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Does Motivation Affect Students' Understanding And Performance In Engineering Statics?

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Abstract

Students' understanding of fundamental engineering concepts is not necessarily reflected by their good academic performance. The difficulty that many students face in Statics has often affected their course performance and other follow-on courses, consequently, disheartening them from continuing with their engineering programme. The findings of this study indicate that most students attributed their performance in Statics to their own effort and self-efficacy. This supports Bandura's claim that students' motivation influence their achievement. Consistent with the cognitive theory, students are perceived to have more responsibility for their own learning. Does motivation actually make the students succeed in Statics? This paper presents the findings from four case studies in the public universities in Malaysia.

Keywords: Engineering Statics; performance; understanding; motivation;

1. Introduction

Statics is a fundamental engineering course which many students find to be difficult (Chen, Kadlowec, & Whittinghill, 2004; Dollár & Steif, 2007; Haik, 1999). The difficulty has resulted in poor students' performance in Statics and other follow-on courses (Dollar & Steif, 2004; Sidhu & Ramesh, 2006), which consequently has often discouraged students from pursuing engineering (Sidhu & Ramesh, 2006). Studies on engineering students' academic achievement revealed that students who are academically successful do not necessarily have a deep

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understanding of fundamental concepts (Haron, 2008; Montfort, Brown, & Pollock, 2009; Streveler, Geist, Ammerman, Sulzbach, & Miller, 2006). Difficulties in learning Statics are mainly due to universal impediment such as the difficult concepts, local culture and work habit of students (Chen et al., 2004; Steif, 2008).

Considerable research in education and educational psychology has revealed that motivational variables are highly related to students' learning (Kizilgunes, Tekkaya, and Sungur, 2009). Pintrich (2004) suggested that students' motivation is related to the use of learning strategies that influence their academic achievement. Meanwhile, Schunk (2009) advocated that motivation results in meaningful learning and promotes self-regulated learning (SRL). It directs learners' thoughts, feelings and motivated behaviour toward the attainment of their goals in learning (Schunk, 2009; Reid & Petocz, 2008; Bembo & Seli, 2008).

As students hold the ultimate responsibility for their own learning (Chen, 2002), and learning Statics demands students to achieve both deep understanding and good performance, this paper discusses the influences of the motivational factors on students' concept test scores and Statics assessment scores.

2. Methodology

This study was carried out in two phases; Phase 1 was carried out at one institution and Phase 2 at four institutions. Table 1 shows the data collection methods, the period of collection and the sample size.

Table 1. Data collection methods and period, and the sample size

Phase	Data collection method	Data collection period	Sample size
Phase 1	Document analysis	Records from 2004 – 2008	124 students
	Observations	Semester 2 2007-2008 Semester 1 2008-2009	109 students 18 students (only class offered)
	Interviews	Semester 2 2007-2008 Semester 1 2008-2009	Two lecturers and four students
	Questionnaires	Semester 2 2007-2008	131 students
Phase 2	Questionnaires and concept tests	Semester1 2009-2010	636 students from four institutions in Malaysia.

The data in Phase 1 were collected over one year using four methods; document analysis, class observations, interviews and questionnaires. The faculty records from 2004 to 2008 on student results were analyze for passing rates in Statics and performance trend. Meanwhile, class observations were carried out in two semesters to observe students behaviours during class. Interviews and questionnaires were also conducted. Interviews were conducted on both students and lecturers. The lecturers interviewed were with more than ten years experience in teaching Statics. The interviews were to investigate on how they perceive their students learn Statics, and their own experiences teaching the course. Meanwhile, the students were interviewed regarding their perceptions of Statics and experiences in learning Statics. The questionnaire distributed was to investigate the students' learning goals, motivation in learning Statics and perceptions of the factors that influence their Statics performance.

In Phase 2 the students' performance in Statics, understanding of Statics concepts and their self-regulated learning were measured. Data were collected at four institutions of higher learning in Malaysia; one from the north, another from the south and two other from the central regions. The criteria for selection of the four institutions were based upon commonality of the syllabus, textbook, assessment and teaching methods. The respondents were engineering undergraduate students taking Statics and their participation was voluntary.

3. Instruments

The data for students' performance were their Statics scores at the end of the semester. The score consists of marks from the final exams, tests and assignments. Meanwhile, data set for students' understanding of Statics concepts was their scores obtained from the concept tests conducted. The concept test measures students' ability to use core Statics concepts. The concept questions were adopted from an established Statics Concept Inventory (Steif & Danztler, 2005) consisting of 27 multiple-choice questions that represent nine distinct concepts in Statics. The test is available online but for this study it was administered using paper and pencil method.

Data on students' self-regulated learning strategies was measured using the self-report questionnaire, adapted from the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, 1991). The questionnaire was developed based on the cognitive view of motivation and learning strategies. It was designed to measure the college students' motivational factors and their use of different learning strategies in college courses. The instrument consists of two constructs: motivational and learning strategies. For the purpose of this study, items in the questionnaire were modified to suit to Statics. The total number of items in the questionnaire was reduced from 81 to 58. Responses were scored using a 4-point Likert scale, from 1 (not at all true of me) to 4 (very true of me). Factor analysis was carried out and resulted in the following renamed subscales:

- Motivation – Study goals and values; anxiety; learning beliefs and self-efficacy.
- Learning strategies – Critical thinking and elaboration; organization and memorization; persistence and regulation; study effort; meta-cognitive regulation; help seeking.

4. Results and analysis

The data analysis methods are shown in Table 2. The analysis methods in Phase 1 vary according to the respective data collection methods. Data from Phase 2 were analyzed using the statistical software SPSS version 18. The results are presented below.

Table 2. Data analysis techniques

Phase	Data collection	Data analysis
Phase 1	Document analysis	Using Excel for percentages and graphs.
	Observations	Students' behaviour patterns were identified from observation notes.
	Interviews	Keywords from transcript representing the interviewees' perspectives.
	Questionnaires	SPSS for finding the percentages.
Phase 2	Questionnaires and concept tests	Statistical data analyses using SPSS: percentages, correlations and multiple regressions.

4.1. Document analysis

Records from the academic office on 124 students who had failed Statics were analyzed. The analysis shows that students entering the program have varied academic background. Whilst the majority of students came into the program with a high school national exam certificate, *Sijil Pelajaran Malaysia* (SPM) that is equivalent to O-Level, there were about 9% who entered with polytechnic certificates. The students from polytechnics were given transfer credits for a number of pre-requisite courses, such as Physics and Mathematics, thus these courses were not taken during their first year. From the faculty record it was identified that some of the students given the transfer credits had to repeat Statics, with several cases repeating it twice or more.

Students' results from six classes, taught by six different lecturers were analyzed. A stacked line graph in Figure 1 showed a similar pattern of students' grades for the different lecturers teaching the course. The lecturers were of similar background and teaching approaches, with work experiences between 10 to 15 years. This finding implies that students' performance in Statics does not vary with who taught the course.

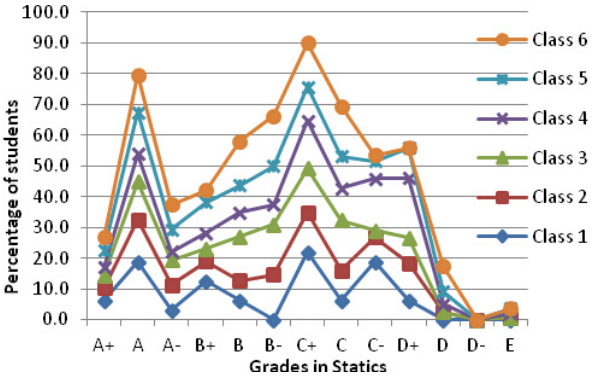

Fig. 1. Stacked line graph showing the distribution of students according to Statics grades per class, each with different lecturer

4.2. Observations on students' behavior

In Semester II, 2007-2008, about 27% of the students enrolled in Statics were repeaters, with some of them taking the course for the third time. It was observed that only about 10% of the students in the class were participating in the class activities; solving problems given on the whiteboard, discussing the questions with friends and asking questions to the lecturer. The rest were seen passive, appeared to be waiting for the lecturer to provide the solutions, or waiting for the next activity. About 10% out of these passive students appeared to be uninterested throughout the class session and not even copying the solutions given on the whiteboard. These students were seen to hurriedly leave the classroom at the end of the period. It was also observed that there was no opportunity for the students to reflect and digest the information given during the class period, as the students were expected to be busy copying solutions from the whiteboard. The classes were also generally quiet throughout, except towards the end of the class period when the students were noisy with own conversations. They only paid attention to the lecturer when tips on the coming test were given.

In the following semester, it was observed that although some students were unable to solve the Statics textbook problems given in class, most of them were engaged and appeared to be motivated to try. The lecturer was seen to be giving a more personalized attention to students whilst they were doing the exercises. However, a student in particular was observed to be de-motivated and passive. This student was invited for the interview.

4.3. Interviews

This section is divided into two; one presents the results from the lecturers' interviews, and the other from the students' interviews.

4.3.1. Lecturers

From the lecturers' perceptions, students' attitude and behaviour are perceived as the main factor for their poor performance in Statics. The lecturers were in the opinion that students who did not perform well in Statics

were not yet adjusted to the first year transition period, not interested in the course, and for some of them not interested in doing engineering altogether. The lecturers believed that most of the students are lacking in the mathematical ability, thus unable to solve the mathematical problems in Statics. This perception was arrived at from the lecturer's knowledge on student's pre-requisite course grades.

The students were also perceived as passive, uninterested in Statics because they were not willing to seek help when encountered with problems in Statics exercises, and did not participate in class activities. It was glaring to the lecturers that those few students who regularly seek their help performed better in Statics. It was noticeable to the lecturers that repeating students have a disadvantage with regards to the timetable. Their class schedule often clashes with other courses that they have to take in the same semester. This had often caused them to miss some Statics classes, came in late or left earlier, especially when Statics classes were run in two periods consecutively.

As to how they conduct their lectures, the lecturers informed that lessons are conducted face to face, using whiteboard as the teaching aid, and occasionally using the PowerPoint slides. Related lab experiments in Statics are offered to students as a separate course. The textbook exercises were used for in-class worked examples.

It can be summarized that the lecturers highlighted issues related to the transition period from high school to university learning environment, pre-requisite course requirements, motivation, learning strategies and class schedule. They also described about their teaching approaches.

4.3.2. Students

Students expressed that the transition period from school to the university curriculum was a factor for their poor performance in Statics. Apart from Statics being the first engineering course they encountered in the program, the learning and teaching approaches were very different from what they had experienced before. They felt that the learning strategy now is different in many ways, which include the need for less rote memorization but more independence in their effort to study. They feel the need to be more proactive in seeking additional information on the courses taught and in communicating their ideas, thoughts and questions.

One student who had gone through the course several times indicated that she had put a mental block to learning Statics, 'I just sit in class, trying to focus but it seems I can't take in anything anymore'. Learning to pass the examination had become her main agenda. This student and another repeating student shared their experiences taking Statics with different lecturers. Comparing the teaching approaches, they felt that learning is more effective with a more personalized approach to problem solving, and a more elaborated explanation of what Statics is all about. The researcher noted that this more personalized approach was made possible due to the smaller class size in the semester it was offered, as it was mainly for the repeating students.

Students who had previously failed admitted that they gained more confidence and understanding in Statics when taking it the second time. All of the students interviewed expressed that the motivation to learn would come with understanding of what was learnt. The students elaborated that they believe they can perform well in examinations if they practice a lot in solving Statics problems. The students, including those who had failed, believed that the calculation part was not a problem; but understanding the concepts in Statics is a struggle.

To summarize the outcomes from the students' interviews, issues that were highlighted include those related to the transition period, teaching approaches, learning strategies, learning goals and motivation.

4.4. Questionnaires

This section is divided into two; one describes the analysis of the data from the questionnaire in Phase 1, and the other describes the correlation and multiple regression analyses from the data collected in Phase 2.

4.4.1. Phase 1 Questionnaire

Students' learning goals, perceptions on their motivation and factors contributing to their Statics performance are described below.

4.4.1.1. Learning goals

The students were asked to select the learning goals that are relevant to them. The choices of whether students' goals in learning Statics were a combination of to pass (G1), score (G2) and/or to gain understanding (G3) indicated the following (as a percentage of respondents):

- 62.1% focused on gaining understanding (G3),
- 43.8% aimed to score Statics (G2),
- 19.7% targeted to pass (G1),
- 8.5% aimed to pass and score (G1 and G2),
- 10.3% aimed to pass and gain understanding (G1 and G3), and
- 18.6% targeted on both gaining understanding and scoring high marks (G2 and G3).

The results implied that the majority of students put priority in gaining understanding when they learn Statics, followed by scoring instead of just wanting to pass the course. Comparing the number of times students took Statics and the three learning goals, all student categories showed emphasis on gaining understanding when learning Statics. Even students who took Statics more than twice put priority in understanding the course rather than merely getting a pass (Table 3). Another specific question asked was to gauge the students' appreciation in knowing where to apply the Statics concepts. The result was 94% of the respondents agreed that it could help them in understanding Statics better.

Table 3. Number of times taking Statics vs. goals of learning (choices were a combination of to pass, score and/or to gain understanding)

No. of times taking Statics	Percent (%) of total respondents	To pass, G1 (%)	To gain understanding, G3 (%)	To score, G2 (%)
Once	83.0	19.2	48.8	39.1
Twice	14.0	4.7	8.4	4.5
More than twice	3.0	0.3	1.8	1.6

4.4.1.2. Motivation

A question on students' motivation in learning Statics revealed the data in Table 4. It is shown that 70% of the students were mostly motivated to learn Statics, even though there were 5% of them who felt not confident of themselves. It is interesting to note that more than half of the 30% of students who were not motivated were actually confident in doing well in Statics.

Table 4. General feelings in Statics class

	General feelings in Statics class
Motivated (70%)	Motivated and confident – 65% Motivated but not confident – 5%
Not confident (30%)	Not confident but motivated – 16%* Not confident and other thoughts – 14%

4.4.1.3. Contributing factors

Students were asked to choose from a given list the possible factors that could affect their performance in Statics. The factors shown in Table 5 can be grouped into the intrinsic and extrinsic factors. Interest, effort, ability, understanding of Statics concepts are the intrinsic factors. Meanwhile, the extrinsic factors include the influences from the coursework marks, teaching methods, lecturer's attitude, and friends. The statistical analysis shows that the students perceived the intrinsic factors to be more influential on their performance in Statics; and ranking effort as the most influential factor.

From the total respondents, 10% of them selected all four intrinsic factors; meanwhile, 4% selected all four extrinsic factors. This emphasizes the fact that students put themselves responsible for their own success, more than blaming others or other external factors for their weak performance. This finding seems to support the lecturers' perceptions that students' attitude, interest and effort in learning Statics are the factors for students' performance in Statics.

Table 5. Factors Influencing Students' Performance

No.	Influencing factors	Percentage (%)
1.	Effort	20
2.	Understanding	17
3.	Interest	14
4.	Ability	12
5.	Teaching method	12
6.	Lecturer's attitude	9
7.	Friends	8
8.	Coursework	7
9.	Other factors	1

4.4.2. Phase 2 Questionnaire

There were over 600 respondents, of which were 81% males and 19% females. 73% of these students were between 17 to 20 years of age, whilst the remaining 27% were above 21 years old. Results of the correlation and multiple regression analyses are shown in the following two sections.

4.4.2.1. Correlation analysis

Students' responses to the self-regulated learning questionnaire were analyzed using SPSS to investigate the correlations between the SRL subscales, performance and concept understanding. The relationships listed below are found to be highly significant but moderate between Statics score and the following SRL subscales:

- Learning beliefs and self-efficacy (r = .325, n = 495, p < .001)
- Meta-cognitive regulation (r = .307, n = 493, p < .001)

However, although they are highly significant, the relationships are found to be weak between the concept score and the same subscales:

- Learning beliefs and self-efficacy (r = .231, n = 598, p < .001)
- Meta-cognitive regulation (r = .224, n = 595, p < .001)

4.4.2.2. Multiple regression

The multiple regression analysis was used to predict the SRL contributors that affect students' performance and understanding. This section describes the associations between SRL variables and Statics score, followed by the associations between SRL variables and the concept score. The variables from the learning strategies and motivation variables (measuring SRL) were analyzed together using the SPSS method Enter (Standard), first with the Statics score (measuring performance), then with the Concept score (measuring concept understanding).

Table 6 shows a moderate correlation of all SRL variables with the Statics score (R = 0.46). This value implies that the SRL variables could explain about 21% of the variance in the Statics score. Table 7 shows the regression is highly significant F (9,483) = 14.084, p < 0.001. It implies that this model is a significant fit of the overall data.

Table 6. Multiple Correlation Variables: Statics Score

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.456 [a]	.208	.193	14.449

a. Predictors: (Constant), Help-seeking, Anxiety, Learning beliefs and self-efficacy, (Lack of) study effort, Organization and memorization, Study goals and value, Meta-cognitive regulation, Persistence and regulation, Critical thinking and elaboration.
b. Dependent Variable: % Statics score.

Table 7. Independent Variables Significance: Statics Score

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	26464.810	9	2940.534	14.084	.000[a]
	Residual	100841.520	483	208.782		
	Total	127306.329	492			

a. Predictors: (Constant), Help-seeking, Anxiety, Learning beliefs and self-efficacy, (Lack of) study effort, Organization and memorization, Study goals and value, Meta-cognitive regulation, Persistence and regulation, Critical thinking and elaboration.
b. Dependent Variable: % Statics score.

Table 8 shows that the study goals and value, and anxiety are negatively and significantly associated to the concept score. Meanwhile, learning beliefs and self-efficacy, persistence and regulation, and meta-cognitive

regulation made positive statistically significant contributions. The Beta values indicate that learning beliefs and self-efficacy factor makes the largest unique contribution (beta = 0.241, $p < 0.001$).

Table 8. Correlation Coefficient and Independent Variables Significance: Statics Score

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B		Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1 (Constant)	43.189	7.676		5.627	.000	28.107	58.271					
Study goals & Values	-.530	.253	-.109	-2.093	.037	-1.028	-.032	.061	-.095	-.085	.603	1.660
Anxiety	-1.151	.295	-.185	-3.899	.000	-1.731	-.571	-.224	-.175	-.158	.728	1.374
Learning beliefs &Self-efficacy	1.132	.280	.241	4.049	.000	.583	1.682	.325	.181	.164	.462	2.165
Critical Thinking & Elaboration	.036	.256	.008	.141	.888	-.467	.539	.214	.006	.006	.477	2.096
Organization & Memorization	-.327	.222	-.081	-1.470	.142	-.763	.110	.157	-.067	-.060	.536	1.865
Persistence & Regulation	.839	.325	.150	2.580	.010	.200	1.478	.269	.117	.104	.483	2.072
(Lack of) Study Effort	.378	.273	.066	1.386	.167	-.158	.913	.166	.063	.056	.730	1.369
Meta-Cognitive Regulation	1.165	.391	.167	2.976	.003	.396	1.934	.307	.134	.121	.521	1.918
Help Seeking	.272	.411	.029	.662	.508	-.535	1.080	.112	.030	.027	.869	1.151

a. Dependent Variable: % Statics score.

Tables 9 and 10 show the multiple correlations of all SRL factors with the concept score as moderate (R = 0.33). It also shows that the SRL variable could explain about 11% of the variance in the concept score, with the highly significant regression F (9,585) = 7.683, $p < 0.001$. This implies that the model is a significant fit of the overall data. Table 11 shows that learning beliefs and self-efficacy, meta-cognitive regulation, and the (lack of) study effort are positively and significantly associated to the concept score. Meanwhile, organization and memorization has negative significant association. The Beta values indicate that learning beliefs and self-efficacy makes the largest unique contribution (beta = 0.145, p < 0.05).

Table 9. Multiple Correlation Variables: Concept Score

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.325[a]	.106	.092	13.701

a. Predictors: (Constant), Help-seeking, Anxiety, Learning beliefs and self-efficacy, (Lack of) study effort, Organization and memorization, Study goals and value, Meta-cognitive regulation, Persistence and regulation, Critical thinking and elaboration.
b. Dependent Variable: %Total concept score.

Table 10. Independent Variables Significance: Concept Score

ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	12978.634	9	1442.070187.708	7.683	.000[a]
Residual	109809.069	585			
Total	122787.704	594			

a. Predictors: (Constant), Help-seeking, Anxiety, Learning beliefs and self-efficacy, (Lack of) study effort, Organization and memorization, Study goals and value, Meta-cognitive regulation, Persistence and regulation, Critical thinking and elaboration.
b. Dependent Variable: %Total concept score.

Table 11. Correlation Coefficient and Independent Variables Significance: Concept Score

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B		Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1 (Constant)	5.551	6.624		.838	.402	-7.58	18.560					
Study goals & Values	-.264	.219	-.061	-1.210	.227	-.694	.165	.069	-.050	-.047	.603	1.660
Anxiety	-.330	.255	-.059	-1.297	.195	-.830	.170	-.106	-.054	-.051	.728	1.374
Learning beliefs &Self-efficacy	.610	.241	.145	2.529	.012	.136	1.084	.231	.104	.099	.462	2.165
Critical Thinking & Elaboration	.378	.221	.097	1.712	.087	-.056	.812	.192	.071	.067	.477	2.096
Organization & Memorization	-.459	.192	-.128	-2.396	.017	-.836	-.083	.086	-.099	-.094	.536	1.865
Persistence & Regulation	.447	.281	.090	1.594	.112	-.104	.998	.199	.066	.062	.483	2.072
(Lack of) Study Effort	.503	.235	.098	2.139	.033	.041	.965	.130	.088	.084	.730	1.369
Meta-Cognitive Regulation	.814	.338	.131	2.410	.016	.151	1.477	.224	.099	.094	.521	1.918
Help Seeking	.238	.355	.028	.670	.503	-.459	.934	.090	.028	.026	.869	1.151

a. Dependent Variable: % Concept score.

5. Discussions

The discussions are divided into two sections; related to the findings from Phase 1 and Phase 2.

5.1. Phase 1

The students and lecturers believed that good performance in Statics examinations can be achieved if students put effort in solving the textbook exercises. The interview results are consistent with the students' feedback in the questionnaire. The feedback shows that students believed their effort, understanding, and interest are the influencing factors on their performance in Statics. Ability and the teaching method came fourth in the list, implying that students believed the intrinsic factors are more influential than the extrinsic factors. Based on the attribution theory of motivation (Dembo & Seli, 2008), how students perceive the cause for their success or failure determines how they will approach the particular task, and how long they will persist at it. Since the students attributed the causes of their learning outcome to their own effort, they can be expected to choose the correct learning strategies, such as seeking help from the lecturers, to overcome their problems. They would be more likely to try harder in future and persist on difficult tasks. These students appear to have the characteristics of a self-directed learner. However, it is worth noting that attribution does not always reflect reality.

The lecturers believed that, for the non-performing students, seeking help from other students or lecturers can help them to perform better in Statics. However, from their observations these students are hesitant to seek their assistance when encountered with problems. The lecturers also shared that students who were repeating Statics are usually faced with clash class schedule, which they believed to be the cause for these students to become passive and to lose interest in learning the course. It should be noted that students who attribute the causes for their difficulties to 'uncontrollable' factors, such as the teaching method and learning environment, are less likely to seek help or put additional effort to improve. It is also possible that the students do not seek help because they do not want to appear incompetent (Dembo and Seli, 2008). Therefore, if this is the case, some external intervention is necessary to guide this group of students to be self-regulated learners.

The majority of students who responded to the survey felt motivated and confident in learning and doing well in Statics. Even from among those who were not confident, most of them were motivated. However, the findings from observations on students' attitude in class and the lecturers' perceptions of students' behaviour seem to contradict with the students' responses from the questionnaire. There is a difference between perceived motivation and observed motivation. This difference may perhaps be a factor of the teaching and learning approaches or the study environment. In one of the observations in a two-hour class period, some class distractions were noted. There were students who came in late, took time to settle down, and some left earlier than scheduled. This kind of learning environment can be distracting to other students in the classroom. The distractions may affect negatively on students' actual motivation, which also depends on the time of the day it was held, or the period in the semester (Dembo & Seli, 2008). One possible reason for the discrepancy is perhaps related to the students' inability to remain persistent in their tasks.

It was observed that students paid attention to the lecturer when emphasis was made on the test topics, thus, indicating an influence of the performance goal. However, the frequency data of students' learning goals from the questionnaire showed that students' foremost goal was to gain understanding, instead of just wanting to pass. And as opposed to the general perception, repeating students too put priority in understanding the course material when they learned Statics. Following understanding, students' goal was to score good grades, and the least favourable was just to pass the course. This finding implied that students put mastery learning goal as priority, and this supports their feedback from the interviews. Learning goals are associated with the way students think and behave, and play a very important role in motivating students and predicting academic performance.

5.2. Phase 2

In Phase 1, the study shows that students have mastery learning goals. However, the statistical analyses in Phase 2 show that the study goals and value subscale do not have a significant effect on students' performance and understanding. This conflict may be due to students not using the appropriate learning strategies to learn Statics. It is possible these students are influenced by both internal and external regulations. Boekaerts (1999) suggested if students use internal regulation they would specify their own learning goals and choose own learning strategy. In contrast, if they depend on external regulation they would wait for others to direct their learning. Therefore, the students may need external intervention to help them achieve their mastery learning goals.

It is worth highlighting that the relationships between all other SRL subscales and performance are highly significant, although each vary in strength. However, this is not the case for the relationships between the SRL subscales and understanding. Results indicated that the learning strategy variables; organization and memorization, study effort and help-seeking do not have significant relationships with concept understanding.

Comparing the effects of SRL subscales on performance and understanding, the correlation strengths are greater for students aiming to perform well in the examinations. This differing effect of SRL subscales on concept understanding and performance could be explained by the different types of tasks involved in achieving them. To achieve better understanding of Statics concepts, students may require external intervention. Conversely, students have a better control in preparing themselves for the examinations. Students have a higher level of learning beliefs and self-efficacy in Statics performance perhaps because they are familiar with the examination format and have a better control in their learning strategies. Assessment questions are mostly calculation based, thus, can be mastered using drill and practice strategies. On the other hand, since concept understanding is more dependent on the teaching methods, students have less control in the learning strategies.

Learning beliefs and self-efficacy, and meta-cognitive regulation are the two most used strategies related to concept understanding and performance. They have moderate effect on students' performance, but have weak links with concept understanding. Learning beliefs and self-efficacy is the most significant predictor on understanding of Statics concepts and performance in Statics. This finding is consistent with studies by Wolters and Pintrich (1998) and Kosnin (2007), who found self-efficacy to predict performance. The researchers in self-regulated learning believe that students' perceptions of themselves as learners and their use of various processes to regulate their learning are critical in the academic achievement (Zimmerman, 1989). Self-efficacy represents students' beliefs of their performance capability in a particular domain; whilst, control of learning reflects students' perception on having internal control of their own learning and effort (Pintrich, 2004). Students who have learning beliefs and self-efficacy ("I always believe I will get an excellent grade in Statics class") would choose appropriate strategies in controlling their own learning and effort to materialize their beliefs. Results from the correlation analysis showed that such students would choose learning strategies like the critical thinking and elaboration, meta-cognitive regulation, persistence and regulation.

Anxiety is another motivation predictor, which was found to significantly affect Statics performance. Anxiety usually causes students to adopt performance avoidance strategies or to procrastinate, thus, causing them to have poor results in assessments. This finding is consistent with works reported by Wolters and Pintrich (1998). However, anxiety was not found to affect concept understanding probably because the students knew that the concept marks do not contribute to their final grade, but are purely for use in this study. Therefore, they were able to take the concept test in a more relaxed manner.

It should be noted that some anxiety can give positive effect, pushing students to do better in examinations. But generally anxiety that occurs before and during a test can interfere with students' concentration and performance. Negative association between anxiety and Statics performance reflects that students probably used more negative motivational strategies, like the self-handicapping strategies ("When I take tests I think of the consequences of failing"). Self-handicapping strategies usually resulted in decreasing effort in studying, and procrastination in learning or completing assignments (Pintrich, 2004). However, there are motivation strategies that students can use to control the negative effects of anxiety. Pintrich (2004) quoted anxiety researchers regarding two strategies, self-talk ("don't worry about grades now") and defensive pessimism. Meanwhile, Wolters (1998) suggested that by invoking negative affects (such as shame or guilt) students may be able to motivate themselves to persist at a task.

6. Conclusions

This study reveals that motivation affects students' concept understanding and performance in Statics through their learning beliefs and self-efficacy. The learning beliefs and self-efficacy subscale has positive significant effect on both performance and understanding. However, its effect is greater on their performance than understanding, implying that the students had a better control of their learning strategies in preparing for the assessment rather than in learning to understand the concepts in Statics.

It was also identified that anxiety is another motivation predictor of performance. However, the significant effect is as expected to be negative, indicating that students perform poorly when they are anxious. It was also as predicted that anxiety has no significant relationship with the concept understanding because the students knew that the concept test was conducted purely for this study and the marks will not be counted for their final Statics score. However, the researcher's observation on students' commitment to complete the concept test supports the findings from the questionnaire in Phase 1 that students were motivated to learn Statics, irrespective of the number of times they took Statics and their confidence to perform well.

On the other hand, class observations seems to support the lecturers' perception that the students have poor motivation and did not use appropriate learning strategies in learning Statics. The conflict between the observed and the perceived motivations has lead to a recommendation for further research on the influence of the teaching and learning approaches towards students' motivation. This recommendation is supported by the students' feedback from the interviews that they would be more motivated to learn Statics if they have a better understanding of the course and a more personalized teaching approach.

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