliability is when a measurement is being repeated, one would obtain a constant result. Both validity and reliability are necessary in order to rank a measurement as being sensible, truthful, relevant, and unbiased (Ruel, et al., 2018).

For surveys to be reliable, the measurements taken should be steadfast, replicable, and stable. They describe it in the book that the measurements taken should be in such a way that in minimises random error. The book mention two ways in which random error happens. Firstly, random error will happen when the consumer of the survey randomly guesses an answer, this could be due to poorly stated questions that are misleading. Secondly, random error could happen when the consumer unintentionally chooses an answer by accident. One will achieve these unreliable responses when the consumers know very little about the specific survey content. One should take terrific care when creating questions in a survey so that the questions will be easily understood by all the potential participants. With clearly written questions in a survey that avoids confusing language in the questions as well as in the answer options, one will collect a much more reliable source of data. Validation in surveys is important cause it ensures the researcher that he/she is studying what he/she ought to be studying. According to the book, The Practice of Survey Research: Theory and Applications, there are different types of validity when it comes to survey research design namely, measurement validity, internal validity, and external validity. Valid research is necessary to be able to perfectly reveal and describe the intended the real world phenomena. The article, Reliability, and Validity in research states the severity of research methods and credibility of research findings are ways of demonstrating and communicating reliable and validated data. For research to be useful, it should avoid misleading the person using the research (Priest, 2006).

2.1.8 Prioritization Modelling

Oke and Ayomoh began to develop a prioritization model in 2005. In the article, The hybrid structural interaction matrix: a new prioritizing tool for maintenance, they contrasted a modified approach, the hybrid structural interaction matrix (HSIM), with the original, analytical hierarchy process (AHP) by illustrating how the new approach's main elements have a significant effect on the improvement

of maintenance productivity. AHP is a research method that is used repeatedly in scientific investigations, more specifically in maintenance research. But AHP has limitations and it is evident in this article that the HSIM offers enormous opportunities for system improvement regards to the inherent limitations in AHP. Their methodology that they proposed, clearly identified the significance of weighting factors in the model structure. These factors are used to challenge the current underlining factors that are being treated as equally important, with a maximum factor scale of 9. The idea of scaling applied in HSIM is similar to the properly-studied concept prioritization in AHP. Compared to the methodology used in AHP where factors get assigned arbitrary values, the HSIM includes the assignment of giving values to the intensity of importance. This intensity of importance is grounded on the results of a piecewise comparison matrix. This will consequently lead to the opportunity that the less skilled staff can now also monitor the system because HSIM reduces subjectivity (Oke & Ayomoh, 2005).

In another article by Ayomoh and Oke, they demonstrated how the application of the new approach, HSIM, will be more feasible in an organization by prioritising their safety parameters. In this article, they conceptualize their HSIM prioritization concept by integrating the structural interaction matrix (SIM), the hierarchical tree structured diagram (HTSD), and the goal programming (GP) concept from the field of decision science. They presented an easier methodology to apply, which will decrease the subjectivity normally present in existing prioritizing methodologies. Businesses suffer a huge amount of pressure to better their efficiency. As a result of this, many businesses are forced to shift their focus away from safety in order to stay keep their competitiveness amongst their rivals. Ayomoh and Oke used HSIM to present a model that will treat optimization factors as goals. Analysis on the safety of the manufacturing organization was done and all the important factors were identified, in order to enable the safety manager to have a more exact measurement and understanding of the safety system. This will result in a drop in measurement errors, due to the fact that human assessment in safety performance is bias and may be characterised by previous safety prioritization paradigm (Ayomoh & Oke, 2006).

The existing management prioritization tools for quality in a manufacturing organization can be advanced by applying the concept of HSIM, developed by Oke, Ayomoh, Akanbi, and Oyawale. To analyse a specific situation, they presented in the article, Application of hybrid structural interaction matrix to quality management, a process that could be used by showing that one could combine the SIM and HTSD to create a new model called HSIM. This model will result in the feasibility of applying this model in specific situations to gain useful insight into the problem area. It is evident in their research that the application of HSIM will save manufacturing organisations a lot of energy and cost,

that was used in the past on alternative prioritisation techniques. This model will minimise the time organisations spend on seeking experts of opinion on the above mentioned issues (Oke, et al., 2008).

In the article, An approach to tackling the environmental and health impacts of municipal solid waste disposal in developing countries, the HSIM was used as a prioritisation tool on the environmental health implications of municipal solid waste disposal. The main identified health implications that resulted from improper disposal of waste were prioritised by using the HSIM. The article showed that by tacking on the environmental health impacts from the factors that were prioritized from the most negative impact through to the optimal resource allocation, one would be able to either reduce or completely eliminate the impacts associated with less prioritized factors that are directly related to the highest negatively impacting factors. By using this model, decision-makers will have the ability to know which set of systematic factors should get preference above less prioritized sets of systematic factors and to what extent preference should be given at a certain period of time (Ayomoh, et al., 2008).

Thus, it is evident in the 4 articles above that one can use the HSIM tool to develop a model to be able to identify influencing factors to specific situations in an organisation to propose control measures that can be used by management to minimise challenges within an organisation.

2.2 Alternative Solutions

In most of the studies above, they made use of surveys to gather data regarding the intellectual development of students in higher educational systems. The researcher will use the methods in the review, to determine the important factors of intellectual dynamics and to conduct purposeful questions for the questionnaire. The methods used to improve student retention and how to keep track of students' intellectual dynamics in a university are good solutions but, will only be used to make recommendations on how to solve the proposed problem for this research. One method that the researcher could make use of is the HSIM tool to develop a prioritization model for the important factors that negatively impact the intellectual development of students in higher education because this directly relates to this study problem.

The researcher can also make use of measurement validity, internal validity, and external validity to ensure that the surveys developed for this research are valid. Also, the researcher can minimise random error in the data by creating questionnaires with measurements that will limit poorly stated and misleading questions in the surveys. Unreliable responses will be minimised by using Qualtrics

or Survey Monkey as survey software to create the surveys and also to only distributing surveys to respondents that are relevant and known with the subject topic. By using these measurements, the researcher will be able to have reliable data for analysis. The model used by Thompson, which is based on the concept of the Capability Maturity Model, will not be used in this study as this were only the first steps in creating a learning process maturity model for students and more research in this field is still lacking in the literature. The BEAR Assessment System (BAS) developed by Wilson is based on a construct map, that will measure the student's position alongside a learning progression, that will advance the scientific study on learning progression. This is related to the intended problem of this research. Lastly, another method used to solve relating problems to this study is the model created by Pavlik Jr, Cen, and Koedinger. Their model showed how the results of pairwise transfer relationships could be articulated in a Q-matrix domain model. They added the learning domain to this model, and it resulted in a model that not only answers questions related to what item-type is best, but it also answers how much more practice should be given to the item-type. ANOVA and the chi-square test are really good IE techniques used to do a statistical analysis.

2.3 Preferred Solution

The preferred solution of this project will be to use the method of HSIM in the literature review to develop a prioritisation model of the identified causative factors, found in the investigative survey results, to establish the criticality level with which these factors influence intellectual dynamics and learning capacity. The researcher preferred the HSIM technique above the BEAR Assessment System and the Q-matrix domain model because both these methods focus more on methods used by the students to improve their learning maturity, whereas the HSIM tool will propose control measures that can be applied by the management of the university to minimise challenges of the intellectual dynamics of students in higher education. Also, it will guide the management by pointing out which influencing factors will have the most negative impact on the intellectual dynamics of students and how these factors can be eliminated. The investigative surveys that will be created for this research will be created using the survey software Qualtrics combined with methods stated in the in the book, The Practice of Survey Research: Theory and Applications, to ensure to capture reliable and valid data in order to perform a comprehensive data analysis. The researcher will make use of the chi-square test to do the statistical analysis of the investigative surveys. The chi-square tests were chosen above ANOVA because the researcher is more familiar with the chi-square test.

Research Approach/Research Methodology

3.0 Introduction

The research approach and IE techniques used to carry out a statistical and reliability analysis on investigative surveys as well as the techniques used to develop a prioritisation model for the intellectual dynamics of students, in higher education, are discussed in detail in the conceptual and theoretical framework of the study. The research methodology of this study gives an overview of the structure/sections used in the questionnaire of the study survey and what the intended purpose was of each section in the questionnaire.

3.1 Conceptual Framework

The conceptual framework to improve the intellectual dynamics of students and student retention in higher educational systems can be found in **figure 4**. In the development of statistical analysis and reliability evaluation of the intellectual dynamics of students and their learning maturity in higher education, it is important to consider the stated problem, objectives, and proposed technical solutions to completely grasp the research approached that needs to be followed to successfully complete this project. During the course of this project, Industrial Engineering techniques will be used, and each technique will play a particular role in the delivering prosses of the research solutions. The diagram in **Figure 4** maps out the connectivity between the research trio (Problem-Objectives-Research Activities-IE Techniques) and what actions need to be followed through to complete this study topic.

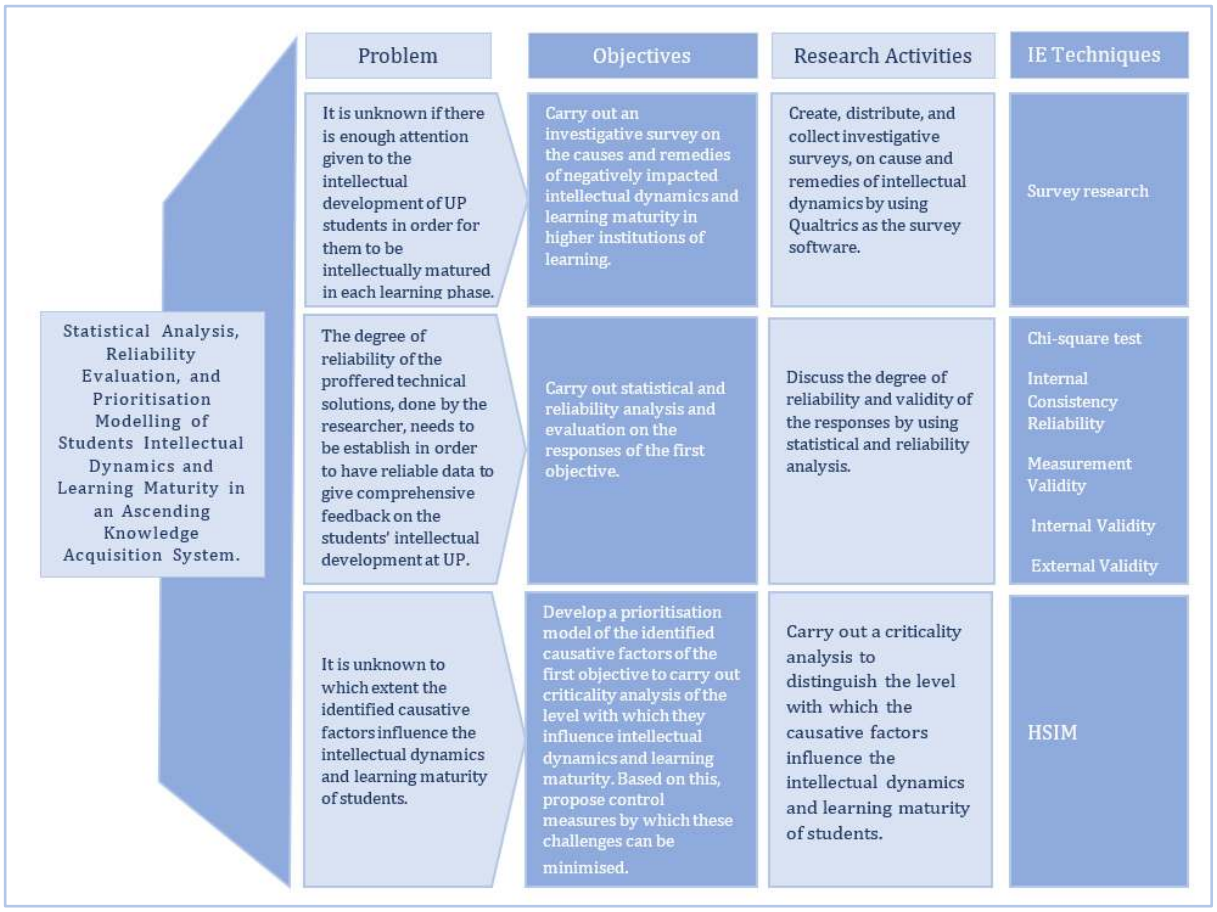


Figure 4-Framework of intellectual Dynamics of students and student retention improvement.

3.2 Theoretical framework

The theoretical framework clarifies how the IE Techniques listed in **Figure 4** will be used to implement and execute this project's objectives.

3.2.1 Survey Research

Survey research is a research method that involves standard questionnaires or interviews to collect data about humans and their preferences, thoughts and behaviours in a systematic manner. Survey questions may be structured or unstructured. The online surveys that will be created for this project will include structured questions (Bhattacherjee, 2010). The researcher will be able to capture responses to structured questions by using one or more of the response formats listed in **Figure 5** on the next page.

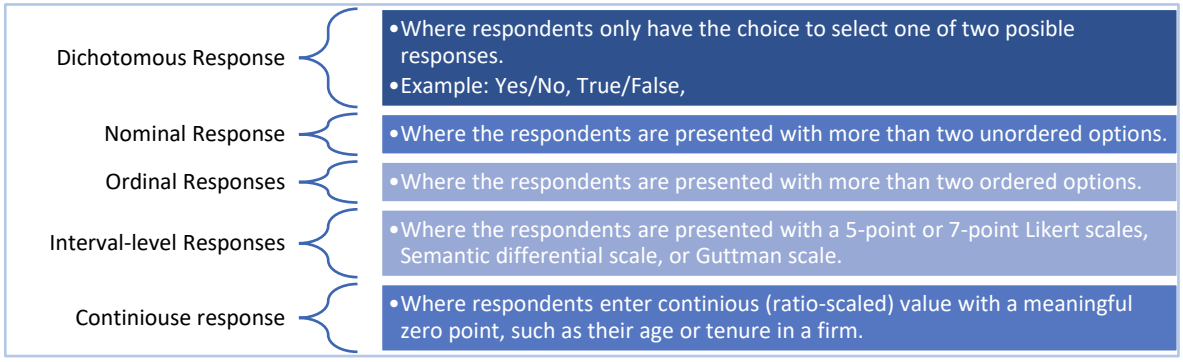


Figure 5- List of response formats for structured questions.

During the construction of the questionnaires of the online surveys, the researcher will make use of the above listed response formats to develop structured questions.

3.2.2 Chi-square test

The Chi-square Test for goodness of fit is used by Researchers to test if the observed distribution of levels will follow a hypothesized distribution. The list in **Figure 6,** contains the conditions that need to be met when one wants to do a Chi-square test for goodness of fit.

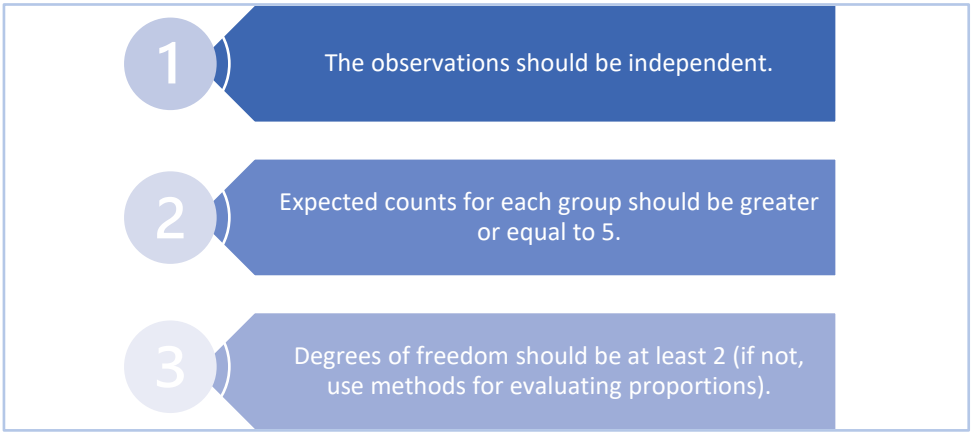


Figure 6- Lists of conditions that need to be met to do a Chi-square Test for goodness of fit.

The following steps describe how the researcher will go about when doing the Chi-square Test for goodness of fit (statslectures, 2010).

STEP 1: Define the Null hypotheses and the Alternative hypothesis

H_0: The observed distribution follows the hypothesized distribution, and any other differences are due to chance.

H_A: The observed distribution does not follow the hypothesized distribution.

STEP 2: State alpha

$\boldsymbol{\alpha} = 0.05$, Always use alpha as 0.05

STEP 3: Calculate the degree of freedom

$\boldsymbol{df} = \boldsymbol{k} - 1$, where $\boldsymbol{df}$ = degree of freedom and $\boldsymbol{k}$ = number of groups observed.

STEP 4: State Decision Rule

- Use the calculated degree of freedom and alpha in the chi-square table to find the values you are going to use in your decision rule
- State your decision rule for example:

$If\ \boldsymbol{X^2}\ is\ greater\ than\ the\ value\ obtained\ from\ the\ above\ steps, reject\ \boldsymbol{H_0}$,

where $\boldsymbol{X^2}$ = Chi − square Test and $\boldsymbol{H_0}$ = Null Hypothesis.

STEP 5: Calculate the test statistic

$$X^2 = \sum_{i=1}^{k} \frac{(observed\ count - expected\ count)^2}{expected\ count},$$

Where $\boldsymbol{k}$ = number of groups observed.

STEP 6: State Results

Compare your results in step 5, with your decision rule in step 4, and state whether you will reject or not reject the Null Hypotheses.

STEP 7: State Conclusion

Make a conclusive status in the end so that the reader will understand what the conclusion of the goodness of fit test was.

3.2.3 Internal Consistency Reliability

To establish to the degree of which different questions of the same construct are producing similar results, one can use Internal Consistency Reliability as a measurement of reliability. By comparing and correlating the responses of both versions the researcher will be able to assess the consistency of the alternative versions. Split-Test (Split – Half) Reliability is one of the complex forms that can be used in internal consistency reliability (Ruel, et al., 2018). The Split- Test (Split half) Reliability can be applied by doing the following steps:

STEP 1: Group all questions in a survey that probe the same construct.

STEP 2: Split the grouped questions into two sets with an equivalent amount of questions.

STEP 3: Calculate the responses of the one group and document the results.

STEP 4: Calculate the responses of the other group and document the results.

STEP 5: Compare the results of each set of "half" group with one another to assess the correlation between them.

STEP 6: Comment on the correlation found in step 5. The correlation of reliable questions should be high among questions that probe the same construct.

3.2.4 Measurement Validity

The extent to which a survey item (or group of items) elicits an accurate description of the targeted concept is credited to measurement validity. Firstly, a clear definition of the target concept is required, a target concept that suggests some appropriate dimensions that can be measured with survey questions. Measurement validity is important, because when measurements are not valid, researchers may not be studying what they actually intended to study and ending up studying another concept altogether. There are many types of different measurement validity, but when it comes to survey research, four principle types of measurement validity are sought after (Ruel, et al., 2018). The four principles types of measurement validity are described in **table 5.**

Table 5- The four principles of measurement validity for survey research.

Measurement Validity Type	Description
Face Validity	The measure appears to be a reasonable way to estimate the targeted construct, in other words, at the face value it looks good.
Content Validity	The comprehensiveness, relevance, and representativeness of the measurement.
Criterion-based Validity	The measurement's agreement with or empirical association with some criterion that is considered the "gold standard" for measuring that particular concept.
Construct Validity	The soundest but also the most rigorous measure of validity. It is demonstrated when the instrument is truly measuring the construct it was designed to measure, and not some other construct

The researcher will make use of Face Validity as the measurement validity type for the survey research for this project. The reason for this is, because according to the article, Principles and Methods of Validity and Reliability Testing of Questionnaires Used in Social and Health Science Researches, it is the most commonly used form of measurement validity type used in developing countries (Bolarinwa, 2015).

The Face Validity will be established when the researcher who is skilled on the project topic reviews the questionnaire and concludes that the characteristic or trait of interest is being measured by the questionnaire. By looking at the questions in the questionnaire and approving that the questions are a valid measure of the concept, which is being measured in this study the researcher, who is skilled on the project topic, is measuring the validity on the face of it. Meaning the researcher evaluates whether each question in the questionnaire matches any given conceptual domain of this project (Bolarinwa, 2015).

3.2.5 Internal Validity

How well the researcher's survey design tests the accurate relationship between the dependent and independent variables is called internal validity. When sound arguments, adequate statistical controls, and rigour research design are applied, to establish a causal relationship between correlated variables, one would achieve internal validity (Ruel, et al., 2018).

3.2.6 External Validity

If a researcher's finding can be generalized to other populations, time, environments, and settings, it can be classified as external validity. External validity associates with how the results of the study

can be applied elsewhere. The three threats to a survey's external validity are listed in **Figure 7** below. The assessment across groups of people, varying situations, and significant periods of time are important factors for external validity. One should be careful when sampling from a large population and properly framing the study's results, to ensure that the results of the research are generalizable to the real world external to the study.

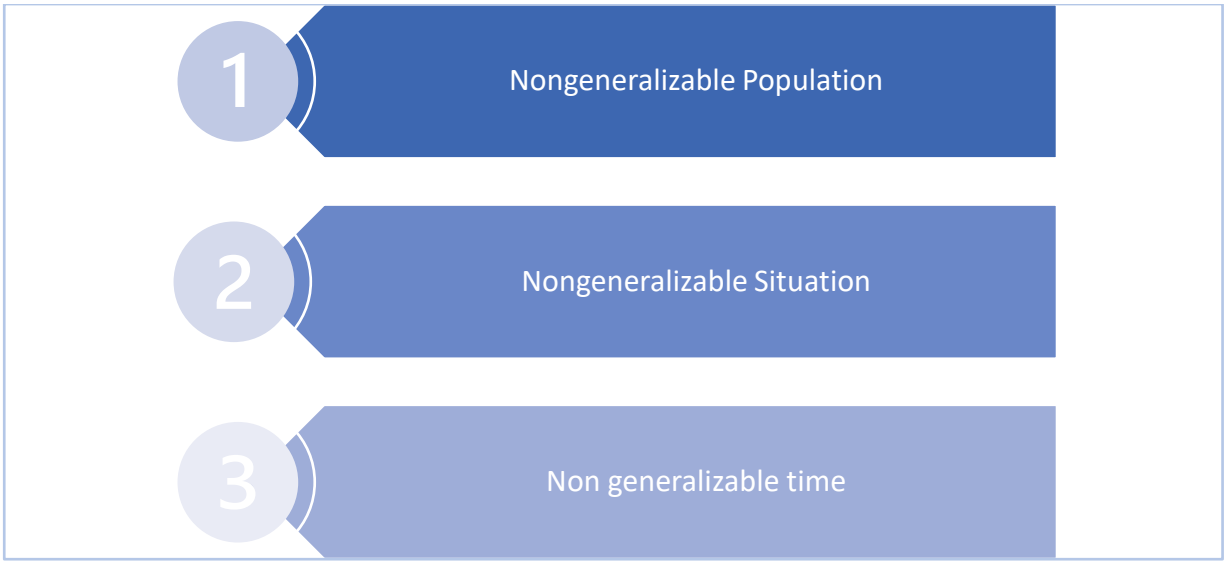


Figure 7-List of three threats to external validity of a survey.

3.2.6 HSIM

In **Figure 8**, is the theoretical framework of the application of HSIM as shown in the article done by Oke and Ayomoh in 2005 (Oke & Ayomoh, 2005). After the theoretical framework follows the description of the processes and the methodology of the 10 steps listed in the framework for the application of HSIM. The formulas for the calculation of the weight determination, weight normalisation, and resource allocation of the prioritized factors can be seen after the 10 steps of the application of HSIM. These calculations were obtained from the article, An approach to tackling the environmental and health impacts of municipal solid waste disposal in developing countries (Ayomoh, et al., 2008).

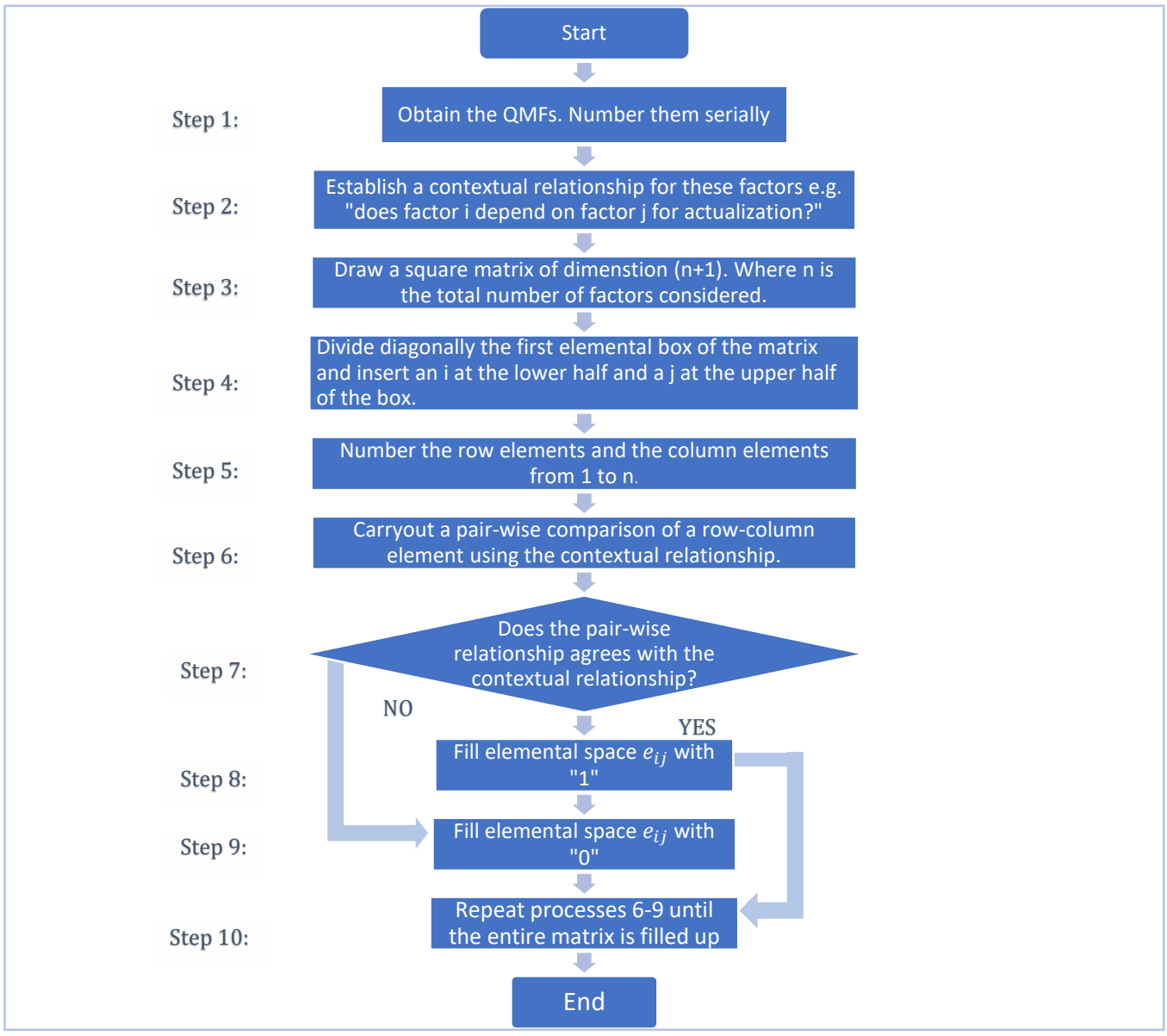


Figure 8-Theoretical framework of the application of HSIM

STEP 1: Contains the listing of all relevant factors and the serial attachment of numbers.

STEP 2: Establish the contextual relationship for the factors in step one Only the interaction that has a particular contextual relationship relevant to the problem at hand should be considered, although an element might act in several other ways as well. The contextual relationship used in the development of HSIM is the following, "does the implementation of factor j lead to possible actualization of factor i?" After a pair-wise relation of factors, when the response by the decision maker is "no", it attracts the value "0" in the specified elemental space, while the response "yes" attracts the value "1".

This is mathematically written as:

$$e_{ij} = \begin{cases} \mathbf{1} & if\ \boldsymbol{i}\ is\ actualized\ as\ result\ of\ \boldsymbol{j} \\ \mathbf{0} & if\ \boldsymbol{i}\ is\ not\ actualized\ as\ result\ of\ \boldsymbol{j} \end{cases} ,$$

Where e_{ij} represents an element in row i and column j.

STEP 3: Draw a square matrix with the dimensions **(n+1)**, where n will be the total number of factors considered for the specific problem at hand.

STEP 4: Draw a diagonal line in the first block on the upper left corner of the square matrix so that the block is divided into two triangles. This is meant to demarcate the row elements from the column elements. Assign variables **j** (representing columns) and **i** (representing rows) in the upper (right) and lower(left) position to the demarcated box.

STEP 5: Serially number all the factors considered in the study. The numbering should range from **j** to **n**, where n represents the last factor considered. The numbering of both variables **i** and **j** should be symmetrical, i.e. $\boldsymbol{i} \equiv \boldsymbol{j},\ \boldsymbol{i+1} \equiv \boldsymbol{j+1},\ \boldsymbol{i+n} \equiv \boldsymbol{j+n}$. An example of how the square matrix should look like after applying steps 3 to 5 (for example n= 6 factors) can be seen in **Figure 9** below.

j \ i	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Figure 9-Square matrix with dimensions (n+1) where n = 6

STEP 6: Full up the empty spaces in the matrix by making use of the questions posed in step 2. This will form the basis for completion of each elemental spaces, better known as the contextual relation, that is utilized for filling up the elemental spaces e_{ij}.

STEP 7: The binary digit (1 or 0) the is assigned to a particular elemental space e_{ij}, will depend on the outcome of the pair-wise relationship between the row and column elements.

STEP 8 and 9: If the outcome of the pair-wise interaction is "yes", assign the binary digit "1" to that particular elemental space, and if it is a counter outcome of "no, assign the binary digit "0" to that particular elemental space.

STEP 10: This step is basically a repetition of steps 6-9 until all the elemental spaces in the square matrix are filled.

Weight determination for prioritised factors Weighting model:

The following calculations are used to determine the weight/intensity of the importance of the prioritised factors.

$$\boldsymbol{I_{RFi}} = \left\{\frac{\boldsymbol{N_{SFi}}}{\boldsymbol{T_{NF}}} \times \boldsymbol{M_{SR}}\right\} + \left\{\frac{\boldsymbol{b}}{\boldsymbol{T_{NF}}}(\boldsymbol{M_{SR}} - \boldsymbol{C})\right\},$$

$$\boldsymbol{C} = \frac{\boldsymbol{M_{PSF}}}{\boldsymbol{T_{NF}}} \times \boldsymbol{M_{SR}},$$

$$\boldsymbol{b} = \boldsymbol{N_{SFi}} + \mathbf{1},$$

where $\boldsymbol{I_{RFi}}$ is the intensity of importance rating of factor i, $\boldsymbol{N_{SFi}}$ the number of subordinate factors to a particular factor i, $\boldsymbol{M_{PSF}}$ the maximum possible subordinate factors, $\boldsymbol{C}$ the constant, $\frac{\boldsymbol{b}}{\boldsymbol{T_{NF}}}$ the variant ratio, $\boldsymbol{T_{NF}}$ the total number of factors, $\boldsymbol{M_{SR}}$ the maximum scale rating.

Weight Normalisation Model:

$$\boldsymbol{N_{wi}} = \frac{\boldsymbol{X_i^{1/n}}}{\sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \boldsymbol{X_i^{1/n}}},$$

where $\boldsymbol{N_{wi}}$ is the normalised weight for factor i, $\boldsymbol{n}$ the total number of factors considered, $\boldsymbol{X_i}$ the initial value of factor i before normalisation.

Resource Allocation Model:

Below is a generalised form of the model proposed for optimality in resource distribution.

$$\boldsymbol{C_i} = \frac{\boldsymbol{N_{wi}}}{\sum_{\boldsymbol{n=1}}^{\boldsymbol{n}} \boldsymbol{N_{wi}}} \times \boldsymbol{C_T},$$

$$\boldsymbol{C_T} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \boldsymbol{C_i N_{wi}} = \boldsymbol{C_i N_{wi}} + \boldsymbol{C_{i+1} N_{wi+1}} + \boldsymbol{C_{i+2} N_{wi+2}} + \cdots + \boldsymbol{C_{i+n-1} N_{wi+n-1}} + \boldsymbol{C_{i+n} N_{wi+n}},$$

where $\boldsymbol{C_T}$ is the total available resources, $\boldsymbol{N_{wi}}$ the normalised weight of factor i, $\boldsymbol{C_i}$ the resources available to each factor.

3.3 Data Collection Procedure

The researcher will make use of a survey process for collecting data on the intellectual dynamics of students in higher institutions of learning. The data type will be qualitative as the data for this research will be obtained through survey questionnaires. The data collection procedure can be seen in **Figure 10** on the next page.

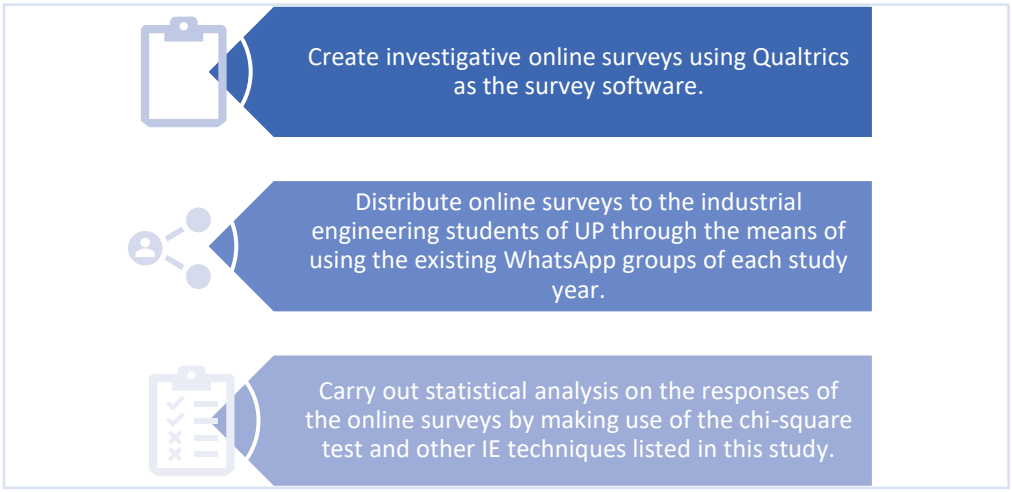


Figure 10-The data collection procedure of this project

The specific population group that the researcher will target, will be the Industrial Engineering Department of UP. The population cluster will consist of the students studying industrial engineering. The reason for the population cluster is to discover what the causes and remedies are of intellectual dynamics and learning maturity through the viewpoints of students in higher institutions of learning. The sample size of this research will be 10% of the population. The reason for a sample size of 10% is because in the article, How to choose a sample size (for the statistically challenged), it states that the minimum benchmark for sampling in a given population is 10% of the size of the population. However, if this 10% is greater than 1000 items, then you can scale down the percentage (Bullen, 2014) The population of students currently studying industrial engineering that are on the WhatsApp groups is more or less 100 students on the firsts year group, 151 students on the second year group, 121 on the third year group, and 226 on the fourth year group, resulting in a population of 598. Thus, the researcher will work with a minimum sample size of 10% of the population resulting in a minimum of 60 survey responses. The researcher anticipates reaching more than 60 students and would like to have a sample size of 80, meaning 20 online survey responses in each year group of the industrial engineering students of UP. The Chi-square Test is the data analysis tool that the researcher will adopt in ensuring that the data observed is not due to chance.

3.4 Data presentation and analysis.

The overview of the structure/sections of the questionnaire used in this study survey and the intended purpose of each section will be discussed in this subheading of the research approach/methodology section. The questionnaire was divided into 6 sections namely: Academic Background, Language Gap, Housing, Intellectual Maturity, University Setup, and Finance. Below is the discussion of the intended purpose of each of these sections of the questionnaire.

3.4.1 Academic Background

The purpose of the academic background was to determine if the students were studying Industrial Engineering since this was one of the limitations of this project. Also, this section was used to determine if and why students are struggling and failing modules. This section was also used to group the research respondents in different academic levels.

3.4.2 Language Gap

The intended purpose of this section was to see if there is a language barrier for the students studying Industrial Engineering and how this is affecting their academic success or journey in becoming intellectually matured.

3.4.3 Housing

The Housing section of the survey questionnaire was used to establish if the residential circumstances of the students have impacted their academic success in a positive or negative way. Also, do students that do not live at home any more have an academic advantage or disadvantage over students studying from their home.

3.4.4 Intellectual Maturity

The purpose of this section was to spark the idea of intellectual maturity at the students and find out what they think would happen with their academic success if more attention were given to intellectual maturity in higher educational systems. In other words, to discover if intellectual maturity is a factor that needs more attention in higher educational systems.

3.4.5 University Setup

The University Setup section's purpose was to get the opinion of the students on how the lecturers, classrooms, workload, module structures, etc. had influenced their attitude towards achieving academic success and discovering what factors can be given attention to by the university to avoid student retention.

3.4.6 Finance

The sole purpose of this section was to get an idea of how the students' financial status influences their academic success. The researcher will use the data of this section to see if it is an important factor to consider and what other actions can be taken specifically in the area of student finances.

Data Presentation and Model Validation

4.0 Introduction

In this section of the project report, the reader can expect to find data, applicable to this study, that is presented in a way that is easily understandable. Data presentation and validations will be given in detail in this section. The researcher will also discuss and present the data obtained by the IE techniques used to achieve these study objectives.

4.1 Data Presentation

Graphs and tables are presented in such a manner that the reader can easily interpret what has been done with regards to the gathering of data for this project.

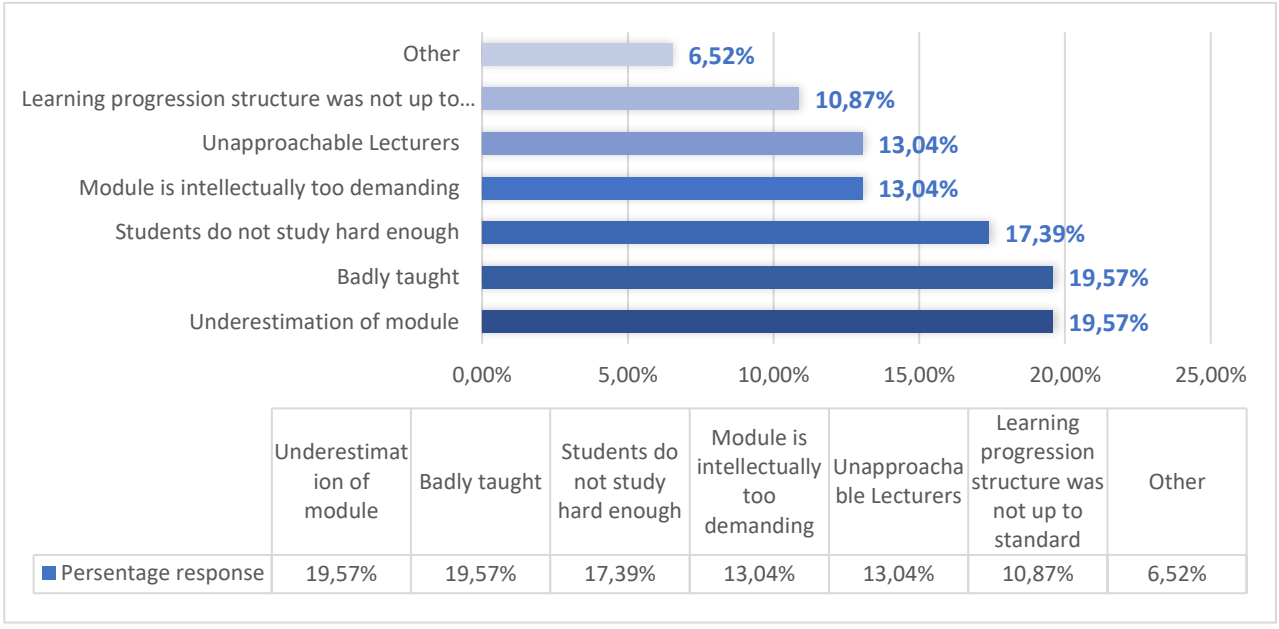
4.1.1. Presentation of Gathered Data

Why students fail and occasionally drop out of the faculty of Engineering?

The researcher used this question above, as the main question from which all the other questions were formed. The following questions, in the questionnaire, brought factors to light that causes students to fail and occasionally drop out of Industrial Engineering faculty of UP.

Question 10: Why do you think you failed the same module more than once?

Graph of response output:

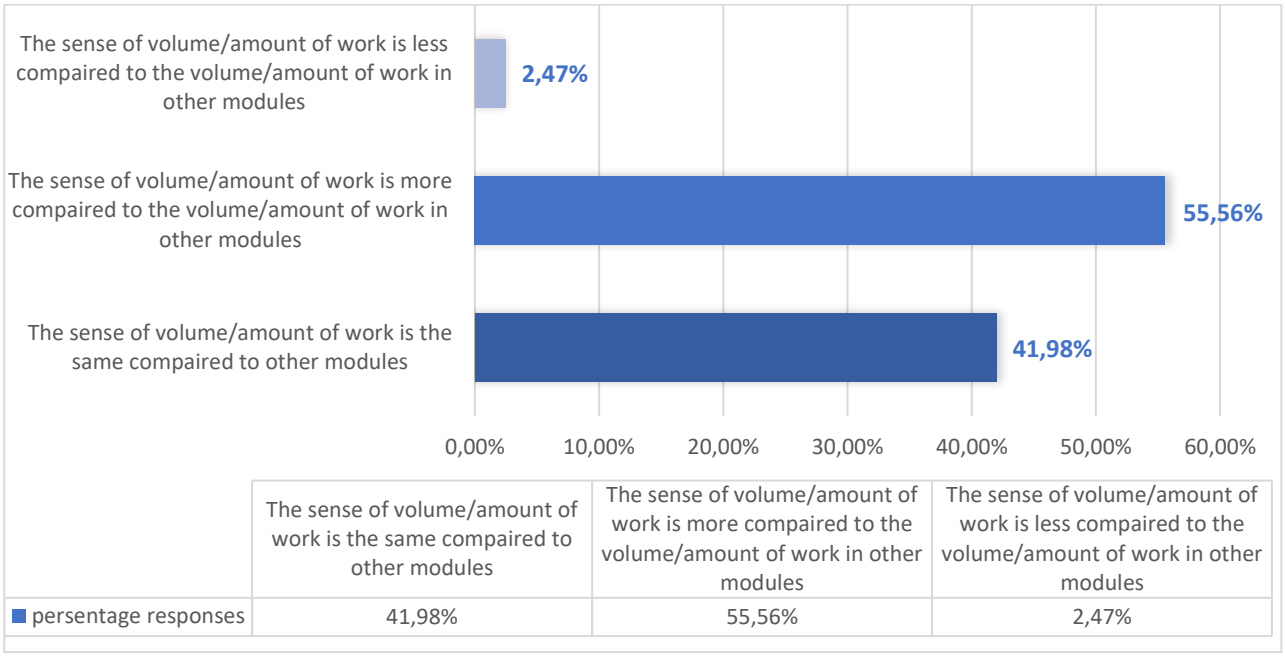


	Underestimation of module	Badly taught	Students do not study hard enough	Module is intellectually too demanding	Unapproachable Lecturers	Learning progression structure was not up to standard	Other
Persentage response	19,57%	19,57%	17,39%	13,04%	13,04%	10,87%	6,52%

Figure 11-Responses to question 10; Factors that cause students to fail the same module more than one.

Question 12: Compared to other modules, what is your sense of volume/amount of work in the module you mentioned you struggle the most to pass?

Graph of response output:

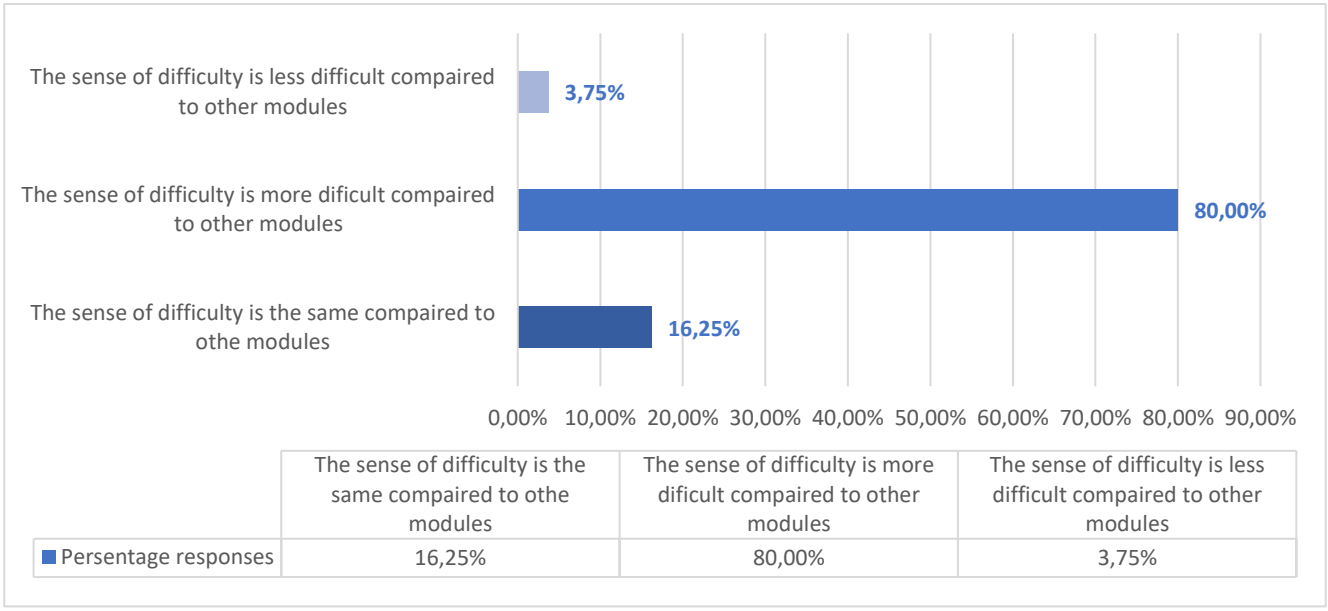


	The sense of volume/amount of work is the same compaired to other modules	The sense of volume/amount of work is more compaired to the volume/amount of work in other modules	The sense of volume/amount of work is less compaired to the volume/amount of work in other modules
persentage responses	41,98%	55,56%	2,47%

Figure 12-Responses to question 12; Module volume/amount of work as a factor why students struggle with some modules more than others.

Question 13: Compared to other modules, what is your sense of difficulty of the material in the module you mentioned you struggle the most to pass?

Graph of response output:

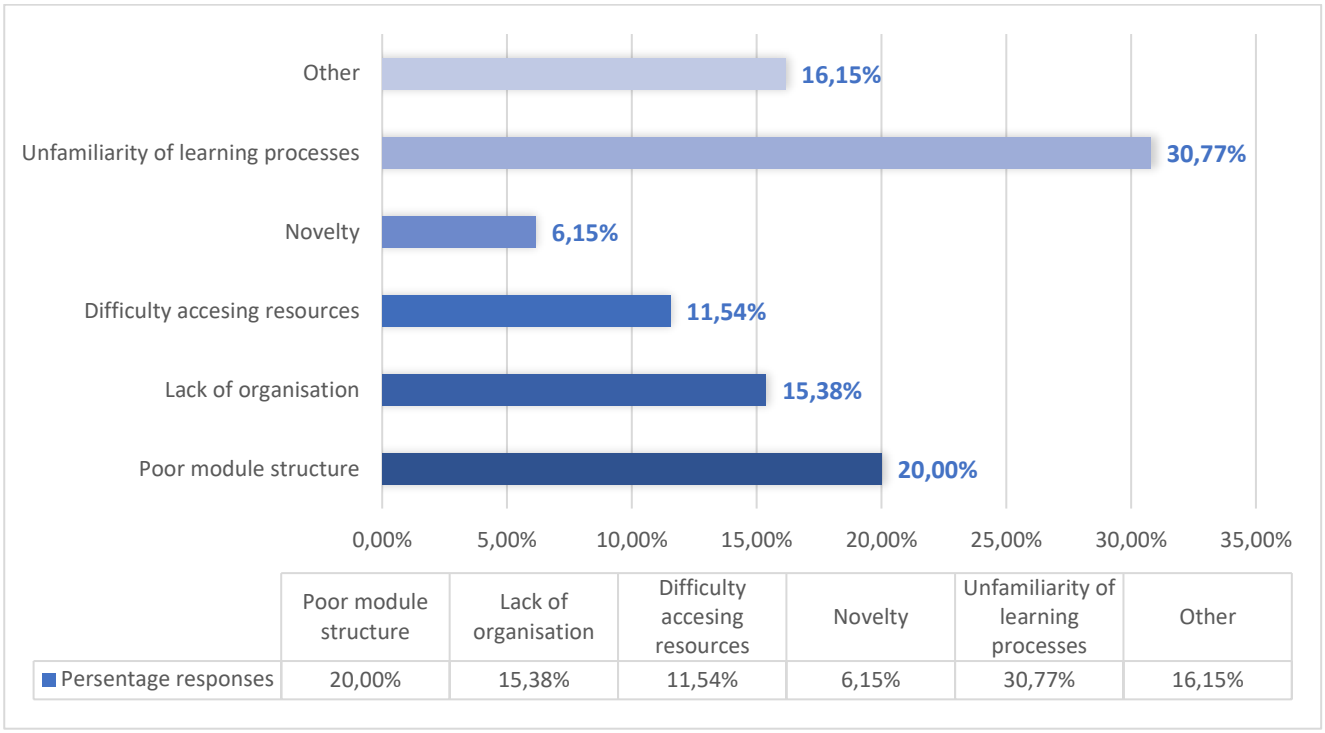


	The sense of difficulty is the same compaired to othe modules	The sense of difficulty is more dificult compaired to other modules	The sense of difficulty is less difficult compaired to other modules
Persentage responses	16,25%	80,00%	3,75%

Figure 13- Responses to question 13; Module difficulty as a factor why students struggle with some modules more than others.

Question 14: What 'other factors' might have contributed to making this module's workload feel or appear greater than it is? (the module you struggled the most to pass)

Graph of response output:

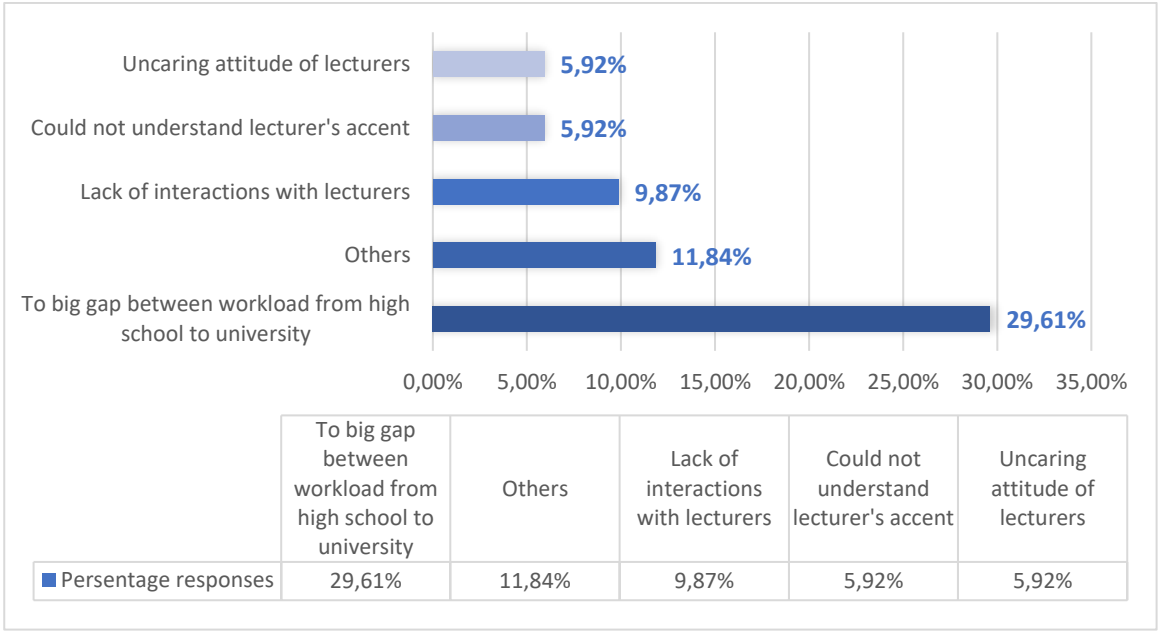


	Poor module structure	Lack of organisation	Difficulty accesing resources	Novelty	Unfamiliarity of learning processes	Other
Persentage responses	20,00%	15,38%	11,54%	6,15%	30,77%	16,15%

Figure 14- Responses to question 14; Factors contributing to making some modules workload feel or appear greater than it is.

Question 15: Why do you think students drop out of the engineering faculty at UP?

Graph of response output:



	To big gap between workload from high school to university	Others	Lack of interactions with lecturers	Could not understand lecturer's accent	Uncaring attitude of lecturers
Persentage responses	29,61%	11,84%	9,87%	5,92%	5,92%

Figure 15- Responses to question 15; Factors causing students to drop out of the faculty of engineering at UP.

Question 17: Do you think that studying in a different language than you used to has an effect on your academic success?

Graph of response output:

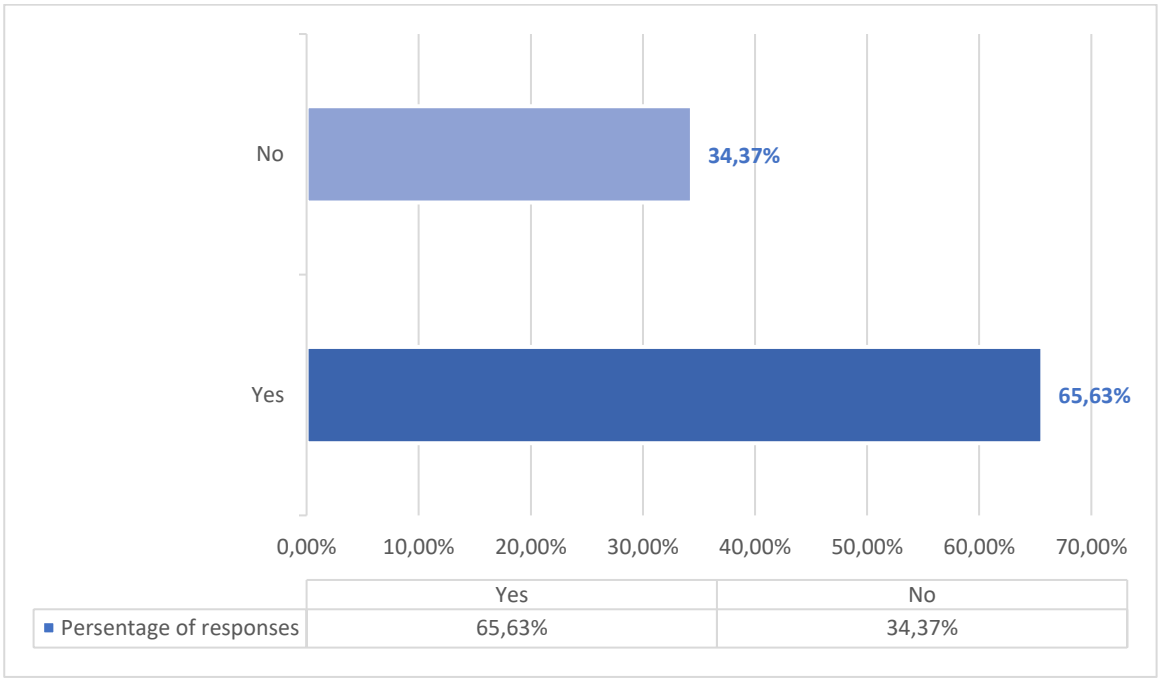


Figure 16- Responses to question 17; Language gap as an influencing factor on academic success.

Question 21: Did factors such as your own freedom, social distractions, and new environment, etc. have a negative influence on your academic success?

Graph of response output:

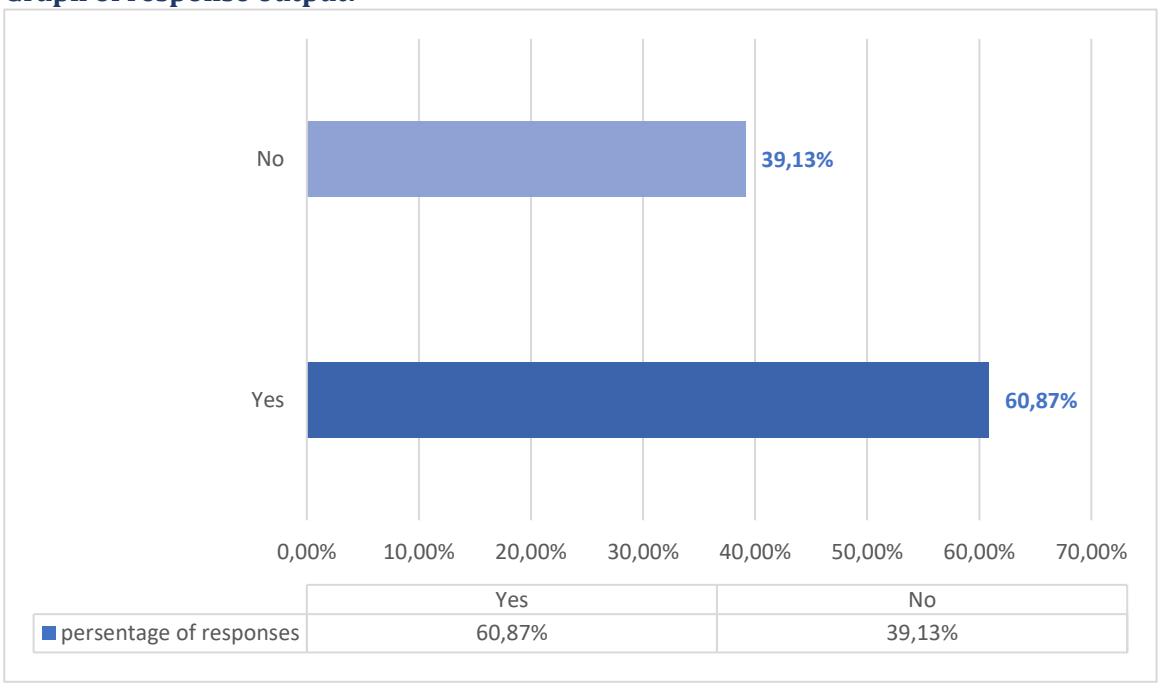


Figure 17- Responses to question 21; Factors such as own freedom, social distractions, and the new environment as negative influences on academic success.

Question 25: Do you think that it will help with the success of students if more attention is given to the intellectual development of students during each learning phase?

Graph of response output:

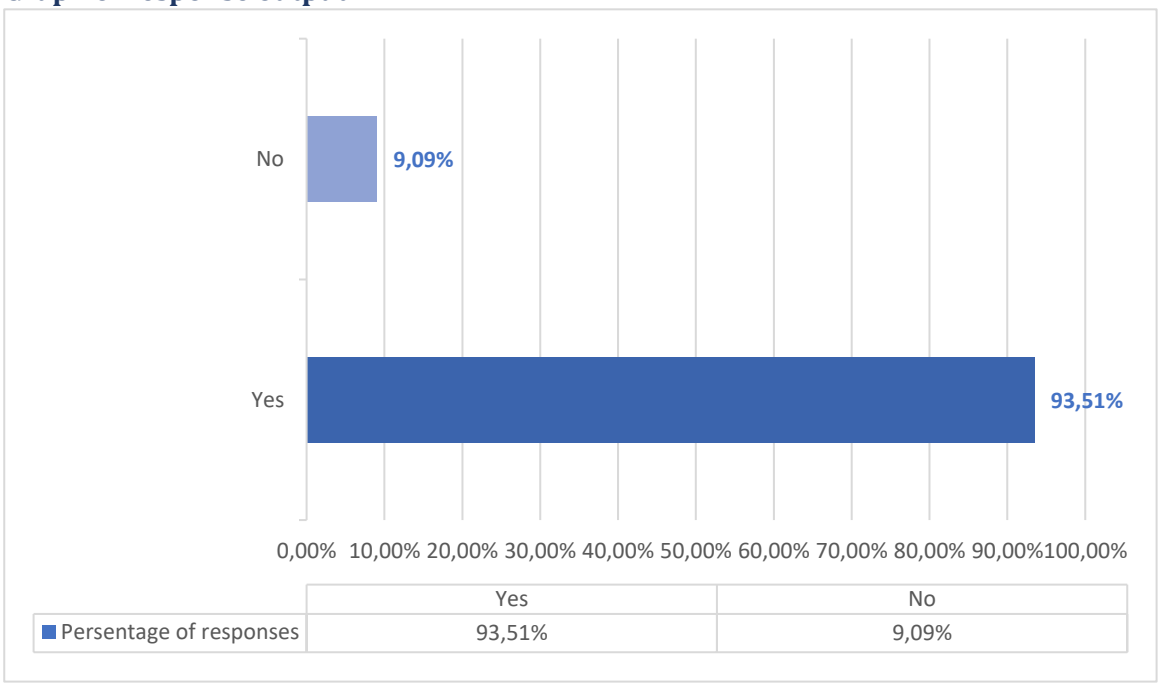


Figure 18- Responses to question 25; Intellectual development as a factor that influences students' academic success.

Question 31: Do you think that financial instability has an effect on students' academic performance?

Graph of response output:

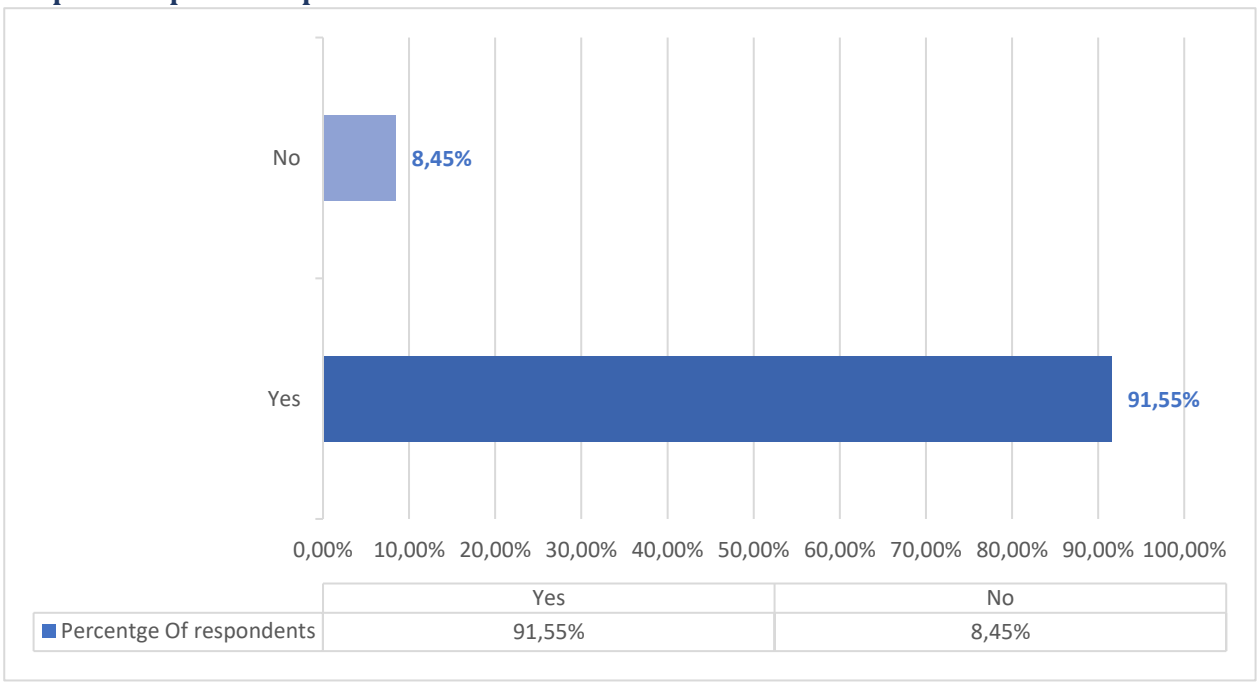


Figure 19- Responses to question 31; Financial instability as an influencing factor on students' academic success.

Question 32: Would you classify the effect of financial instability as a positive or negative effect towards students' academic success?

Graph of response output:

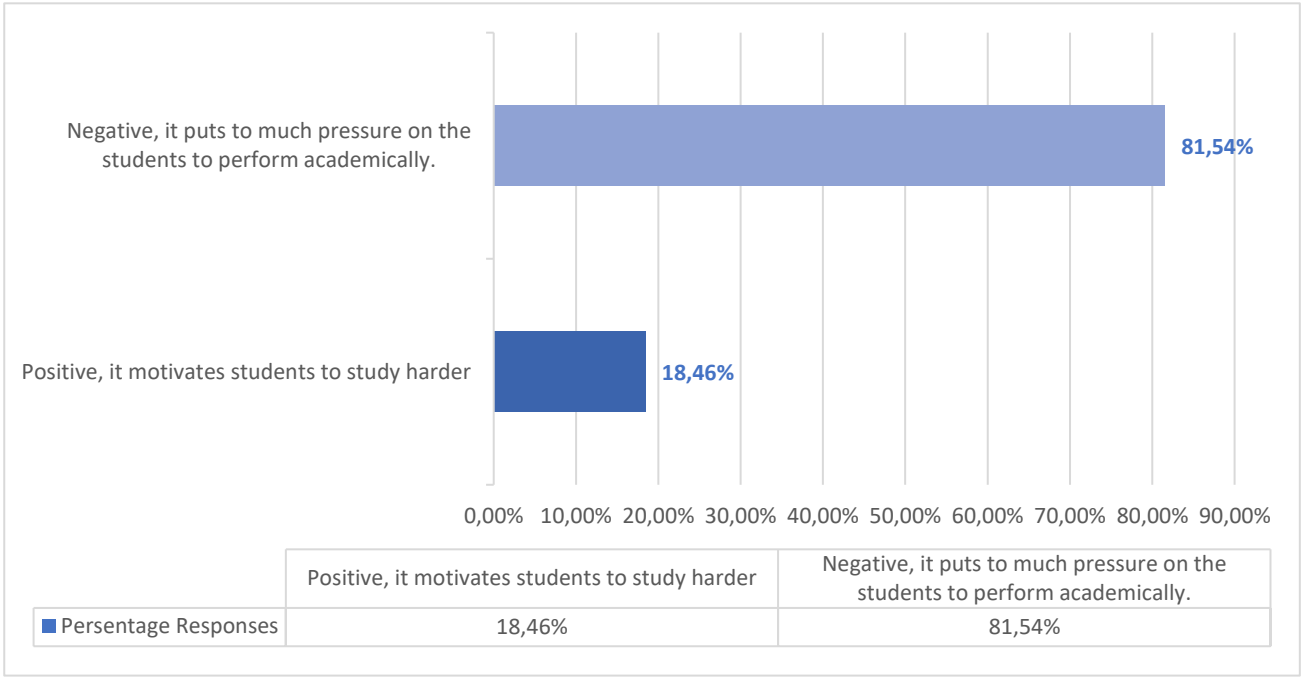


Figure 20- Responses to question 32; Financial instability as a positive or negative influencing factor.

As seen from the above questions and responses the following factors in **table 6** were identified by the researcher as causative factors that influence the students' academic success in higher educational systems.

Table 6- Extraction of causative factors out of the above questions' responses, on why students fail and occasionally drop out of the faculty of Engineering.

Factors	Description of factor
Module Pre-Judgement	Underestimation of the module is a big factor causing students to fail.
Teaching methods	Badly taught modules are a concerning factor when it comes to the success rate of modules.
Personal Study Effort	Lack of personal effort is a causative factor when it comes to the students' academic success.
Intellectual Capability	Intellectually too demanding modules causes students to fail because of the fact that they are intellectually not developed enough.
Lecturer's Unfriendliness	Unapproachable lectures are factors that lead to negative attitudes towards modules and cause students to fail.
Module Work Volume	The volume/amount of work in modules students struggle to pass is a causative factor on students' academic success.
Level of Difficulty	The sense of difficulty of the material in modules students struggle to pass is a factor to consider when dealing with failing students.
Module structure	Poor module structure/organisation is a factor that influences the students' appearance on the workload of modules.

Learning Processes of modules	The unfamiliarity of learning processes in new modules is a contributing factor that influences the students' perception of the workload of modules.
Semester Workload	The fact that the workload of engineering is too hard for students, especially the workload gap from high school to university, is a concerning factor when one looks at why students drop out of the faculty of engineering.
Language barrier	The language gap for students who study in a different language is a factor that negatively impacts their academic success.
Misuse of Freedom	Own freedom is a factor that negatively impacts students' academic success.
Socialization	Social distractions like Partying, peer-pressure influence, gang-related activities including the use of drugs, etc. are factors that negatively impact students' academic success.
Environment	The learning environment is a factor that can have a negative impact on students' success.
Financial Constraint	Financial instability is a factor that has a negative effect on students' academic success than positive.

4.2 Model Validation

In this section, the above mentioned questions from the questionnaire will be validated to ensure that the data gathered are valid and reliable. There were two IE techniques used to prove the validity of this questionnaire. Firstly, Face Validity was used as the type of Measurement Validity, and secondly, a table of Questionnaire Respondent Validity was used do to the internal and external validation. The researcher's mission was that validity of respondents is not just about the number of responses submitted but the number of meaningful responses.

4.2.1 Measurement Validity:

The researcher made use of Face Validity as the measurement validity type for the survey research for this project. The researcher reviewed the questionnaire and established Face Validity by concluding that the characteristic and trait of interest is being measured by the questions present in the questionnaire of this study. The researcher approved that the questions present in the questionnaire are valid measures of the concept, within this project scope. All the questions in the questionnaire match the given conceptual domain of this project, which is why the researcher approved that this questionnaire is valid on the face of it.

4.2.2 Internal and External Validity:

Table 7 presents the ratio of respondence on each of the critical questions identified in section 4.1.1 so that the reader can clearly see what the validity of the questions are in order to know how relevant the factors are that resulted from the questions. The scale used for the validity is from 0-1,

where 1 = credible validity and 0 = low validity. Any value above 0.8 gives an indication of good validity and any value below 0.6 is not certain meaning that the validity of that particular question is not certain. The researcher made use of e-distribution to distribute the survey questionnaire. Because of this, there is no cap on the max responses the researcher could have received. Thus, the benchmark used to calculate the ratio of respondents to the questionnaire was 93 responses, as this was the number of students who confirmed that they were studying industrial engineering in question 2 (Q2). If a student was not studying industrial engineering, they were sent to the end of the questionnaire and was not able to respond to any other questions. The max number of respondents able to access the particular question is the number of respondents in the previous question who selected the answer that would give them access to the particular question.

Table 7-Table of Questionnaire Respondent Validity

Questionnaire Respondent Validity				
Question no.	**Question Description**	**Max no. of respondents able to access particular question**	**The ratio of respondence (Validity of respondents)**	**Calculation of ratio on follow up questions responses = (Total responses)/ (Max no. of respondents able to access the particular question)**
Q10	Why do you think you failed the same module more than once?	16	0.84	= Ratio Q7 x Ratio Q8 x Ratio Q9 x Ratio Q10 =(Q7/Q2) x (Q8/Q7_result) x (Q9/Q7_result) x (Q10/Q9_result) = (88/93) x (39/42) x (40/42) x (16/16) = 0.8368
Q12	Compared to other modules, what is your sense of volume/amount of work in the module you mentioned you struggle the most to pass?	93	0.87	=Ratio Q12 = Q12/Q2 =81/93 =0.8710
Q13	Compared to other modules, what is your sense of difficulty of the material in the module you mentioned you struggle the most to pass?	93	0.86	=Ratio Q13 = Q13/Q2 =80/93 =0.8602
Q14	What 'other factor' might have contributed to making this module's workload feel or appear greater than it is? (the module you struggled the most to pass)	93	0.85	=Ratio Q14 =Q14/Q2 =79/93 =0.8495
Q15	Why do you think students drop out of the engineering faculty at UP?	93	0.85	=Ratio Q15 =Q15/Q2 =79/93 =0.8495
Q17	Do you think that studying in a different language than you used to has an effect on your academic success?	32	0.84	= Ratio Q16 x Ratio Q17 =(Q16/Q2) x (Q17/Q16_result) = (78/93) x (32/32) =0.8387
Q21	Did factors such as your own freedom, social distractions, and new environment, etc. have a negative influence on your academic success?	23	0.84	= Ratio Q20 x Ratio Q21 =(Q20/Q2) x (Q21/Q20_result) = (78/93) x (23/23) =0.8387

Q25	Do you think that it will help with the success of students if more attention is given to the intellectual development of students during each learning phase?	93	0.83	=Ratio Q25 =Q25/Q2 = 77/93 =0.8280
Q31	Do you think that financial instability has an effect on students' academic performance?	93	0.76	=Ratio Q31 =Q31/Q2 =71/93 =0.7634
Q32	Would you classify the effect of financial instability as a positive or negative effect towards students' academic success?	65	0.76	=Ratio Q31 x Ratio Q32 =(Q31/Q2) x (Q32/Q31_result) = (71/93) x (65/65) = 0.7634

As one can see in the table above, all the identified questions from the questionnaire have very good validity and can be used as valid information to reflect true data that can be used for analysis purposes for this project.

4.2.3 Chi-Square Test Analysis:

The Chi-square Test is the data analysis tool that the researcher will adopt in ensuring that the data observed is not due to chance. The chi-square test can be used in this study since it meets all the requirements needed to perform the test. The reader can see below all the steps followed while doing the chi-square test including the results of the chi-square test to ensure that enough students responded to the questionnaires to make a comprehensive data analysis. The observed responses were gained using the results of question 4 from the distributed survey questionnaire. This can be seen in **Appendix C**.

Table 8- Table of the data of the observed and expected survey responses of four academic groups.

	1st Academic Year	2nd Academic Year	3rd Academic Year	4th Academic Year
Observed Responses	26	9	25	30
Expected Responses	20	20	20	20

STEP 1: Define the Null hypothesis and the Alternative hypothesis

H_0: There is not a sufficient number of respondents to the survey in each learning level to make a comprehensive data analysis.

H_A: There is a sufficient number of respondents to the survey in each learning level to make a comprehensive data analysis.

STEP 2: State alpha

$$\boldsymbol{\alpha} = 0.05$$

STEP 3: Calculate the degree of freedom

$$\boldsymbol{df} = \boldsymbol{k} - 1$$

$$= 4 - 1$$

$$= 3$$

, where ***df*** = degree of freedom and ***k*** = number of groups observed.

STEP 4: State Decision Rule

Decision Rule = $If\ \boldsymbol{X^2}\ is\ greater\ than\ 7.81473, reject\ \boldsymbol{H_0}$

, where $\boldsymbol{X^2} = \text{Chi} - \text{square Test and } \boldsymbol{H_0} = \text{Null Hypothesis.}$

STEP 5: Calculate the test statistic

$X^2 = \sum_{i=1}^{k} \frac{(observed\ count - expected\ count)^2}{expected\ count}$, Where ***k*** = number of groups observed.

$$X^2 = \left(\frac{(26-20)^2}{20} + \frac{(9-20)^2}{20} + \frac{(25-20)^2}{20} + \frac{(30-20)^2}{20} \right)$$

$$X^2 = 14.1$$

STEP 6: State Results

$$X^2 = 14.1 > decision\ rule = 7.81473$$

STEP 7: State Conclusion

Thus, reject $\boldsymbol{H_0}$ meaning that there is a sufficient number of respondents to the survey in each learning level to make a comprehensive data analysis. This proves that the students responded well towards the questionnaire. Thus, this questionnaire can be used for further analysis to this study.

4.2.4 HSIM Model

STEP 1: Contains the listing of all relevant factors and the serial attachment of numbers.

Table 9- The Students' Academic Success dependent factors include:

Serial Number	Factors
1	Module Pre-Judgement
2	Teaching methods
3	Personal Study Effort
4	Intellectual Capability
5	Lecturer's Unfriendliness
6	Module Work Volume
7	Level of Difficulty
8	Module structure
9	Learning Processes of modules
10	Semester Workload
11	Language barrier
12	Misuse of Freedom
13	Socialization
14	Environment
15	Financial Constraint

STEP 2: Contextual Question

Will the effect of factor (i) on students' academic performance be influenced by factor (j)?

This is mathematically written as:

$$e_{ij} = \begin{cases} \mathbf{1} & if\ factor\ \boldsymbol{i}\ is\ influenced\ by\ factor\ \boldsymbol{j} \\ \mathbf{0} & if\ factor\ \boldsymbol{i}\ is\ not\ influenced\ by\ factor\ \boldsymbol{j} \end{cases} ,$$

where e_{ij} represents an element in row i and column j.

STEP 3: Binary Interaction Matrix

In **Figure 21** on the next page, is the prioritisation matrix. The reader would find the pair-wise comparison mapping of the causative factors on the students' academic success. The researcher used **STEP 6 to 10** of the Theoretical framework of the application of HSIM (Figure 8, section 3.2.6) to fill out the entire matrix. Also, the prioritisation of the factors is calculated in **table 10.** The calculations used in this table were gained from Ayomoh, Oke, Adedji, and Charles-Owaba's article, An approach

to tackle the environmental and health impacts of municipal solid waste disposal in developing countries (Ayomoh, et al., 2008).

The method of the calculations used, in **table 10** of the weight determination, weight normalisation and resource allocation of prioritized factors can be seen in section 3.2.6.

Figure 21-Piecewise comparison matrix of the causative factors on students' academic success.

Matrix: Pair-wise comparison mapping result for causative factors on students academic success.															
i \ j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	1	0	1	0	0	1	1	1	1	1	0	0	1	1
2	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0
3	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1
4	0	1	0	0	0	1	1	0	0	0	1	1	1	1	1
5	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
6	1	0	0	1	0	0	1	0	1	1	1	1	1	1	1
7	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1
8	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
9	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0
10	0	0	0	1	0	1	1	0	0	0	1	0	1	1	1
11	0	0	0	1	0	0	1	0	0	1	0	0	0	0	1
12	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1
13	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1
14	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1
15	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0

Table 10- Weight determination and weight normalisation for prioritised factors of students' academic success.

S/N	No. of (sub.fac)	T(Num.Fac)	Max scale	Max Subordinating	C	B	IIRF(i)		Normalised
1	4	15	9	14	8,4000	5	2,6000	1,065773	0,0654
2	4	15	9	14	8,4000	5	2,6000	1,065773	0,0654
3	3	15	9	14	8,4000	4	1,9600	1,045885	0,0642
4	11	15	9	14	8,4000	12	7,0800	1,139381	0,0699
5	1	15	9	14	8,4000	2	0,6800	0,974617	0,0598
6	7	15	9	14	8,4000	8	4,5200	1,105798	0,0679
7	9	15	9	14	8,4000	10	5,8000	1,124334	0,0690
8	3	15	9	14	8,4000	4	1,9600	1,045885	0,0642
9	5	15	9	14	8,4000	6	3,2400	1,081524	0,0664
10	5	15	9	14	8,4000	6	3,2400	1,081524	0,0664
11	8	15	9	14	8,4000	9	5,1600	1,115604	0,0685
12	7	15	9	14	8,4000	8	4,5200	1,105798	0,0679
13	7	15	9	14	8,4000	8	4,5200	1,105798	0,0679
14	7	15	9	14	8,4000	8	4,5200	1,105798	0,0679
15	10	15	9	14	8,4000	11	6,4400	1,132207	0,0695
								16,2957	1,0000

Section 4 of this report presents the data of all the methods and models used to achieve the stated objectives of this report. Data validation and the application of the methods as explained in the theoretical framework of this project are given in this chapter. The reader will be able to follow the steps as the researcher presented the data in an understandable manner.

Results and Discussion

5.0 Introduction

The reason why students seem to be failing in some modules are as a result of the factors mentioned in **table 6** above. Each of these factors was given serial numbers in **table 9** and these factors with their corresponding serial numbers were used in the HSIM model. Each factor will be analysed and discussed as well as their percentage obtained in each particular question for each factor. The reader will also be made aware of what factor(s) each critical question represents in the prioritisation presented in **table 10.**

5.1 Analysis and Discussion on the results obtained from the critical questions and the factor(s) they represent

Question 10:

In this question, the most significant factors were **Model Pre-Judgement** and **Teaching Methods. Model Pre-Judgement** represents **factor 1** and **Teaching Methods** represents **factor 2** in **table 10. 19.57%** of the respondents to this question said that the reason why they fail the same module more than once was because of the fact that they underestimated the module and that the module was badly taught. Also, **17.39%** of the respondents said that it was self-inflicting, and they did not study hard enough. This highlights **factor 3**, **Personal Study Effort**. Lastly, there are two factors that got a response of **13.04%** namely **Intellectual Capability** (**factor 4**) and **Lecturer's Unfriendliness** (**factor 5**)**.** The respondents agreed that the module they failed more than once was because of the fact that the module was intellectually too demanding, and the lecturers of the specific modules were unapproachable. The other statements are not significant factors to this study and will not have an influence on the results done in this project. Thus, question 10 represents **factor 1,2,3,4,** and **5** in the prioritisation presented in **table 10.**

Question 12:

The factor **Module Work Volume** got extracted from question 12 and represents **factor 6** in the prioritisation presented in **table 10.** The aim of this question was to establish what the students' sense of the volume/amount of work was on modules they struggle the most to pass. **55.56%** of the students who answered this question voted that the sense of volume/amount of work is **more** compared to the volume/amount of work in other modules. Thus, we can assume that students struggle with modules that they think has a large work volume.

Question 13:

The factor **Level of Difficulty** got extracted from question 13 and represents **factor 7** in the prioritisation presented in **table 10.** The aim of this question was to establish what the students' sense of the difficulty of the material was on modules they struggle the most to pass. **80.00%** of the respondents to this question voted that they struggle to pass certain modules because the sense of the difficulty of the material on that particular module is **more difficult** compared to the level of difficulty in other modules. **16.25%** of the students voted that sense of difficulty is the **same** compared to other modules and **3.75%** of the students voted that the sense of difficulty is **less difficult** compared to other modules. The validity on this question is credible and thus the assumption can be made that **Level of Difficulty** is a critical factor is for this project study.

Question 14:

In this question the researcher wanted to know from the respondents what other factors might have contributed to making the difficult modules' workload feel or appear greater than it is. The following factors got extracted from question 14 namely: **Module structure** and **Learning Processes of modules**. The factor that weighs the most in this question is **Learning Processes of modules** and represents **factor 8** in the prioritisation presented in **table 10. 30.77%** of the respondents to these questions voted that they struggle to pass modules in which learning processes are unfamiliar to them. The factor that had the second most weight was **Module structure modules** and represents **factor 9** in the prioritisation presented in **table 10**. **20.00%** of the students said that poor module structure is a causative factor when one looks at why students fail. The organisation of the module contributes to the factor **Module structure.** When there is a lack of the organisation in a module, **15.38%** of the respondents voted that it contributes to the fact that students fail modules.

Question 15:

This question was asked to obtain reasons for why the respondents think students drop out of the faculty of engineering. The workload of engineering and the workload gap from high school to university forms the factor **Semester Workload,** which represents **factor 10** in the prioritisation presented in **table 10**. **36.84%** of the respondents to this question think that the reason student drop out of the faculty of engineering is because the workload is too hard and **29.61%** thinks that there is a too big gap between the workload from high school to the workload from university and that why students drop out.

Question 17:

65.63% of the students who study in a different language than high school agreed that it has an effect on their academic success. The factor in this question that influences the academic success of students in the university are **Language Barrier.** Through this one can conclude that more can be done to close the language gap of some students and help them overcome their language barrier and succeed academically. Question 17 is represented by **factor 11** in the prioritisation represented in **table 10.**

Question 21:

60.87% of the students who study away from home agree that their own freedom, social distraction, and new environment negatively impacted their academic success. The factors evident here is **Misuse of Freedom, Socialization,** and **Environmental.** The best way to improve the negatively impact of these factors is to invest in teaching students time management and balance. This question is being represented in **table 10** as **factor 12,13,** and **14** (**Misuse of Freedom, Socialization,** and **Environmental**).

Question 25:

Question 25 is to obtain the opinion of students on their intellectual development and if they think this could be an influencing factor on why students fail and occasionally drop out of the faculty of engineering. **Intellectual Capability** is the identified factor in this question and **93.51%** of the students who answered this question think that more attention should be given to the intellectual development of students in university. This question has a validity ratio of 0.83, which is very good in terms of validity, meaning that this factor weighs a lot if one wants to improve student retention and reduce the failure rate in modules. Question 25 is represented by **factor 4** in the prioritisation presented in **table 10**.

Question 31:

Financial Constraint is a big factor when one wants to know what influences student success.**91.55%** of the students who responded to these questions said that financial instability it has an effect on students' academic performance. **Factor 15** in **table 10** represents question 31.

Question 32:

Question 32 was only accessible to the respondents who agreed in question 31 that financial instability has an effect on students' academic performance. Thus, **factor 15** is also representing question 32 in the prioritisation presented in **table 10**. Out of the **91.55%** of the students who said

financial instability has an effect on students, **18.46%** said that this was a positive effect and motivated the students to study harder and **81.54%** of the students said that this had a negative effect because it puts too much pressure on the students to perform academically.

5.2 Analysis and Discussion on the results obtained from the HSIM model

The results of the piecewise comparison matrix in **figure 21** highlights the intensity of the importance of the identified causative factors extracted from the ten critical questions found in this study survey. This will consequently lead to the opportunity that higher educational systems will acknowledge the factors that have the highest normalised weight to allocate their focus on and improving these factors to better the students' intellectual development and retention in universities. The factors with the highest normalised weights are factors 4, 15, and 7. Factor 4, **Intellectual Capacity**, has a normalised weight of **0.0699.** Factor 15, **Level of Difficulty**, has a normalised weight of **0.0695,** and factor 7, **Financial Constraint**, has a normalised weight of **0.0690**. These three factors are also the factors with the most sub factors, meaning that these factors have an influence on most of the other factors. Thus, by focusing on these top factors one will indirectly also influence the other factors to better the students' academic success and retention in higher educational systems.

Section 5 of this report gives a detailed presentation, validation, analysis, and discussion on the factors extracted from the survey questionnaires. These factors prove that it has a significant influence on why students fail and occasionally drop out of the engineering faculty. By focussing on these factors one will be able to better the current situation of students' intellectual dynamics and student retention in higher educational systems.

Conclusion and Recommendations

6.0 Introduction

Chapter 6, Conclusion and Recommendations is about the conclusion of the remarks on this project. The researcher re-affirms the reader of its capabilities in solving the proposed problem and makes future recommendations on research that can be done in the future to improve the study content.

6.1 Conclusion

This report serves as a piece of evidence that the researcher possesses the necessary competence and skills to use the IE techniques, mentioned in the conceptual framework of this study, to achieve this projects objectives. The aim of this was to establish causative factors that influence students' success and student retention in higher education. By the use of survey research, data analysis, validity, and modelling, the researcher successfully identified the causative factors on why students fail and occasionally drop out of the engineering faculty. By looking at the validation of the survey responses, it is evident that all the critical questions can be taken seriously as they had very good validation on the responses of each of these questions. It is evident in this report that the validity of the survey responses is not just about the number of submitted response, but also about the meaningful responses gathered. The chi-square test affirms that data observed through the e-distributed questionnaires are valid and not due to chance. The HSIM model for the interconnectivity and subordination of the identified causative factors gives assurance that the 10 questions extracted from the questionnaire were indeed the critical questions. The HSIM model also highlighted the top three factors which have the highest normalised weights, meaning that these factors are of the utmost importance when one wants to improve the academic success and retention of students in higher educational systems.

Objective one of this project was achieved by completing the survey research of this project. The second objective was achieved by the execution of the Chi-square Test, Measurement Validity, Internal Validity, and External Validity. The researcher decided not to use Internal Consistency Reliability as there were already enough IE Techniques used to achieve objective two. The last objective was achieved by using the HSIM model to carry out a criticality analysis to distinguish the level with which the causative factors influence the intellectual dynamics and learning maturity of students. By successfully achieving the objectives of this report, it proves that the researcher possesses the necessary skills to successfully solve the stated problem of this research.

6.2 Research Findings

The findings of this project were the extraction of the 15 causative factors listed in **table 6** of this report. All these factors have a negative impact on the students' academic success and retention in higher educational systems. The three factors that are the most critical and have the biggest impact on the students' success are **Intellectual Capacity**, **Level of Difficulty**, and **Financial Constraint**. The findings of the HSIM model also confirm that this is the top three influential factors that have the highest normalised weight which will have the most influence on the student's success rate in higher educational systems. By giving attention to these factors, their influences will change from a negative impact to a positive impact on the success rate of students' academic status in higher institutions of learning.

6.3 Recommendations

The way forward for this project is that more research can be done on the impact, of the causative factors, on the students' success rate in higher educational systems. Furthermore, control measurements by which the challenges of the intellectual dynamic in higher education systems can be minimised, can be established and presented to the management of the organisation (in this case UP) to start implementing measures that will improve students' intellectual development and academic success in universities.

Deliverables

7.0 Deliverables:

Deliverables for the proposed study will benefit the Engineering Department as an organisation of the University of Pretoria. The deliverables that will be presented if everything for BPJ 420 is accomplished successfully are:

- A comprehensive investigative survey on the causes and remedies of negatively impacted intellectual dynamics and learning maturity in higher institutions of learning.
- Detailed statistical and reliability analysis on the responses of the investigative online surveys.
- Modelling of a prioritisation model of the identified causative factors to establish the criticality level with which these causative factors influences the intellectual dynamics and learning maturity of student in higher education systems.

The deliverables of this project, when successfully executed, will be in the form of a research report that may be published on the UP Library.

Project Plan

8.0 Research Time-line

Appendix A consists of a detailed Gantt Chart of the researcher's Time-line. The Gantt chart assists the researcher with the planning and preparation of this project to ensure that the deliverables are met before their deadlines.

8.1 Work Breakdown Structure of BPJ 420

The work breakdown structure for BPJ 420 can be seen in the **Figure 22** below.

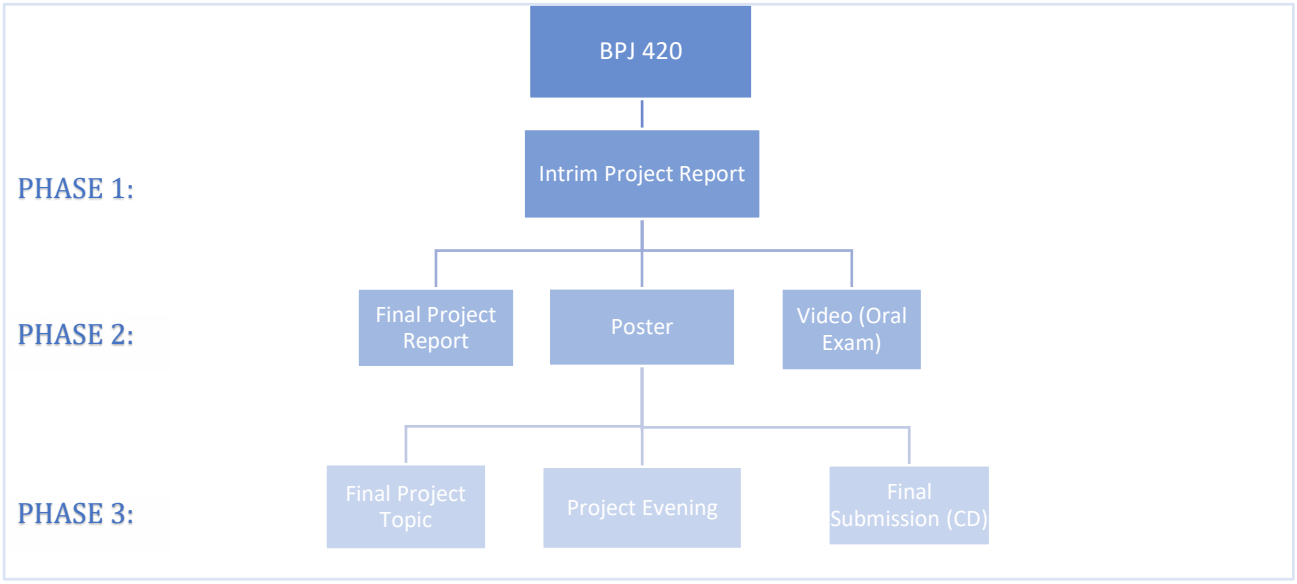


Figure 22-Work breakdown structure for BPJ 420

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Appendices

Appendix A: Project Time-line (Gantt Chart)

In **Figure 12** below, is the Gantt Chart of all the deliverables that are already completed, still in process, and those that still needs to be done. By using this Gantt chart, the researcher ensures that all deliverables are completed before the deadline.

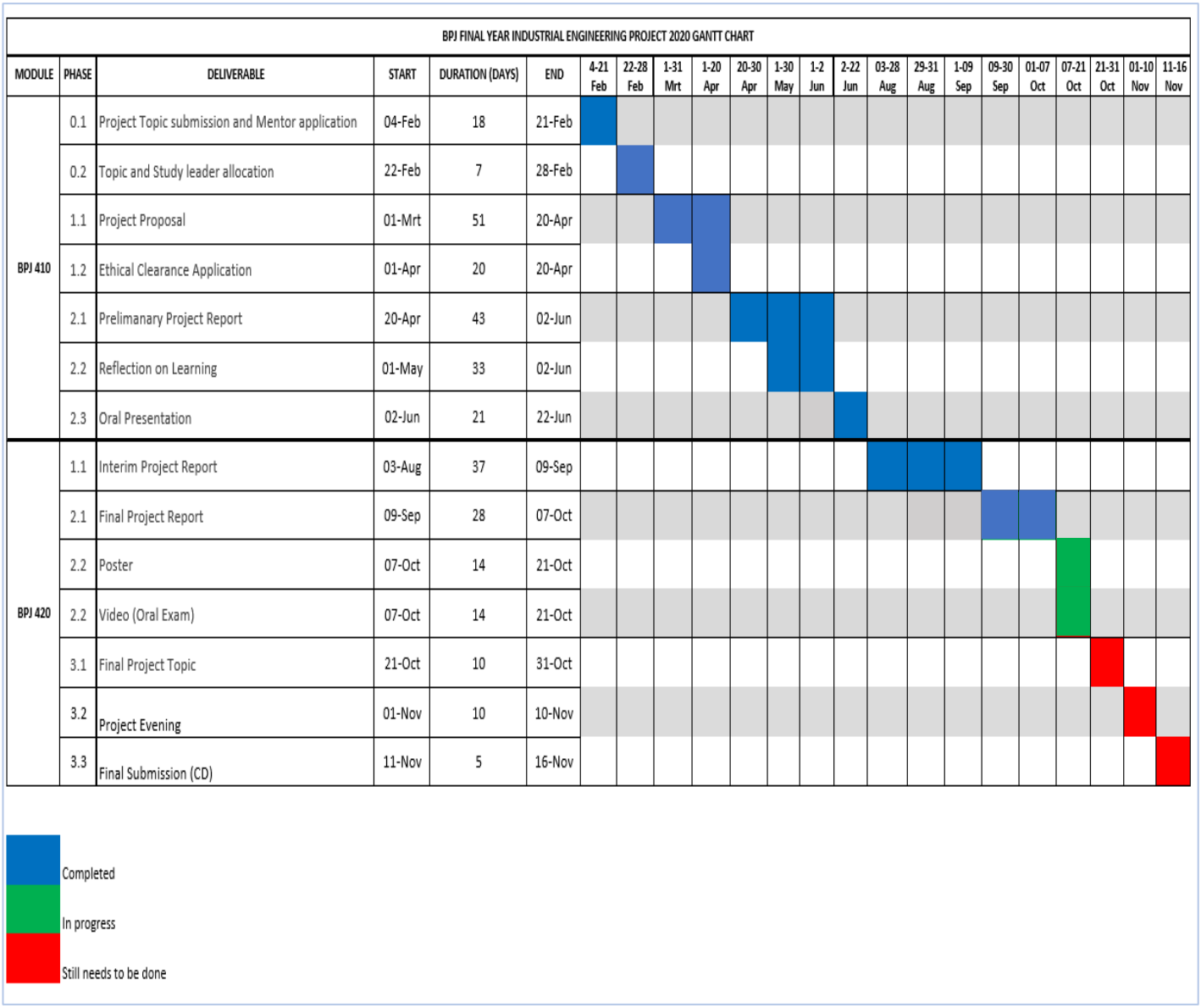


Figure 23-Gantt Chart of researcher's Time-line.

Appendix B: Approval Documents

The following two documents shows that the researcher got the necessary approval from the Dean at the University of Pretoria as well as the EBIT Research Ethics Committee to use UP students as informants to this project study.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Asking Permission to include UP students in my Final Year BPJ 410 Project

Jan Eloff <jan.eloff@up.ac.za>
To: Carla Groenewald <u15006086@tuks.co.za>
Cc: Alice Chan <alice.chan@up.ac.za>, Annzell Marupen <annzell.marupen@up.ac.za>, Wilna Bean <wilna.bean@up.ac.za>

Dear Carla

I hereby give permission for collecting information from EBIT students for the project as described below and in the attachment hereto.

Kind regards
Prof Jan Eloff

[Quoted text hidden]
[Quoted text hidden]
This message and attachments are subject to a disclaimer. Please refer to http://www.it.up.ac.za/documentation/governance/disclaimer/ for full details.
--

Professor Jan Eloff

Deputy Dean Research & Postgraduate studies

DRS Chair in Cyber-security

Professor in Computer Science

Faculty of Eng., Built Environment & IT (EBIT)

University of Pretoria; South Africa

W: http://www.cs.up.ac.za/~eloff

E: jan.eloff@up.ac.za

M +27 83 259 7926

This message and attachments are subject to a disclaimer.
Please refer to http://upnet.up.ac.za/services/it/documentation/docs/004167.pdf for full details.

Figure 24- Permission letter from the Dean to include UP students in this Report.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

Reference number: EBIT/113/2020

Miss C Groenewald
Department: Industrial and Systems Eng
University of Pretoria
Pretoria
0083

Dear Miss C Groenewald

FACULTY COMMITTEE FOR RESEARCH ETHICS AND INTEGRITY

Your recent application to the EBIT Research Ethics Committee refers.

Approval is granted for the application with reference number that appears above.

1. This means that the research project entitled "Statistical Analysis and Reliability Evaluation of Students Intellectual Dynamics and Learning Maturity in an Ascending Knowledge Acquisition System." has been approved as submitted. It is important to note what approval implies. This is expanded on in the points that follow.

2. This approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Code of Ethics for Scholarly Activities of the University of Pretoria, or the Policy and Procedures for Responsible Research of the University of Pretoria. These documents are available on the website of the EBIT Research Ethics Committee.

3. If action is taken beyond the approved application, approval is withdrawn automatically.

4. According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of the EBIT Research Ethics Office.

5. The Committee must be notified on completion of the project.

The Committee wishes you every success with the research project.

Prof K.-Y. Chan
Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

Figure 25- Approval letter from the EBIT Research Ethics Committee

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

April 22, 2020

To whom it may concern

CONFIRMATION OF PROPOSAL ACCEPTANCE

This letter serves to confirm that the following final year project proposal was approved by the Department of Industrial and Systems Engineering, University of Pretoria:

Proposal title:	Statistical Analysis and Reliability Evaluation of Students Intellectual Dynamics and Learning Maturity in an Ascending Knowledge Acquisition System
Student name:	Ms. Carla Groenewald
Student number:	15006086

Sincerely,

Dr. Wilna L. Bean Pr Eng
wilna.bean@up.ac.za
Tel: +27 12 841 6076

Figure 26- Conformation Letter of Proposal Acceptance

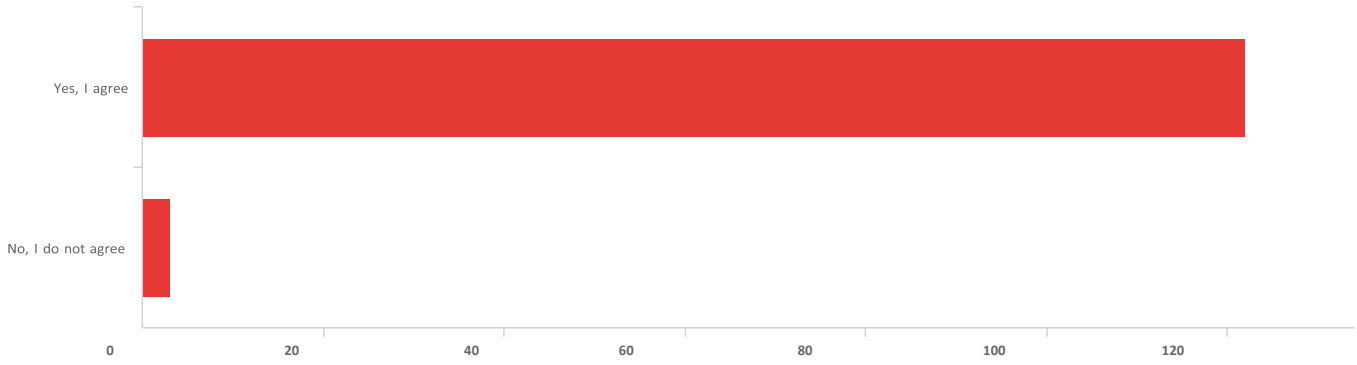
Appendix C: Survey Responses

Below are all the survey responses and data received on the questionnaires that were sent out during this project.

Default Report

BPJ 410 Final Year Project 2020
September 2, 2020 8:14 AM MDT

Q1 - I agree to the terms and conditions as stated above:

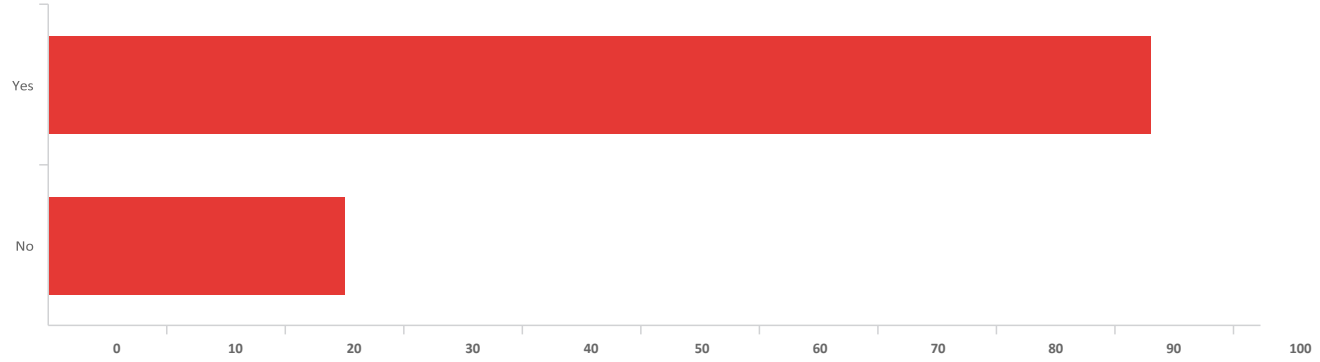


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	I agree to the terms and conditions as stated above:	1.00	2.00	1.02	0.15	0.02	125

#	Field		Choice Count
1	Yes, I agree	97.60%	122
2	No, I do not agree	2.40%	3
			125

Showing rows 1 - 3 of 3

Q2 - Are you an Industrial Engineering Student at the University of Pretoria?

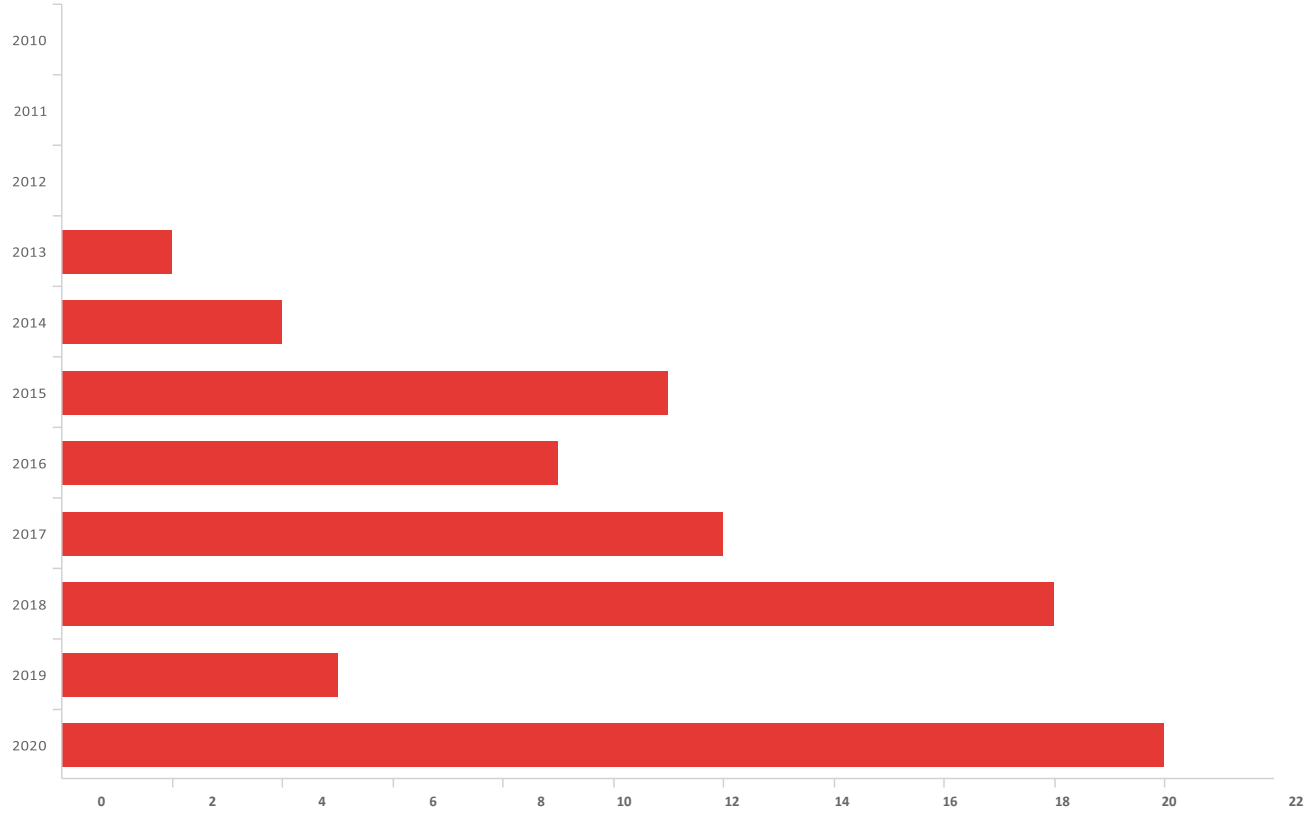


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Are you an Industrial Engineering Student at the University of Pretoria?	1.00	2.00	1.21	0.41	0.17	118

#	Field		Choice Count
1	Yes	78.81%	93
2	No	21.19%	25
			118

Showing rows 1 - 3 of 3

Q3 - In which year did you enrol at the University of Pretoria?



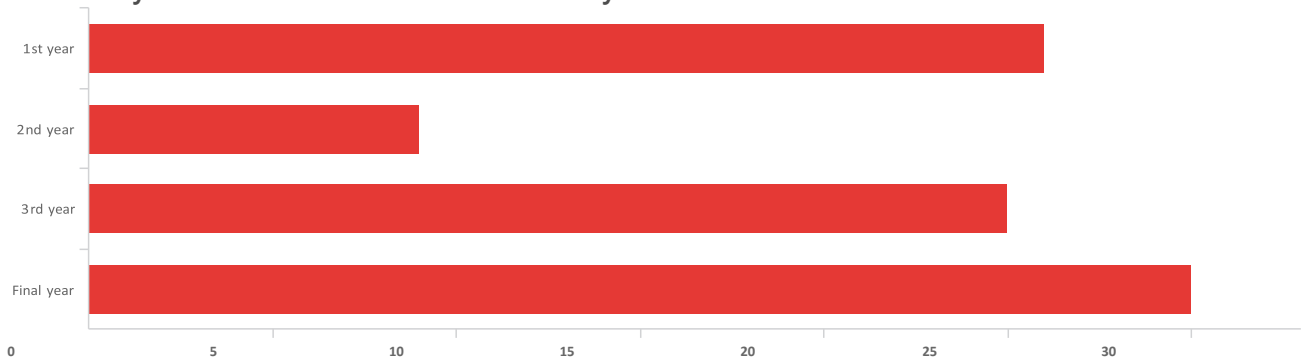
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	In which year did you enrol at the University of Pretoria?	4.00	11.00	8.46	1.99	3.98	81

#	Field		Choice Count
1	2010	0.00%	0
2	2011	0.00%	0
3	2012	0.00%	0
4	2013	2.47%	2
5	2014	4.94%	4
6	2015	13.58%	11
7	2016	11.11%	9
8	2017	14.81%	12

#	Field		Choice Count
9	2018	22.22%	18
10	2019	6.17%	5
11	2020	24.69%	20
			81

Showing rows 1 - 12 of 12

Q4 - What is your academic status currently?

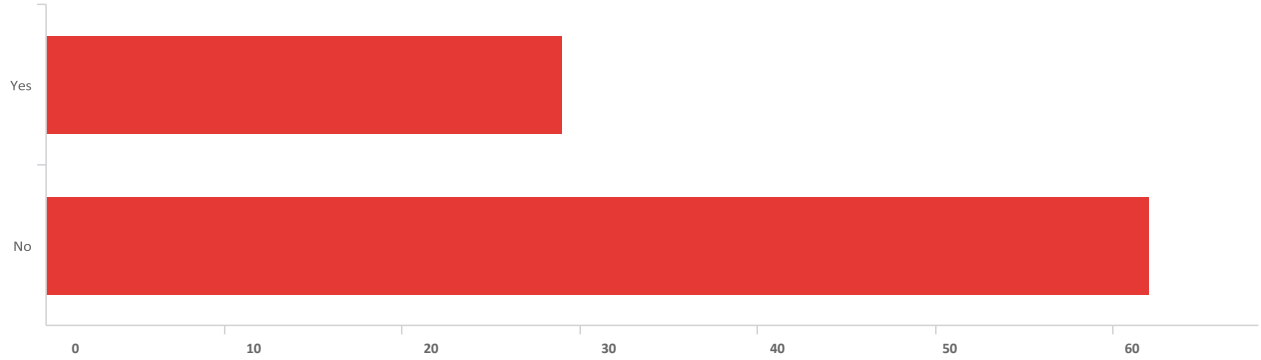


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What is your academic status currently?	1.00	4.00	2.66	1.21	1.47	90

#	Field		Choice Count
1	1st year	28.89%	26
2	2nd year	10.00%	9
3	3rd year	27.78%	25
4	Final year	33.33%	30
			90

Showing rows 1 - 5 of 5

Q5 - Did you change from any other field of engineering to the field of Industrial Engineering?

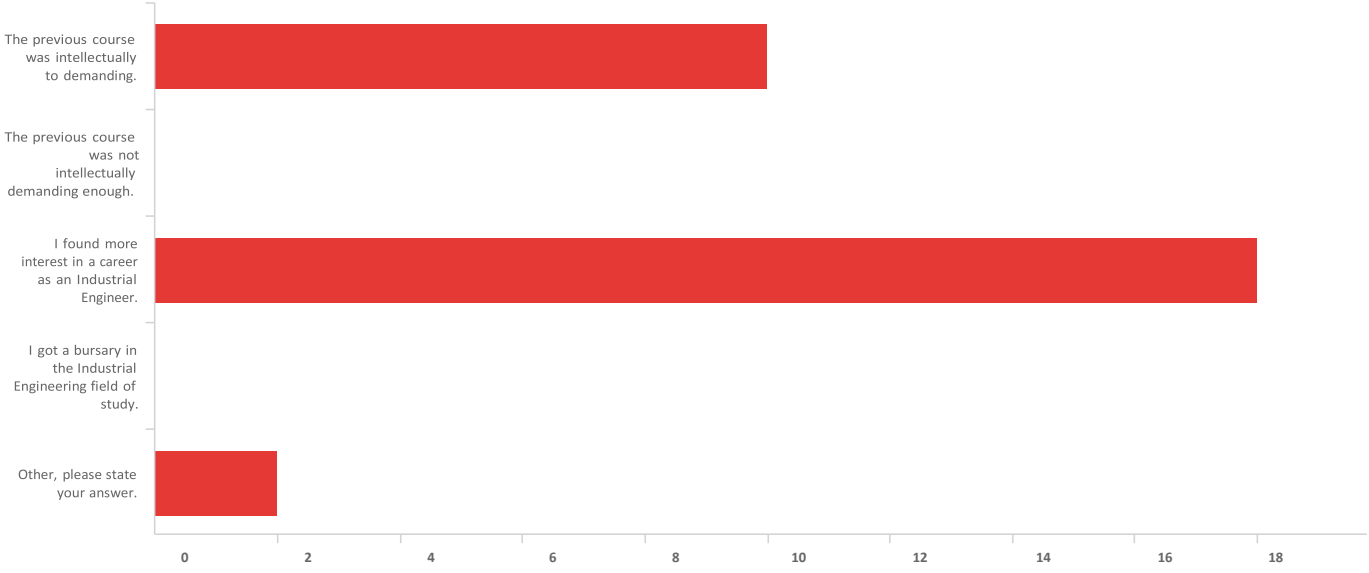


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Did you change from any other field of engineering to the field of Industrial Engineering?	1.00	2.00	1.68	0.47	0.22	91

#	Field		Choice Count
1	Yes	31.87%	29
2	No	68.13%	62
			91

Showing rows 1 - 3 of 3

Q6 - Why did you change courses? (please select all applicable reasons)



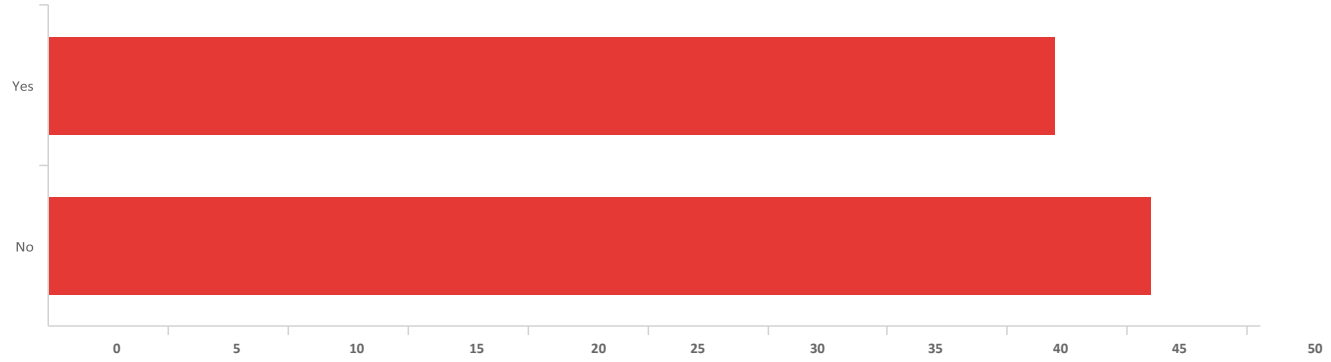
#	Field		Choice Count
1	The previous course was intellectually to demanding.	33.33%	10
2	The previous course was not intellectually demanding enough.	0.00%	0
3	I found more interest in a career as an Industrial Engineer.	60.00%	18
4	I got a bursary in the Industrial Engineering field of study.	0.00%	0
5	Other, please state your answer.	6.67%	2
			30

Showing rows 1 - 6 of 6

Q6_5_TEXT - Other, please state your answer.

Other, please state your answer.
I've always wanted to study Industrial but got accepted for civil my second choice so just moved over before orientation week was over
It was a lot more flexible and diverse to do because I'm still not entirely sure what I want to be doing for the rest of my life

Q7 - Have you failed any industrial engineering modules up to date?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Have you failed any industrial engineering modules up to date?	1.00	2.00	1.52	0.50	0.25	88

#	Field	Choice Count

1	Yes	47.73%	42
2	No	52.27%	46
			88

Showing rows 1 - 3 of 3

Q8 - How many modules did you fail?

How many modules did you fail?

1

6

2

2

3

14

2

1

1

8

5

1

2

8

3

1

2

1

5

1

3

2

How many modules did you fail?

5

2

1

6

2

5

1

6

3

3

3

1

2

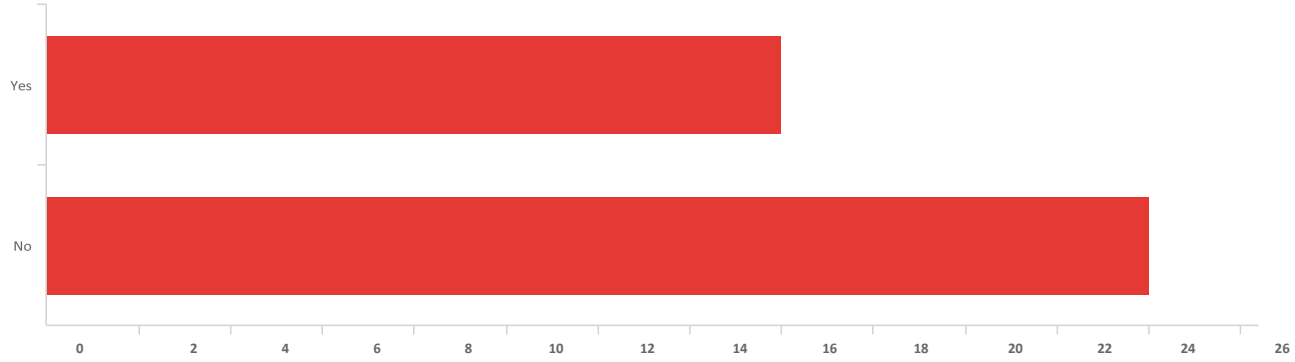
10

10

Lots

15

Q9 - Did you fail one module more than once?

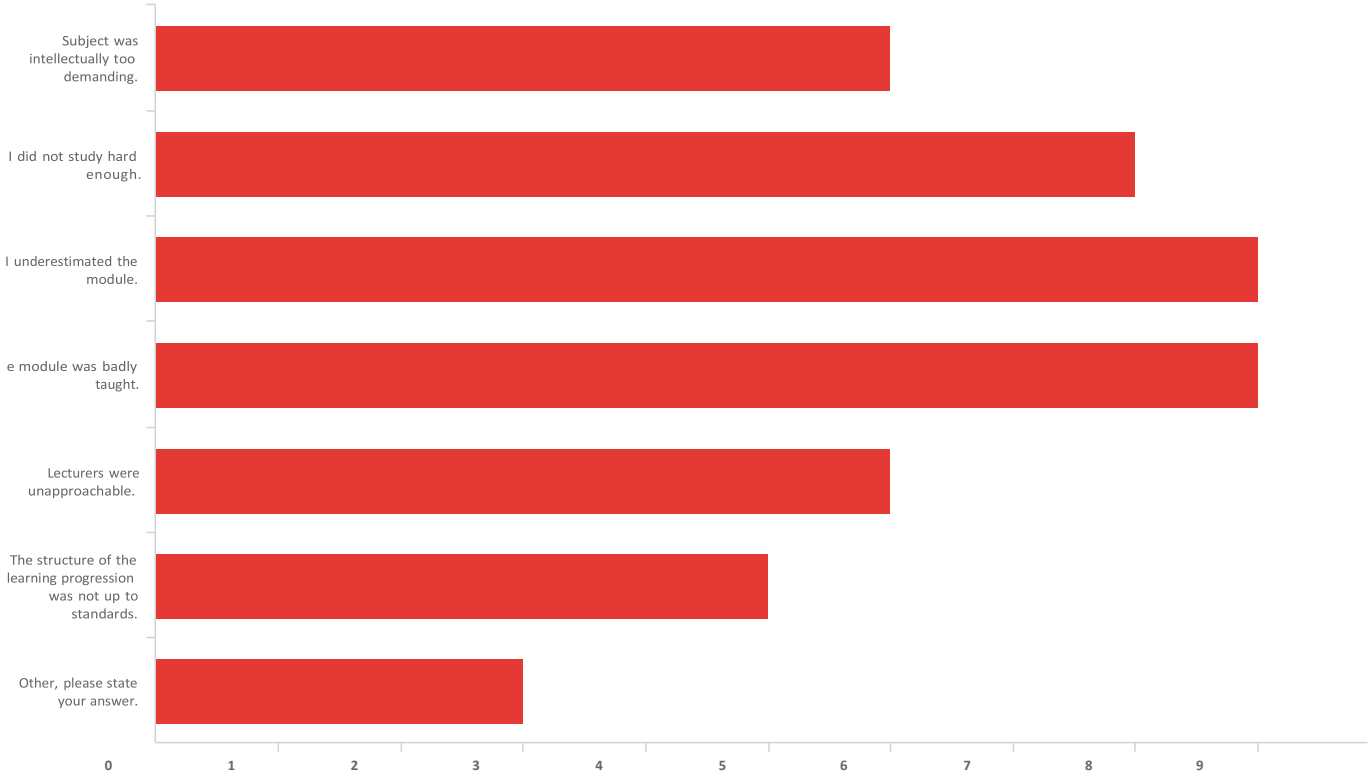


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Did you fail one module more than once?	1.00	2.00	1.60	0.49	0.24	40

#	Field		Choice Count
1	Yes	40.00%	16
2	No	60.00%	24
			40

Showing rows 1 - 3 of 3

Q10 - Why do you think you failed the same module more than once? (please select all applicable reasons)



#	Field	Choice Count	
1	Subject was intellectually too demanding.	13.04%	6
2	I did not study hard enough.	17.39%	8
3	I underestimated the module.	19.57%	9
4	The module was badly taught.	19.57%	9
5	Lecturers were unapproachable.	13.04%	6
6	The structure of the learning progression was not up to standards.	10.87%	5
7	Other, please state your answer.	6.52%	3
			46

Showing rows 1 - 8 of 8

Q10_7_TEXT - Other, please state your answer.

Other, please state your answer.

Other, please state your answer.

The structure of the module the second time changed too quickly for me to adapt to the new presentation style and mark allocation, I felt that the module was mishandled in light of the covid crisis.

The material taught during the semester was not up to the standard that was expected of students during testing.

External factors, I had to work to pay my own studies and sometimes could not balance everything well

Q11 - What module during your studies did you struggle the most to pass? (Write your answer in given space)

What module during your studies did you struggle the most to pass? (Write y...

Ban313, buy321, bob310, boz312 and bid320

SWK 122, NMC 123

NMC

Eir211

WTW 238 and BER 310

WTW238

WTW 238

I have found all calculus modules to be especially challenging.

SWK 122

EBN110

MPR , NMC

BPZ221

MOW210

SWK 122

WTW 258

WTW 238

WTW258

EBN

SWK122

WTW 238

SWK, EBN.

BAN 313

SWK 122

EBN111 WTW 158

WTW 258

MOW, BAN

SWK122

HAS110 AND FSK116

FSK116

WTW238

MGC 110

BAN313

First years SWK module

Calculus

WTW238

SWK 120

SWK 122

WTW 238

CTD220

SWK 122

SWK 210

SWK 122

MTX 221 (Thermodynamics)

FSK

BPJ410

Wtw158 MIA 310

nmc123

FSK 116

MOW217

FSK116

SWK 122

WTW 256

Mechanics (SWK 22)

Wtw 238

BOZ

JPO110

BAN313

Fsk116

NMC, BFB, BPZ

SWK122

FSK 116

WTW 164, SWK122, WTW 258

WTW 238

Calculus 3(wtw258) and SWK(statics)

WTW238

FSK 172 was the most difficult but not that difficult

FSK 116

SWK122

FSK 116

FSK116

EBN 111

SWK 122

EBN111

Electricity and Electronics

SWK

EBN

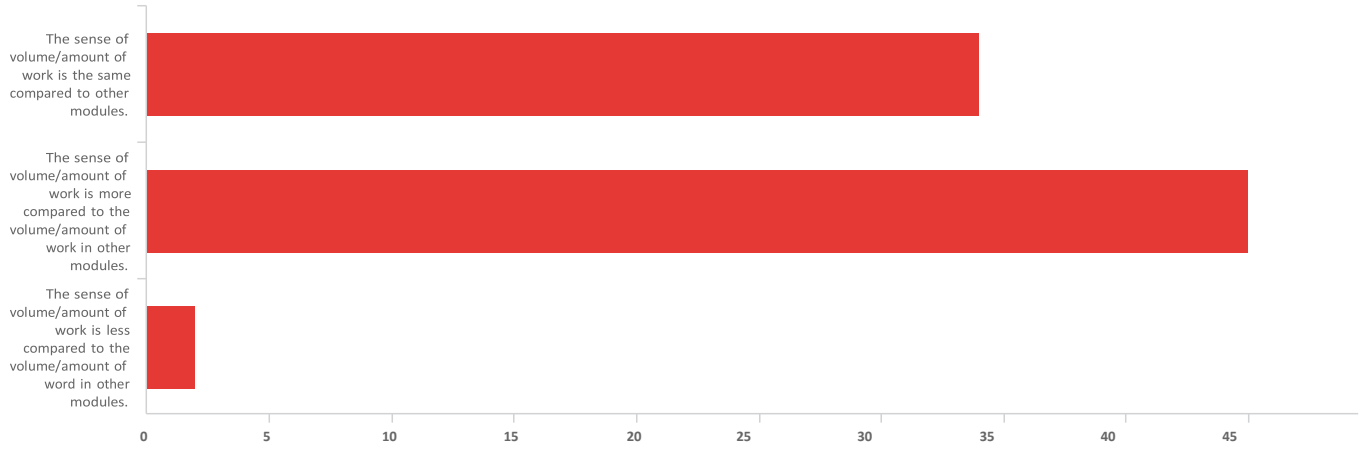
BON

SWK

SWK 120

SWK 120

Q12 - Compared to other modules, what is your sense of volume/amount of work in the module you mentioned in the previous question?

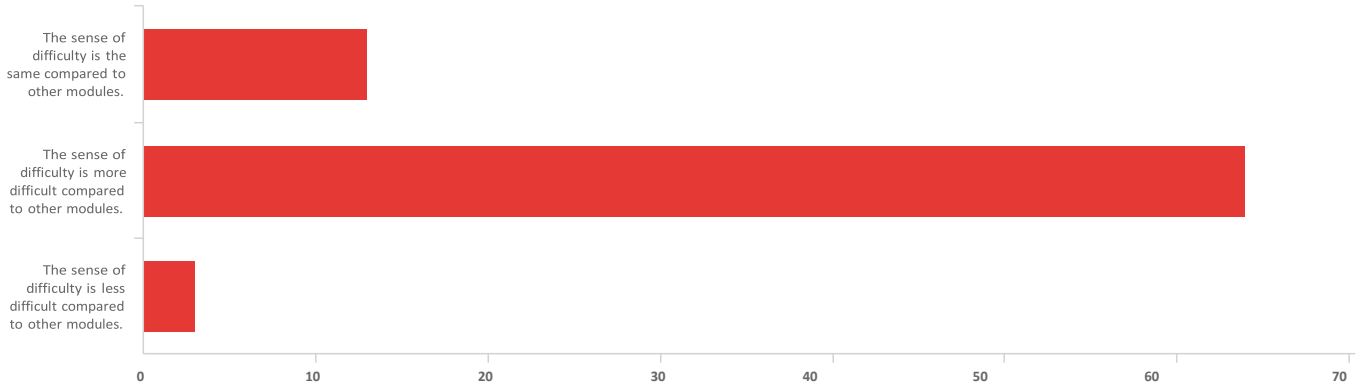


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Compared to other modules, what is your sense of volume/amount of work in the module you mentioned in the previous question?	1.00	4.00	1.63	0.62	0.38	81

#	Field		Choice Count
1	The sense of volume/amount of work is the same compared to other modules.	41.98%	34
2	The sense of volume/amount of work is more compared to the volume/amount of work in other modules.	55.56%	45
4	The sense of volume/amount of work is less compared to the volume/amount of word in other modules.	2.47%	2
			81

Showing rows 1 - 4 of 4

Q13 - Compared to other modules, what is your sense of difficulty of the material in the module that you mentioned you struggle the most to pass?

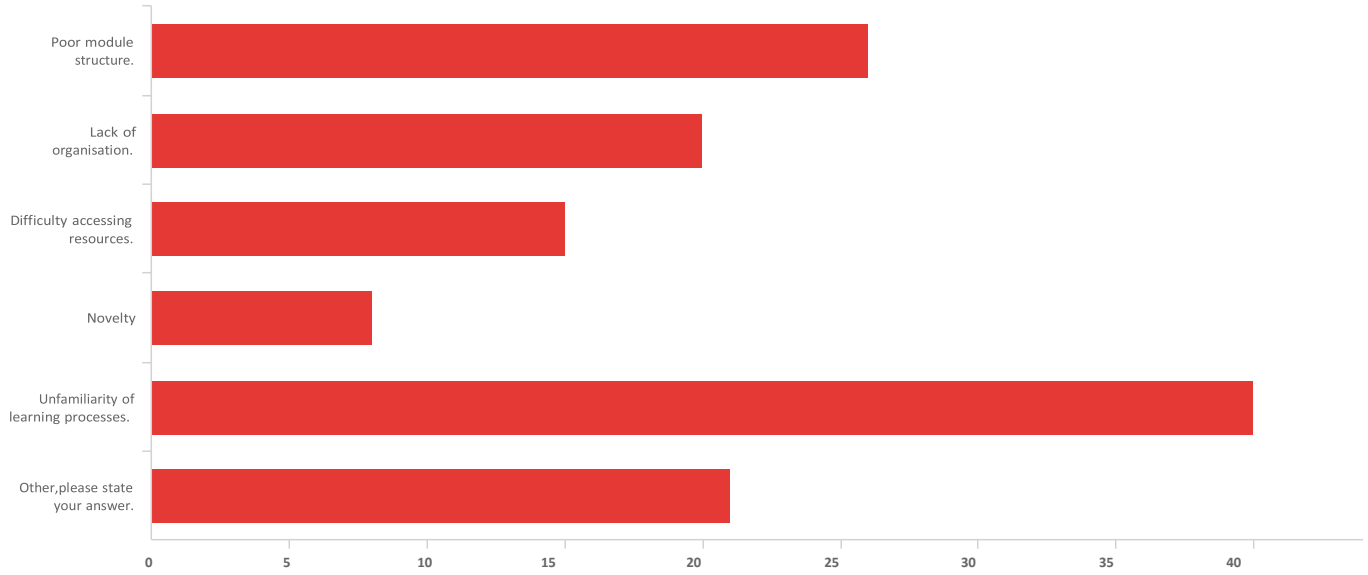


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Compared to other modules, what is your sense of difficulty of the material in the module that you mentioned you struggle the most to pass?	1.00	3.00	1.88	0.43	0.18	80

#	Field		Choice Count
1	The sense of difficulty is the same compared to other modules.	16.25%	13
2	The sense of difficulty is more difficult compared to other modules.	80.00%	64
3	The sense of difficulty is less difficult compared to other modules.	3.75%	3
			80

Showing rows 1 - 4 of 4

Q14 - What 'other factors' might have contributed to making this module's workload feel or appear greater than it is? (multiple answers)



#	Field	Choice Count	
1	Poor module structure.	20.00%	26
2	Lack of organisation.	15.38%	20
3	Difficulty accessing resources.	11.54%	15
4	Novelty	6.15%	8
5	Unfamiliarity of learning processes.	30.77%	40
6	Other,please state your answer.	16.15%	21
	Showing rows 1 - 7 of 7		130

Q14_6_TEXT - Other,please state your answer.

Other,please state your answer.
Test workload.
Was like a new language. But i took two gap years so I also forgot everything from school
Lack of personal effort

Most of the work was self study and self taught.

Other,please state your answer.

Demotivation by certain lecturers and amount of work over all (i.e. too little time to grasp all of the concepts within the module)

I found the subject matter confusing and had difficulty understanding the content

Group project with vague instructions and lazy members

The lecture style was not for me.

Poor time management on my part.

I didnt have a computer background

This was the first industrial module that really challenged your thinking as an industrial engineer, the other modules you could simply apply engineering without actually thinking like one

Poor Lecturer

Extremely poor communication by the module coordinators with the students and their inability to state what it is they are looking for. Also, expecting students to state the provided material word by word during an exam- engineering is not about resisting what you learn but rather applying it.

The fact that the lecturer does not build an interest in the subjects makes the module harder to put effort jnto

Self inflicted

Not having enough time to practice and been constantly tired due to our long days.

Not a very good lecturer

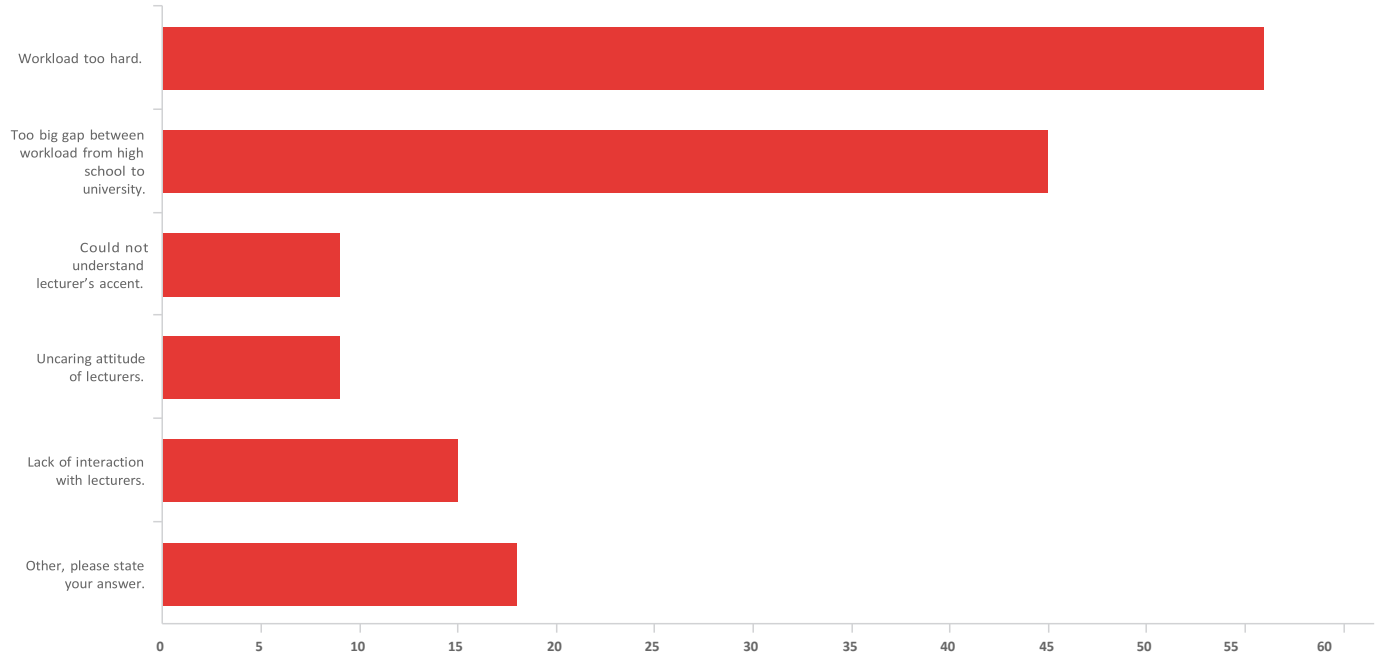
The work they explain in the lectures have little to nothing to do with the work expected in assesments.

Poor lecturer

The tests we received online were much more difficult in comparison to the past papers

With learning being online the module coordinators took continuous assessment too far turning the module into a weekly series of chasing deadlines rather than ACTUALLY learning content.

Q15 - Why do you think students drop out of the engineering faculty at UP? (multiple answers)



#	Field	Choice Count	
1	Workload too hard.	36.84%	56
2	Too big gap between workload from high school to university.	29.61%	45
3	Could not understand lecturer's accent.	5.92%	9
4	Uncaring attitude of lecturers.	5.92%	9
5	Lack of interaction with lecturers.	9.87%	15
6	Other, please state your answer.	11.84%	18

Q15_6_TEXT - Other, please state your answer. Showing rows 1 - 7 of 7 152

Other, please state your answer.

It forces you to think for yourself, sometimes the students get lazy

People dont love engineering just doing it for the money so the motivation is just enough because since I started all engineers say that failing is just part of it and it's actually just a 7 year degree but I started off with 25% in first semester, work as hard as I could because I'm motivated and I passed all my modules

Other, please state your answer.

External factors play a larger role than those posed by The University system. Someone being a drop out isn't a reflection of their intellectual capability. Some drop outs have better intellectual capabilities than graduates. In my experience, your success within this degree is solely based on your alignment within the system and following instructions accordingly. Your success in this degree, is based on ones work ethic and effort. I believe anyone capable of attaining the required APS score can attain this degree. The factors that face the individual within their post schooling career, play a larger role in there eventual success.

Having to fail modules because of poor lecturers that are hired for B.E.E. purposes and not to better the students. Also, the lack of efficient systems. There are a lot of hick-ups in the system, such as unproductive tutorial sessions/classes which could be replaced with online videos/consultations. Attending classes becomes unproductive after hours of concentration, it is much more efficient to watch videos and be able to work at your own pace. Keeping track of assignments are problematic, it would help if lectures use the utilities on blackboard which displays the due dates.

There is very little support. Also students are made to become fearful and they assume they will fail. This is because of the general idea that engineering is very hard but it is worsened by the indoctrination that happens during O week. Students are told repeatedly Engineering is hard, you will not make it, many of you will drop out and very few will finish in minimum time.

I think there are multiple reasons for someone to leave but mainly due to increased workload and people not enjoying engineering as much as they thought they would

Financial reasons

Lack of discipline and understanding of effective (continuous) study methods. In first year, some modules communicated structure and lesson expectations very clearly, with continuous evaluations, while others did not communicate effectively at all.

Students tend to drop out in first years after modules like WTW that has barley nothing to do with industrial engineering. In my final year of studies I have used only one or two concepts of WTW. Students drop out because they think the rest of engineering would be the same, but it is not

In high school if you work hard you get results in university you can work until you are blue in the face, if you don't study a specific module in a specific way you will fail.

Unexpected difficulty of work

Not up for the challenge and not ready to face the hard facts for them to actually study

Not knowing themselves and what they actually want to do with their life

The factors are endless, the pressure, workload, peer pressure, uncertainty, forced to do it my external factors, money

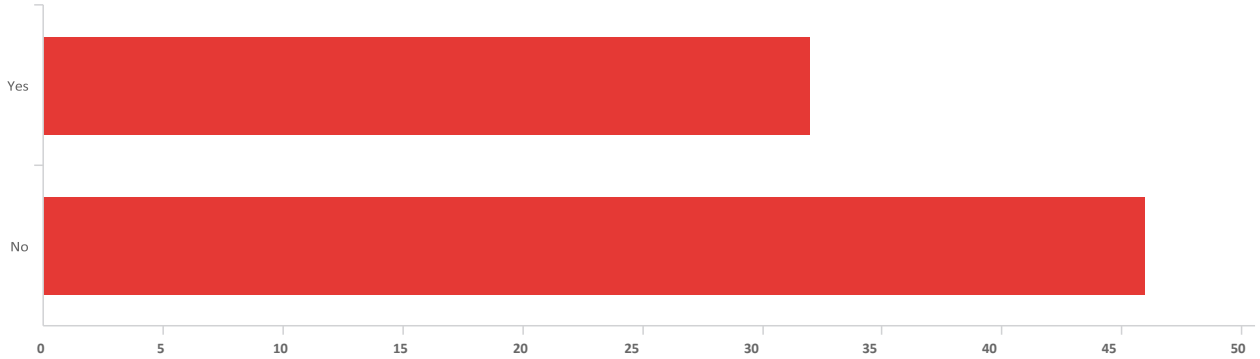
Different to what they expected

The work is quite intense and the pace is extremely fast. Many people underestimate it and go into it thinking its relatively easy to do. We are not informed properly as what the degree actually entails.

Too many distractions

They don't explain the work in the way they expect us to answer exams.

Q16 - Are you currently studying in a different language than what you studied in your school years?

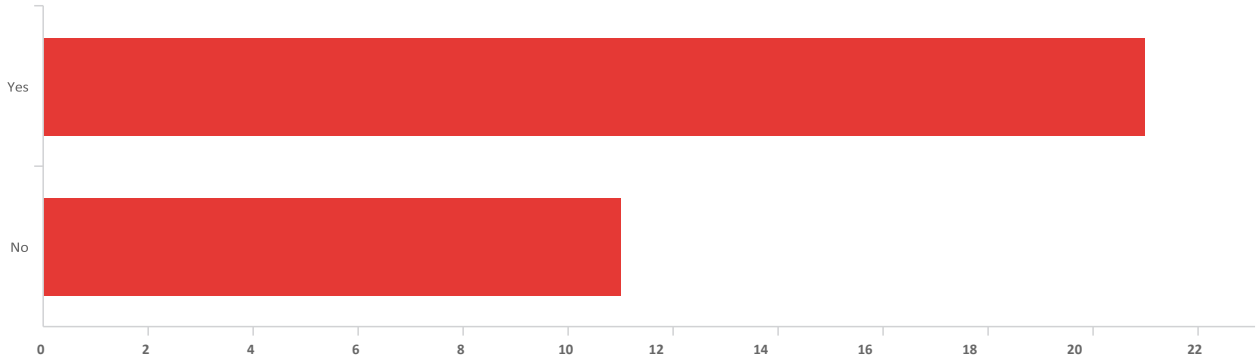


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Are you currently studying in a different language than what you studied in your school years?	1.00	2.00	1.59	0.49	0.24	78

#	Field		Choice Count
1	Yes	41.03%	32
2	No	58.97%	46
			78

Showing rows 1 - 3 of 3

Q17 - Do you think that studying in a different language than you used to has an effect on your academic results?

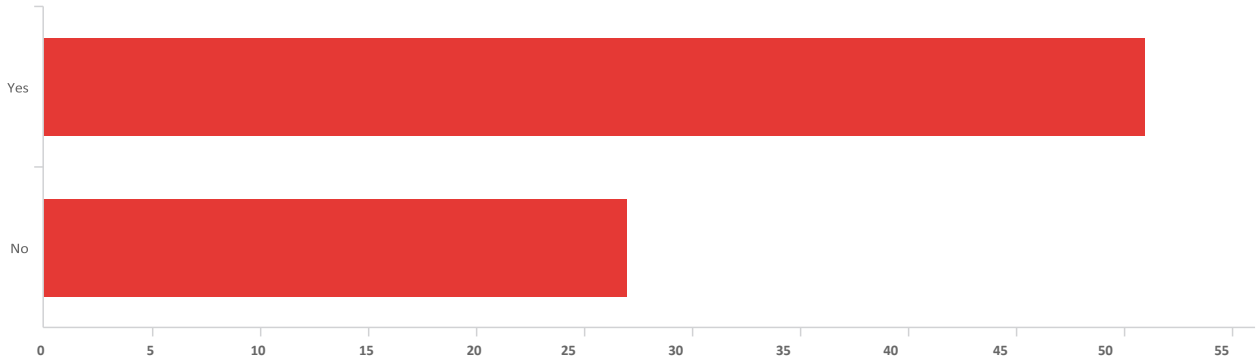


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you think that studying in a different language than you used to has an effect on your academic results?	1.00	2.00	1.34	0.47	0.23	32

#	Field		Choice Count
1	Yes	65.63%	21
2	No	34.38%	11
			32

Showing rows 1 - 3 of 3

Q18 - Was Industrial Engineering your first choice of study?

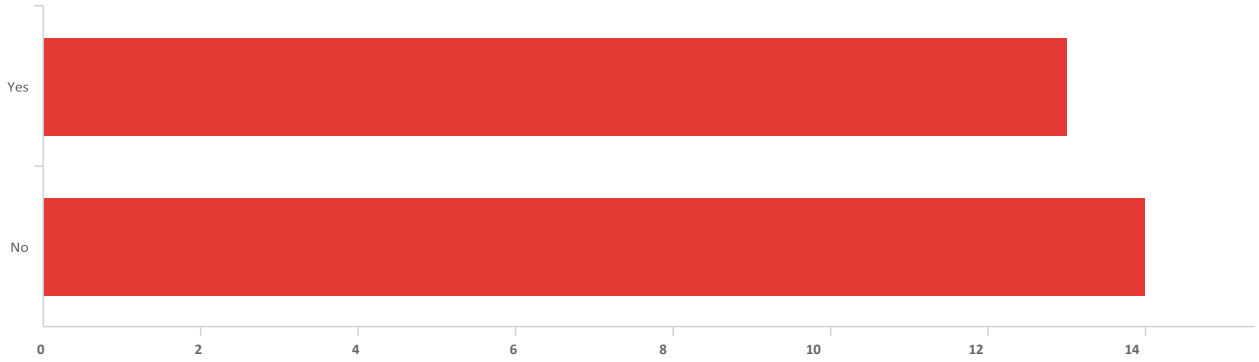


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Was Industrial Engineering your first choice of study?	1.00	2.00	1.35	0.48	0.23	78

#	Field		Choice Count
1	Yes	65.38%	51
2	No	34.62%	27
			78

Showing rows 1 - 3 of 3

Q19 - Do you think that this had an influence on your motivation when studying for your modules?

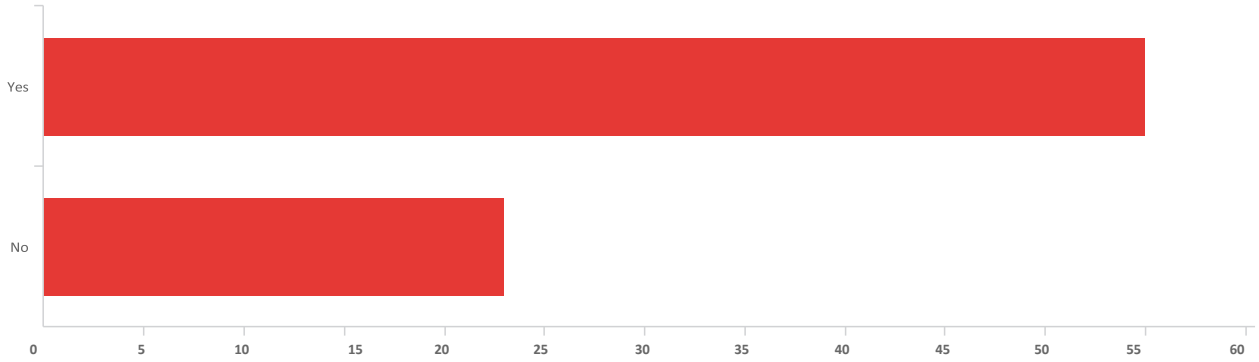


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you think that this had an influence on your motivation when studying for your modules?	1.00	2.00	1.52	0.50	0.25	27

#	Field		Choice Count
1	Yes	48.15%	13
2	No	51.85%	14
			27

Showing rows 1 - 3 of 3

Q20 - Are you studying from home?

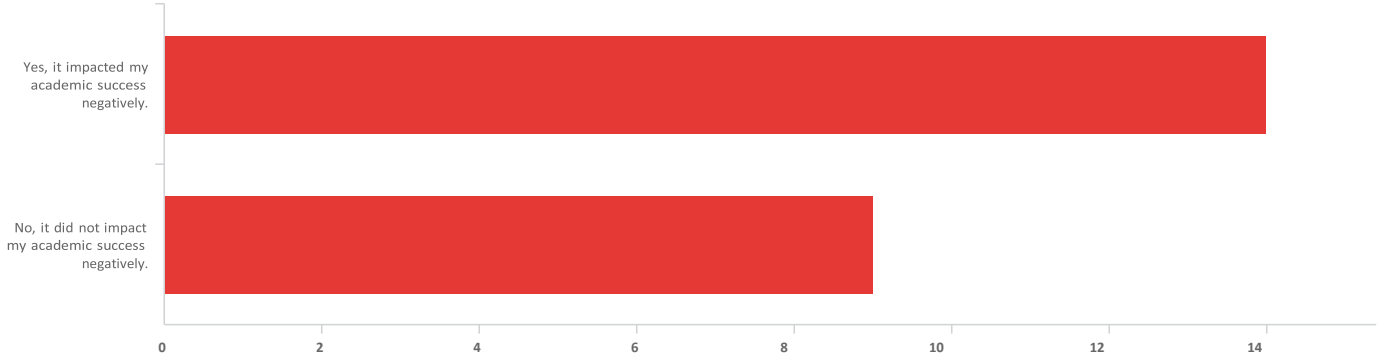


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Are you studying from home?	1.00	2.00	1.29	0.46	0.21	78

#	Field		Choice Count
1	Yes	70.51%	55
2	No	29.49%	23
			78

Showing rows 1 - 3 of 3

Q21 - Did factors such as your own freedom, social distraction and new environment etc. have a negative influence on your academic success?

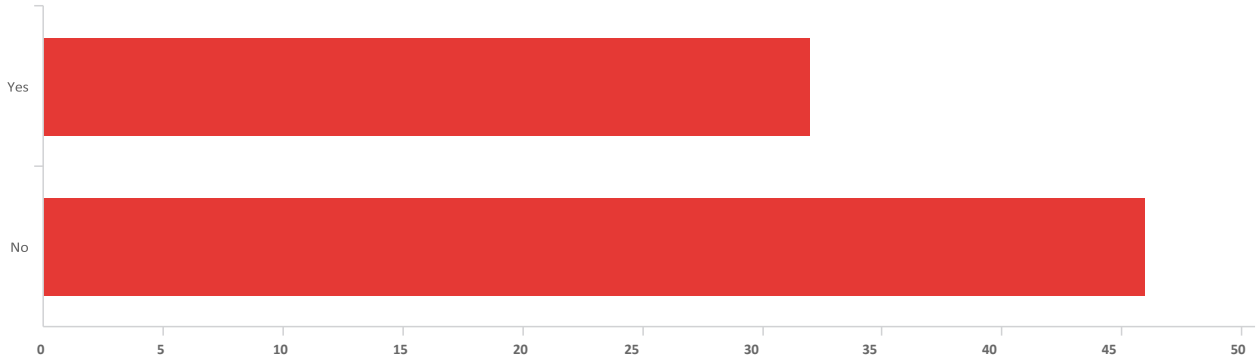


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Did factors such as your own freedom, social distraction and new environment etc. have a negative influence on your academic success?	1.00	2.00	1.39	0.49	0.24	23

#	Field		Choice Count
1	Yes, it impacted my academic success negatively.	60.87%	14
2	No, it did not impact my academic success negatively.	39.13%	9
			23

Showing rows 1 - 3 of 3

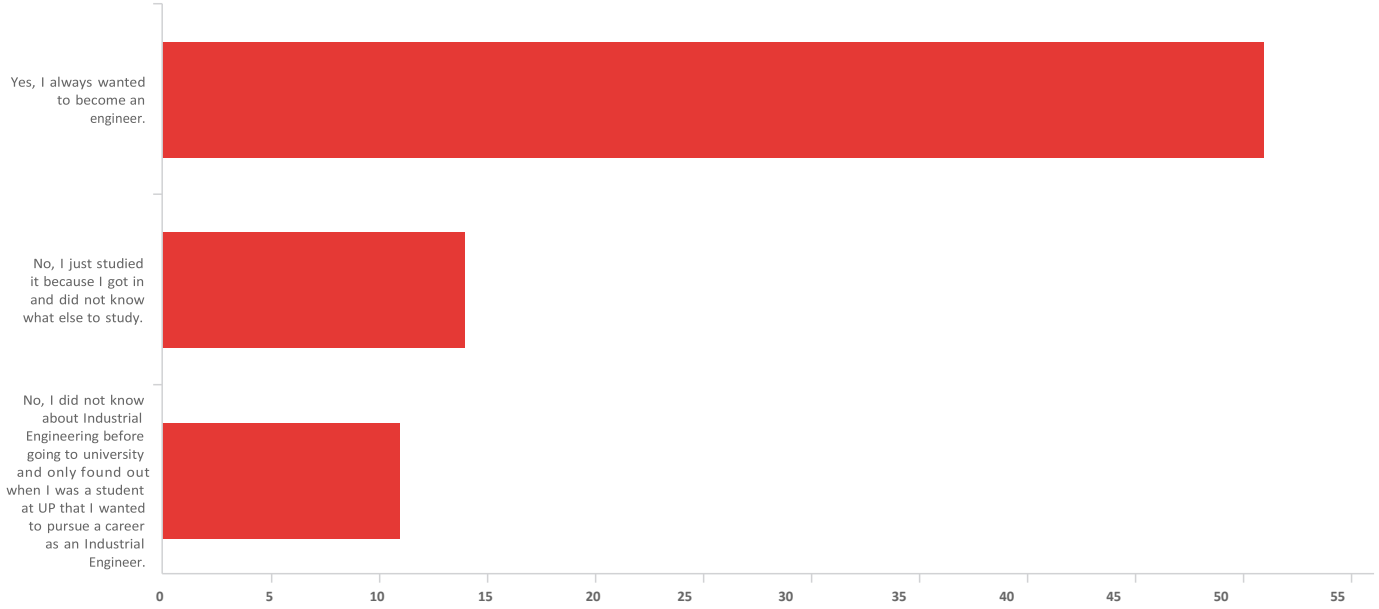
Q22 - Do you think that students who study from home have an academic advantage above students who are not studying from home?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you think that students who study from home have an academic advantage above students who are not studying from home?	1.00	2.00	1.59	0.49	0.24	78

#	Field		Choice Count
1	Yes	41.03%	32
2	No	58.97%	46
			78

Q23 - Have you always wanted to be an engineer after high school? Or did you just started studying engineering because you got accepted and did not know what else to study?

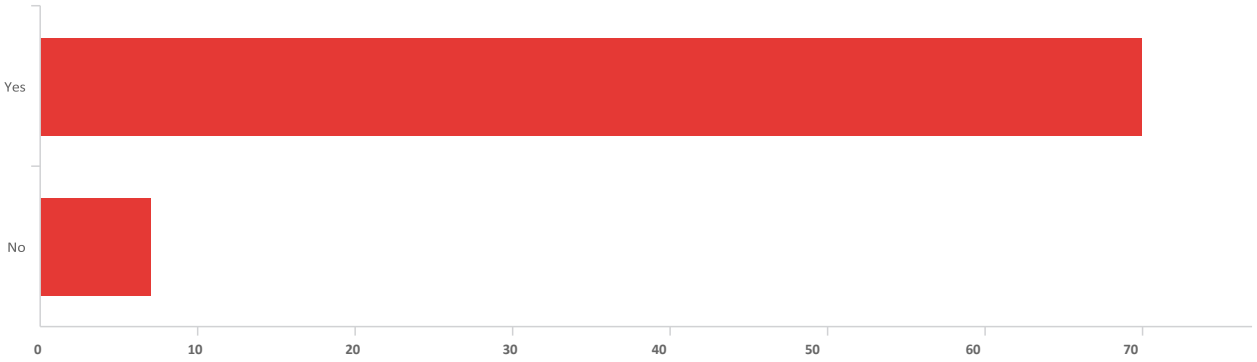


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Have you always wanted to be an engineer after high school? Or did you just started studying engineering because you got accepted and did not know what else to study?	1.00	3.00	1.47	0.73	0.54	76

#	Field	Choice Count	
1	Yes, I always wanted to become an engineer.	67.11%	51
2	No, I just studied it because I got in and did not know what else to study.	18.42%	14
3	No, I did not know about Industrial Engineering before going to university and only found out when I was a student at UP that I wanted to pursue a career as an Industrial Engineer.	14.47%	11
			76

Showing rows 1 - 4 of 4

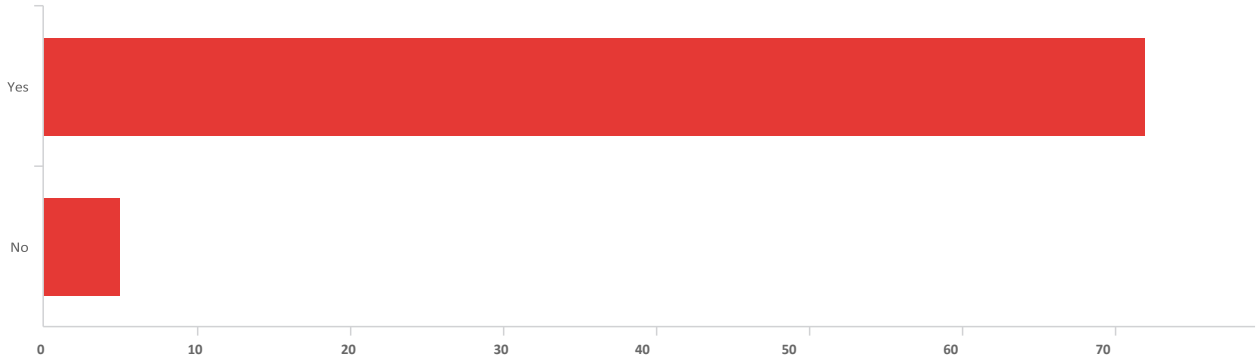
Q24 - Have you ever considered that your intellectual maturity can have an influence on your learning ability?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Have you ever considered that your intellectual maturity can have an influence on your learning ability?	1.00	2.00	1.09	0.29	0.08	77

#	Field		Choice Count
1	Yes	90.91%	70
2	No	9.09%	7
			77

Q25 - Do you think that it will help with the success of students, if more attention is given to the intellectual development of students during each learning phase?

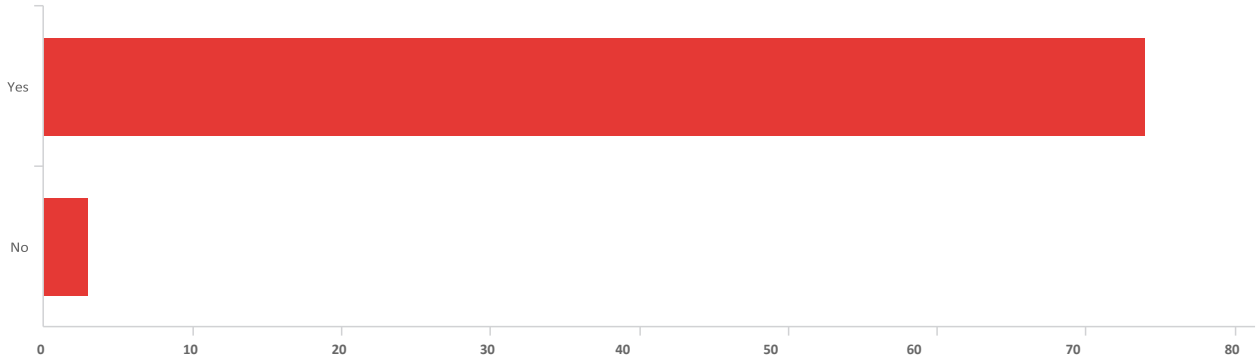


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you think that it will help with the success of students, if more attention is given to the intellectual development of students during each learning phase?	1.00	2.00	1.06	0.25	0.06	77

#	Field		Choice Count
1	Yes	93.51%	72
2	No	6.49%	5
			77

Showing rows 1 - 3 of 3

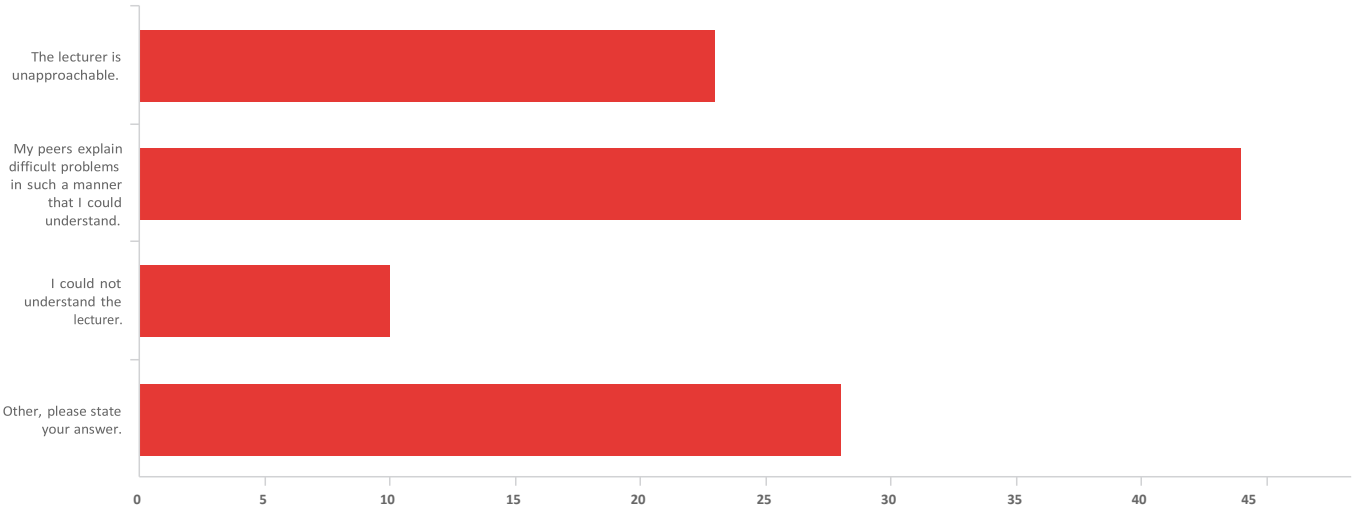
Q26 - When faced with difficult problems, do you ask a fellow engineering student for help instead of the lecturer?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	When faced with difficult problems, do you ask a fellow engineering student for help instead of the lecturer?	1.00	2.00	1.04	0.19	0.04	77

#	Field		Choice Count
1	Yes	96.10%	74
2	No	3.90%	3
			77

Q27 - Why is it that you asked your fellow student instead of the lecturer? (please select all applicable reasons)



#	Field		Choice Count
1	The lecturer is unapproachable.	21.90%	23
2	My peers explain difficult problems in such a manner that I could understand.	41.90%	44
3	I could not understand the lecturer.	9.52%	10
4	Other, please state your answer.	26.67%	28
	Showing rows 1 - 5 of 5		105

Q27_4_TEXT - Other, please state your answer.

Other, please state your answer.

Time availability
(In most modules) A response from a lecturer takes long and you need help immediately.
I have easier access to fellow students than lecturers
It is easier and saves more time, sending an email to the lecturer takes a lot longer than it takes to ask a friend or google it.
Quicker

Takes longer to get a reply and is just much easier to ask a friend

Ease of access and less waiting time

The response of lecturers is unpredictable. They are usually unwilling to explaining something if they have already explained it in the past. Also, their explanations are not sufficient at times. Then I ask friends or consult online videos.

Figuring our work together helped to understand it better

Peers will help you ASAP whereas you have to normally wait for a consultation.

Ease of access to peers. Relationship with peers also mean that they will try to help you as best as possible and not make you feel like a nuisance.

Easier to communicate with someone you know

I generally ask my peers first because it's quicker and easier to contact them and I don't feel like I'm bothering them.

Often the lecturer does not take the time to understand the question asked in detail.

Sometimes I am afraid and scared of asking dumb questions

I first ask a friend before I ask the lecturer.

Because of childhood trauma, it was difficult for me to communicate with people in authority positions, thus making it difficult to speak to lecturers

It is faster, especially with the pandemic, than scheduling a Skype meeting in a few days' time. Peers are often able to help on the same day.

Quicker and simpler replies

Majority of lecturers don't really want to help student who struggle to grasp concepts. They assume all students understand or they do not care or they are too busy to help.

It’s easier to contact friends, and if they don’t know I contact the lecturer

Sometimes the lecturer could be a bit intimidating, unknowingly. People could be shy and anxious to ask questions

I like group work

The lecturer struggles to explain the work over online methods.

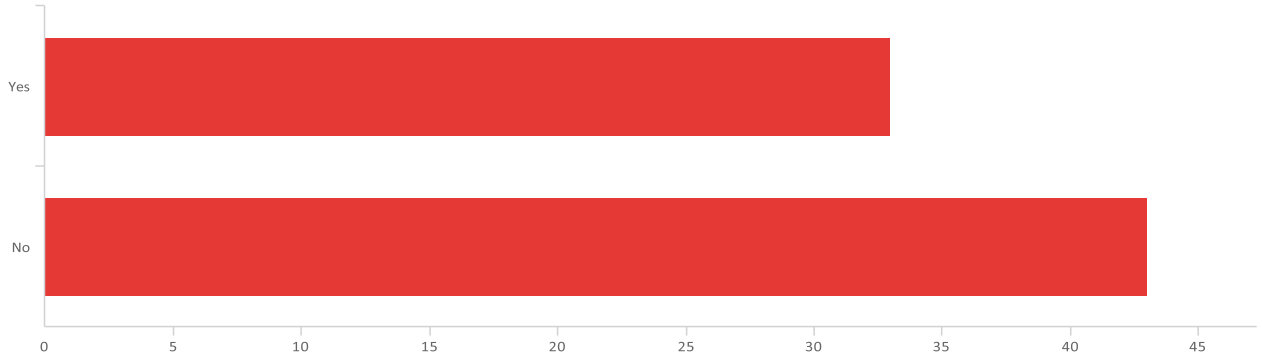
Fear/shyness

Student is easier to approach, they are also more or less in the same boat as myself

It is just easier to contact a friend

Friends are easier to talk to

Q28 - Do you think crowded classrooms are a factor that negatively impacts the success of a student?

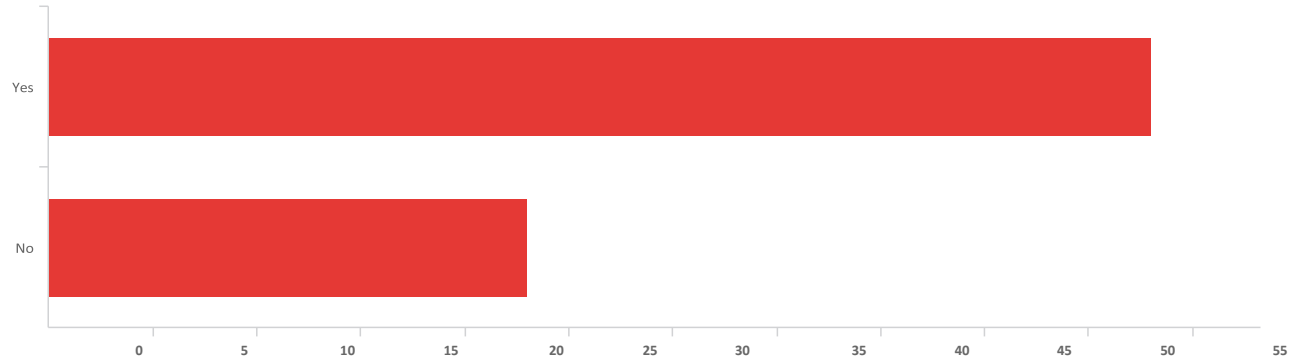


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	ı classrooms are a factor that negatively impacts the success of a student?	1.00	2.00	1.57	0.50	0.25	76

#	Field		Choice Count
1	Yes	43.42%	33
2	No	56.58%	43
			76

Showing rows 1 - 3 of 3

Q29 - Do you think you are able to pay attention and be on-task in this class?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count

1	Do you think you are able to pay attention and be on-task in this class?	1.00	2.00	1.30	0.46	0.21	76

#	Field		Choice Count
1	Yes	69.74%	53
2	No	30.26%	23
		76	

Showing rows 1 - 3 of 3

Q30 - Please explain why you are not able to pay attention and be on-task in the class?

Please explain why you are not able to pay attention and be on-task in the...

Classes are too long. Concentration lifespan is short

The classes are to big and some lectures go to fast, so if you lost them somewhere in the lecturer, you are lost for the rest of the class.

Its very distracting when theres a lot going on in class , people are wispering and the class is very big so there's a lot of thing to take your mind of the lecturer

You focus more on the crowding than what lecturer has to say

There is a lot of people in the class room but mostly id they squeeze us into such small rooms in eng2 it is very crowded and we sit on the stairs

I struggle to focus when there are almost any people/noises around me. Therefore I prefer working through module content at my own time from mu study space.

Lecturer goes off topic and doesn't explain very well

These classes are often quite noisy and the students can be distracting

There are always students who whisper with fellow friends in such environments. Thus, making it difficult to concentrate. There are cases where fellow students start to eat their lunch/snacks - thus, creating an unpleasant odor. Lastly, certain lecture halls during summer does not have sufficient air ventilation, thus leading to students being irratable and not being able to concentrate due to the heat, humidiity and stale air.

You are not able to pause and take in the content at a preferred pace

A crowded classroom generates more noises and it is hard for me to concentrate in such an environment

I have a short attention span and lectures are not engaging enough

Disruptive environments make that you either cannot follow the lecturer, or cannot hear the lecturer.

The speed at which the lecturer teaches the material never seems to be at the right rate. Also being overloaded with work makes it difficult to pay attention because I'm always exhausted

to many distractions and people

Classmates are distracting, lecturers move to quickly or don't assist enough in completing tasks

If the class is crowded, we sometimes had to sit on the floor and work on our laps. Also, some lectures cannot handle such a large group, and the students don't always have the necessary respect for their lecturers and peers to keep quiet so that the lecturer can continue.

It's easy to get distracted and go on your phone without the lecturer noticing

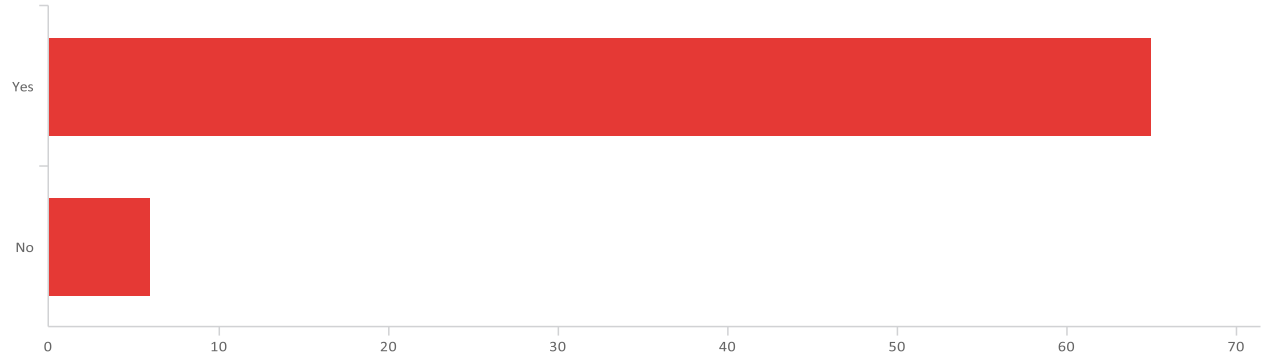
Trying to keep up with the workload and sometimes noisy classes

Distractions, lack of individuality i.t.o asking and understanding questions and work

Please explain why you are not able to pay attention and be on-task in the...

Self discipline

Q31 - Do you think that financial instability has an effect on students' academic performance?

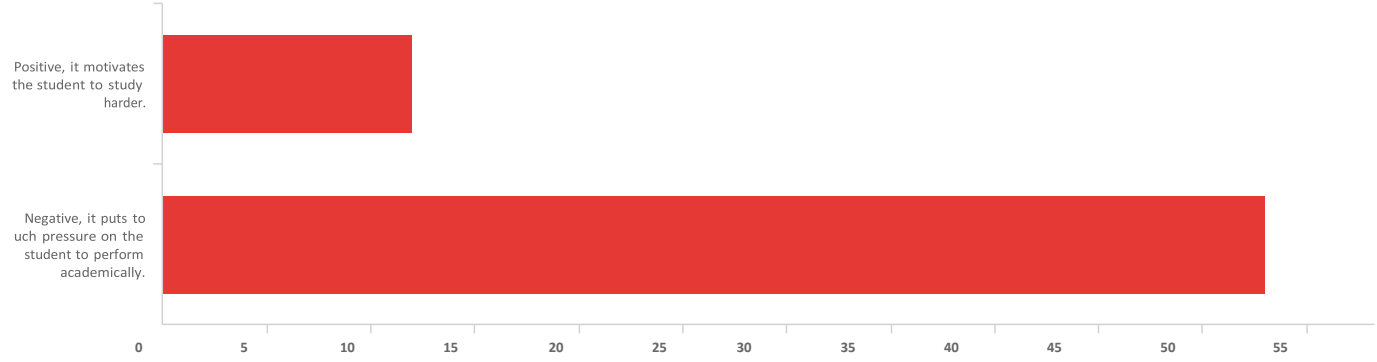


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	inancial instability has an effect on students academic performance?	1.00	3.00	1.17	0.56	0.31	71

#	Field		Choice Count
1	Yes	91.55%	65
3	No	8.45%	6
			71

Showing rows 1 - 3 of 3

Q32 - Would you classify the effect of financial instability as positive or negative towards students' academic success?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Would you classify the affect of financial instability as positive or negative towards students' academic success?	1.00	2.00	1.82	0.39	0.15	65

#	Field		Choice Count
1	Positive, it motivates the student to study harder.	18.46%	12
2	Negative, it puts to much pressure on the student to perform academically.	81.54%	53
			65

Showing rows 1 - 3 of 3

End of Report