The Impact of Stress on Student Tardiness and Subsequent Throughput Rate of Engineering Students: A Case Study*

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Stress is any change that requires a person to adjust to a new situation and is registered in the brain as a threat that causes a stress response in the body. 'Student tardiness' is the term ascribed to students who suffer from tardiness, which is defined as the quality or condition of not being on time. Student tardiness is currently experienced in many higher educational institutions, contributing to poor academic achievements and subsequent low throughput rates. Tardiness is viewed as a construct, which is an abstract concept deliberately created to represent a collection of concrete forms of behaviour including stress or anxiety. The case study on which this article is based explored the relationship between stress or anxiety and tardiness of engineering students, establishing a direct correlation between stress or anxiety and the throughput rate of an engineering module called Design Project III. The empirical study incorporated an ex-post facto study involving a pre-experimental/exploratory design using descriptive statistics. The results of this research were applied to three separate tests which indicated a statistically significant relationship between stress or anxiety and the final throughput rate (75%) of the module Design Project III. Moreover, the presence of a negative correlation indicates that a decrease in the negative aspects of stress or anxiety will result in an increase in the final throughput rate of the module, subsequently influencing the academic success of engineering students.

Keywords: student tardiness; throughput rate; engineering student; stress; anxiety

INTRODUCTION

THE NATIONAL PLAN FOR HIGHER EDUCATION (NHPE) in the Republic of South Africa (RSA) emphasises the importance of improving student success, as well as throughput and graduation rates from the current low levels [1]. The national throughput rate in the RSA for students in Science, Technology, Engineering and Commerce was only 16% in 2000 [2]. Linked to good throughput rates are good teaching output grants from the Department of Education (DoE) in the RSA. These teaching output grants act as an incentive to encourage institutions to establish measures to improve their success, throughput and graduation rates [1].

The throughput rate of a module or course is a good indication of student academic achievement [3]. The DoE in the RSA [4] defines throughput rate as the number of students who are enrolled for a module, course or subject in Higher Education (HE) compared with the number of students who complete that same module, course or subject within a given semester or year, expressed as a percentage. Throughput rate is seldom equal to, but often lower than, the pass rate and takes into account the number of students who drop out of the module, course or subject. Improving through-

put rates in HE may call for a variety of strategies and techniques. One such strategy may be the reduction of student tardiness.

Tardiness presents a threat to the academic achievement of students and subsequently to the throughput rate of educational institutions. This is emphasised by numerous articles that cite tardiness as a serious problem contributing to the enforcement of various rules and policies [5–11]. Tardiness can manifest itself in all areas of life, affecting individuals in upper, middle and lower classes [12–14]. Tardiness is applied in this article to engineering students who delay to complete and submit their reports or assignments on time. Tardiness, which may also be termed academic procrastination, impacts negatively on the academic achievement or success of students [15]. This in turn influences the throughput rate of educational modules. Several factors such as deficiency needs, stress or anxiety, time-management skills, a lack of self-discipline, adrenaline addiction or early childhood training may contribute significantly to tardiness [16].

This article addresses only one of the possible contributing factors to tardiness, namely stress or anxiety. The objective is to explore the relationship between stress, tardiness and throughput rate of engineering students. Authoritative literature pertaining to these terms will first be reviewed to establish this relationship. The research methodol-

ogy and empirical study then follow, which present the results or scientific measurements of this relationship. Conclusions and recommendations based on the statistically significant results are finally discussed. The case study on which this article is based involves selected engineering students ($n = 32$) at the Vaal University of Technology (VUT) during 2005.

STRESS OR ANXIETY: FACTOR CONTRIBUTING TO TARDINESS

High levels of anxiety are often linked to stressful situations [17]. An increase in tardiness is one of the many signs that indicate the presence of stress or anxiety in students [18–23]. Scholten [20] states that stress is any change that requires a person to adjust to a new situation and is registered in the brain as a threat that causes a stress response in the body. The body prepares to fight the change or source of threat or to flee from the change or source of threat by using all bodily systems such as the brain, heart and blood vessels, immune system, digestive system, respiratory system and sensory organs. Conditions that may result in stress or anxiety include heavy workloads, fear, family tragedies and a change in work responsibilities.

Various causes of stress (stressors) exist, which include heavy workloads, insufficient skills and a lack of resources [24, 25]. Cooper, Dewe and O'Driscoll [26] confirm that heavy workloads constitute a significant stressor for many workers. However, a distinction is made between quantitative and qualitative workloads. Quantitative workloads refer to the sheer amount of work required and the time frame within which the work must be completed. The imperative to work under pressure to meet deadlines is a major source of quantitative overload. Qualitative overload, on the other hand, is associated with workers' effective reactions to their jobs. Qualitative overload results when individuals believe that they lack the skill or capacity to perform job tasks in a satisfactory way [23, 26]. Stress is therefore caused by an imbalance between the demands placed on individuals and their capacity to meet these demands [27].

Procrastination may also lead to stress and is often caused by fear (such as a fear of not meeting the demands), fatigue, or poor organisation [28]. Fear of change or a fear of failure may also lead to procrastination or tardiness [29]. Emotional symptoms of stress may include lowered self-esteem, helplessness, reduction of personal involvement with others, being critical of oneself and others, lack of interest and insecurity. Intellectual symptoms of stress may include reduced creativity, lack of concentration, diminished productivity, forgetfulness and difficulty in making decisions. Physical symptoms of stress can include fatigue, sleep disturbance, proneness to accidents, headaches

Table 1. Selected ratings from the Holmes–Rahe scale [25]

Stressful event	Scale of impact out of 100
Death of a close family member	63
Deterioration in health of a close family member	44
Deterioration in financial status	38
Change in responsibilities at work	36

and increased heart rate [25]. Race [27] describes other physical symptoms of stress such as lungs taking in more oxygen and livers working harder to convert carbohydrates. Family tragedies in the form of illness or death in the family may also contribute to stress, forcing individuals to adjust their current lifestyle [30–32].

The Holmes–Rahe scale [31] attempts to quantify the impact of 43 stressful events in terms of the extent to which people would need to adjust their established lifestyles in order to adapt to the stressful event. Table 1 presents selected social readjustment ratings from the Holmes–Rahe scale as described by Burns [25]. The death of a family member ranks high on this scale.

Van Blerkom [33] noted that most students in HE experience stress when they realise that their courses are much more demanding and fast-paced than what they experienced during their high school years. According to the Holms–Rahe scale, this may be regarded as a form of change in responsibilities. Many students also experience stress due to personal and financial problems, which is also ranked by the Holms–Rahe scale. Other students worry about loan repayments, social relationships, health problems or family crises. Still others may spend too much time worrying about money and the sacrifices made by their families to pay for their studies. The foregoing literature suggests that stress or anxiety does indeed contribute to student tardiness. The impact of stress or anxiety on the throughput rate of engineering students was ascertained in the module Design Projects III (DES3), which served as the case study for this article.

CASE STUDY: DESIGN PROJECTS III

DES3 is a compulsory offering or module for the National Diploma: Engineering: Electrical qualification [34]. This module is offered during the final semester of the diploma course. It obliges students to apply their previously acquired knowledge in the design and construction of an electrical engineering project. It also teaches students to exercise engineering judgement and apply it to a practical problem [35]. Some of these projects focus on renewable energy, microcontroller applications and radio-frequency circuits.

DES3 incorporates group work where between two and five students work together on a project

through the semester (duration of approximately 14 weeks). Working in a group affords students the opportunity to check their progress [36], externalize their thinking [37], grow cognitively [38] and promote cooperative learning [39]. Students are afforded the opportunity to select their own group members, from among whom a group leader is chosen to serve as the co-ordinator of the project.

A series of written reports about the project must be presented according to the outline for a master's or doctoral thesis. This assists students to become active learners as they encompass the acquisition of procedural (process), conditional (context), and content knowledge [40]. These reports must be submitted at prescribed times and dates during the semester. Formative assessment is used and the reports are returned to the students with appropriate verbal and textual feedback. This gives students the opportunity to evaluate their progress [41] and rectify any inaccuracies that exist. They must then resubmit the modified reports for a final summative assessment at the end of the semester. However, the lecturer remains available during prescribed consultation hours to assist with any further student enquiries regarding the specified reports. This encourages students to seek information on their own, exploring new ideas and concepts [36]. One such concept may be an appropriate research methodology.

RESEARCH METHODOLOGY

Research methodologies provide the means to explore unexplained phenomena as well as phenomena previously explained but misunderstood. Through the use of methods and techniques that are scientifically defendable, researchers may come to conclusions that are valid and reliable [42]. The research, on which this article is based, incorporated an ex-post facto study involving a pre-experimental/exploratory design using descriptive statistics.

Ex-post facto means 'from after the fact' and is typically used when specific available data could not be generated by experimental research [43, 44]. The ex-post facto design thus provides the means by which the researcher can examine how specific independent variables affect the dependent variable of interest [45]. In the current research, the independent variable is the contributing factor to tardiness, namely stress or anxiety, while the dependent variable of interest is throughput rate. Pre-experimental/exploratory designs may set the stage for future research and usually involve only a single group of respondents [43, 46]. The purpose of exploratory studies is to gain insight into a situation, phenomenon, community or person [43, 47].

The purpose of the empirical study on which this article is reporting, was to gain insight into the lives of students in terms of their stress or anxiety. Descriptive statistics, involving a correlation test, was then used to ascertain whether a statistically significant relationship exists between the contributing factor, namely stress or anxiety, and the final throughput rate of the respondents. Descriptive statistics, rather than inferential statistics, was used in this ex-post facto study because the collected data was only interpreted with regard to a sample of the target population.

The target population taking part in this research was restricted to engineering students enrolled for the module DES3 at VUT.

One hundred and ten students enrolled for this module at the beginning of the second semester of 2005 (from July to November). Not all of these enrolled students could be included in the research as some were not regularly on campus due to employment commitments or other external responsibilities. This resulted in the selection of a non-probability sample as certain students had no chance at all of being included in the research [42].

The non-probability sample comprised mostly the group leaders within DES3, being 32 in total for this research. Forty-seven of these group leaders were polled in the first test during the second semester of 2005. Only 32 out of the initial 47 group leaders responded to the second test involving the questionnaire. This is an acceptable return rate for the exploratory study.

The questionnaire was selected as the main measuring instrument as it involves mainly objective data and is also an inexpensive way of collecting data from a large group of respondents [43, 48]. The validity of the results is also reliant on the honesty of the respondents [49]. The literature review provided the basis for formulating closed-ended questions that were used in the questionnaire.

The reliability of the measuring instrument was ensured through repeated measurements [42–45]. The test–retest reliability of the questionnaire was verified on two separate occasions, six weeks apart.

QUANTITATIVE FINDINGS AND INTERPRETATION

The first test of this research was administered to 47 engineering students in the module DES3 on 22 September 2005. Thirty-two of these 47 students completed the second test on 7 November 2005. Only the 32 students who completed test one and test two were considered in the analysis and interpretation of the results. The loss of students may be attributed to internal and external responsibilities that prevented the students from attending and completing the second test. Male students comprised 72% of the target group while the predominant home language of the respondents was South Sotho (19%). The mean age was 23 years while the median and the mode were 22 and 23 years of age respectively. The time period of interest in which stress or anxiety was measured was the week before submission of one of the required reports for assessment.

The 16 questions posed in the measuring instru-

ment were all negative aspects that would lead to higher levels of stress or anxiety. These questions were presented in different sections, which were numbered numerically (for example 4, 9 and 28) and alphabetically (for example i and B). Three different statistical results were obtained using the Statistical Package for Social Sciences (SPSS), namely:

- Chi-square test: testing whether a statistically significant relationship exists between two variables [50]. The chi-square test is one of the best known and simplest tests of significance [43]. The two variables are the individual questions in test one and test two regarding the contributing factor. The percentage of students who answered 'Yes' to these questions was used in this test to simplify the analysis and interpretation.
- Item–total correlation: testing whether a statistically significant relationship exists between individual questions within the contributing factor and the total number of questions for that same contributing factor. This is done for each separate test and may also be referred to as a point biserial correlation [50]. This test involved the use of 'Yes' and 'No' answers in the questionnaire.
- Correlation between stress or anxiety and the throughput rate: testing whether a statistically significant relationship exists between the contributing factor regarding the negative aspects in each test, and the final throughput rate. This test uses the percentage of students who only answered 'Yes' to the questions in the main measuring instrument in order to simplify analysis and interpretation.

Chi-square test for stress or anxiety: testing for significance between test one and test two

Figure 1 illustrates seven of the possible stress or anxiety indicators in the form of family tragedies, resource deficiencies and financial concerns. Figure 2 considers the other nine possible indicators of stress or anxiety. These results showed a statistically significant relationship between test one and test two regarding illness (question 9), access to a computer and the availability of transport (questions 17 and 26), financial concerns (questions 27 and 28), external responsibilities of students (question 18), other causes of stress (questions 19 and 32) and student insecurities (question 22 and i).

The results of the chi-square test provide a degree of reliability with regard to the correlated questions posed in both tests regarding stress or anxiety. This indicates that the correlated answers between test one and test two provided by the engineering students are relatively trustworthy, reflecting a high degree of honesty by the respondents.

Item–total correlation test for stress or anxiety: testing for significance between specific questions and the total number of questions

An item–total correlation test revealed a statistical significance between specific questions and the total series of questions in terms of stress or anxiety. The results for the negative aspects considered in test one and test two are shown in Tables 2 and 3 respectively. The number of students who answered 'Yes' to the relevant questions in tests one and two are also shown.

Thirteen out of the possible 16 questions were correlated to the contributing factor when considering Tables 2 and 3. These results provide a degree of criterion-related validity as the questions measured or indicated the contributing factor to tardiness, namely stress or anxiety.

Correlation to throughput rate for stress or anxiety: testing for significance between the contributing factor and the final throughput rate

Twenty-eight of the 32 polled students who handed in all of their required reports on time successfully completed the module. This equates to
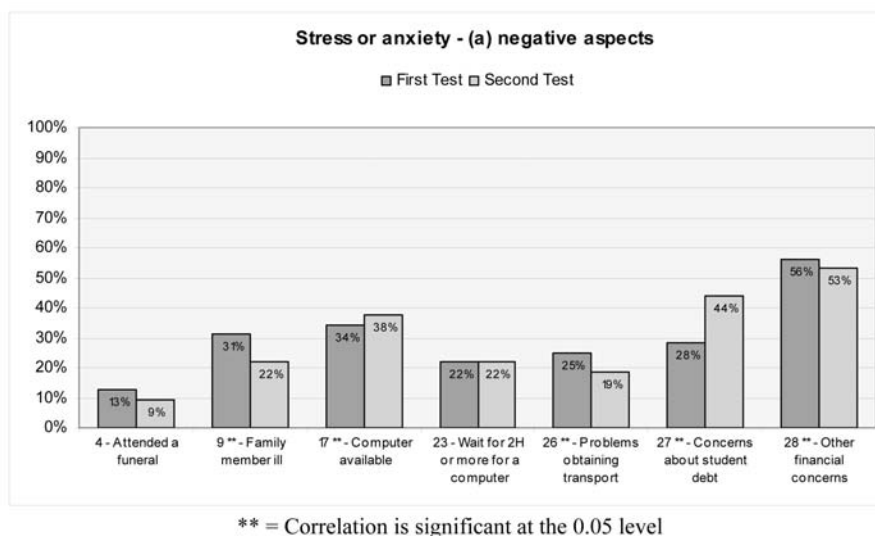

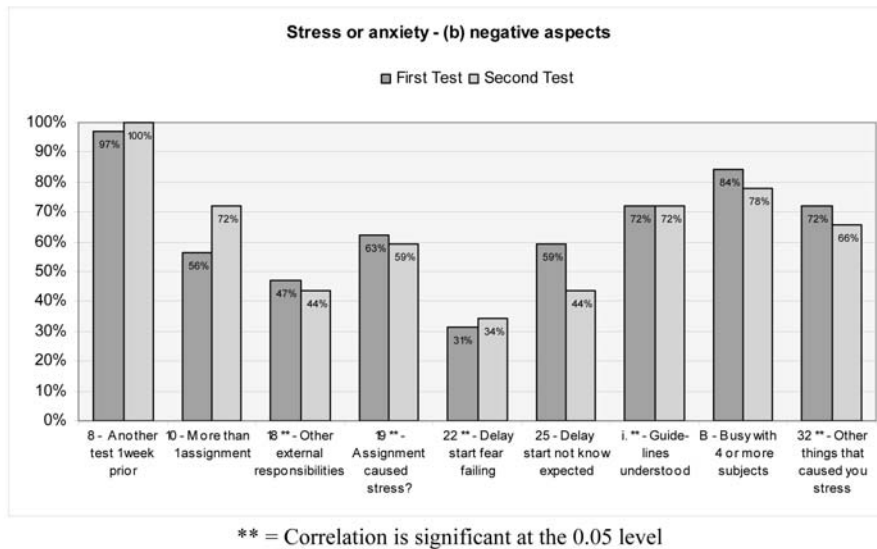Fig. 1. Correlation of the negative aspects of stress or anxiety, such as family tragedies (*n* = 32).

Fig. 2. Correlation of the negative aspects of stress or anxiety using the chi-square test (*n* = 32).

Table 2. Item–total correlation regarding seven negative aspects of stress or anxiety (*n* = 32)

Questions posed in the questionnaire	Yes counts	Type of statistic	Test one (T1)	Test two (T2)
4. Have you attended a funeral during the past week?	T1 = 4 T2 = 3	Pearson r Sig.	0.318** 0.038	0.296** 0.050
9. Was there a member of your family who was ill during the past week?	T1 = 10 T2 = 7	Pearson r Sig.	0.320** 0.037	0.505*** 0.002
17. Do you have your own computer and printer?	T1 = 11 T2 = 12	Pearson r Sig.	0.223 0.110	0.138 0.226
23. Do you have to wait for more than 2 hours on average each day to access a computer?	T1 = 7 T2 = 7	Pearson r Sig.	0.384** 0.015	0.397** 0.012
26. Did you have problems obtaining transport on the morning that you had to submit this report?	T1 = 8 T2 = 6	Pearson r Sig.	0.398** 0.012	0.271 0.067
27. Have you had concerns about your student debt during the past week?	T1 = 9 T2 = 14	Pearson r Sig.	0.413*** 0.009	0.640*** 0.000
28. Were there some other financial concerns that troubled you over the past week?	T1 = 18 T2 = 17	Pearson r Sig.	0.724*** 0.000	0.452*** 0.005

*** = Correlation is significant at the 0.01 level.
** = Correlation is significant at the 0.05 level.

a throughput rate of 75%, which was correlated to the negative aspects of stress or anxiety as depicted in Table 4, which contrasts scores for test one and test two. The correlation indicates a statistically significant relationship between the negative aspects of stress or anxiety and the final through-put rate of respondents in the study. Noteworthy is the presence of a negative correlation, indicating that a decrease in the negative aspects of stress or anxiety will result in an increase in the throughput rate of the module.

DISCUSSION AND CONCLUDING COMMENTS

The item–total correlation test indicated that a number of questions (13 out of 16 from Tables 2 and 3) had a statistically significant relationship to the total number of questions posed regarding the contributing factor, namely stress or anxiety. These questions were based on the literature review which identified stress or anxiety as a contributor to tardiness. It can therefore be concluded that these collective questions as a whole may indicate the presence of stress or anxiety and subsequently student tardiness.

A relatively high percentage of students suffered from stress or anxiety during the period before submitting their assignments. This is indicated by considering the findings presented in Fig. 1 and 2. The elevated stress or anxiety levels were mainly caused by heavy workloads, where students needed to complete a number of assignments or where they had to write several tests within a specified week during the semester. Stress or anxiety may be exacerbated in instances where students do not know how to manage their time correctly.

Table 3. Item-total correlation regarding nine negative aspects of stress or anxiety ($n = 32$)

Questions posed in the questionnaire	Yes counts	Type of statistic	Test one (T1)	Test two (T2)
8. Have you written a test during the past week?	T1 = 31 T2 = 32	Pearson r Sig.	0.215 0.118	a a
10. Did you have more than one assignment to hand in during the past week?	T1 = 18 T2 = 23	Pearson r Sig.	0.361** 0.023	0.489*** 0.002
18. Did you have any other tasks or responsibilities outside the University that you had to care for during the past week?	T1 = 15 T2 = 14	Pearson r Sig.	0.459** 0.004	0.505*** 0.002
19. Would you say that the assignment caused you to stress?	T1 = 20 T2 = 19	Pearson r Sig.	0.639*** 0.000	0.539*** 0.001
22. Did you delay the start of your report for fear that you might fail the assignment?	T1 = 10 T2 = 11	Pearson r Sig.	0.458*** 0.004	0.580*** 0.000
25. Did you delay the start of this report because you did not know what was really expected of you?	T1 = 19 T2 = 14	Pearson r Sig.	0.499*** 0.002	0.662*** 0.000
i. Were the formats and guidelines of the assignment clearly understood?	T1 = 23 T2 = 8	Pearson r Sig.	0.499*** 0.002	0.502*** 0.002
B. Were you busy with 4 or more subjects during the past week?	T1 = 27 T2 = 25	Pearson r Sig.	0.340** 0.028	0.519*** 0.001
32. Were there other things that caused you stress during the past week?	T1 = 23 T2 = 21	Pearson r Sig.	0.750*** 0.000	0.639*** 0.000

*** = Correlation is significant at the 0.01 level.
 ** = Correlation is significant at the 0.05 level.
a = Cannot be computed because at least one of the variables is constant.

Table 4. Correlation of stress or anxiety to the throughput rate ($n = 32$)

Section on negative aspects	Type of statistic	Test one (T1)	Test two (T2)
The original 16 questions with regard to this factor	Pearson r Sig.	−0.312** 0.041	−0.268 0.055
Questions with statistical significance taken from the item-total correlation test	Pearson r Sig.	−0.348** 0.024	−0.319** 0.038

** = Correlation is significant at the 0.05 level.

The negative aspects of stress or anxiety (Table 4) revealed a statistical significant relationship to the final throughput rate of 75% for engineering students enrolled for the module DES3 during the second semester of 2005. Stress or anxiety levels increase when heavy workloads are coupled with a lack of resources (like money and transport and/or access to a word processor). Engineering students tend to experience an increased workload as semesters draw to an end, as outstanding assignments need to be submitted, last minute tests are to be written and preparations for the examinations must commence. This does not bode well for the stress or anxiety of engineering students, which could result in poor academic achievement with a subsequent negative impact on the final throughput rate of the particular module or entire course. This statistically significant relationship was revealed by means of the correlation to throughput rate test (see Table 4). Universities cannot always address all of the factors leading to stress or anxiety. However, universities can address the issue of resources, especially computer resources required to complete assignments. Approximately 22% of respondents had to wait for more than two hours to access a computer while fewer than 38% of respondents had access to a personal computer (Fig. 1). It is recommended that more computer resources for engineering students be made available in order to reduce their stress or anxiety levels when they are preparing for assignments or examinations.

Tardiness will continue to plague all forms of society. It will especially continue to be a threat to the academic achievement of students and subsequently the throughput rates of educational institutions. Tardiness will not be eradicated overnight nor will one unique solution be found that will cure all forms of this tendency in society today. Academics therefore need to experiment with various 'treatments' to curb this growing concern. Governmental authorities and institutions of HE will need to enforce current policies and should search for new methods to curb the growth of student tardiness.

The foregoing results of this research reveal that stress or anxiety can indeed be correlated to the final throughput rate of 75%. The literature review indicated that stress or anxiety is a contributing factor to tardiness. It can therefore be stated that stress or anxiety does indeed impact on student tardiness and subsequently on the final throughput rate of engineering students at VUT. This impact will continue to have far-reaching effects on the teaching output grants that institutions of HE receive from the DoE in the RSA.

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