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Assessment of research efficacy for final year undergraduates based on their teaching and learning experience

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ABSTRACT: Undergraduate students are exposed to basic research processes from their first day of lectures. This is followed by other rigorous teaching and learning tasks, such as field work, laboratory sessions, tutorials, group discussions, problem-based assignments and, eventually, a final year project to complete their undergraduate curriculum. However, the university does not have any knowledge of the research skills possessed by the undergraduates from the teaching and learning processes they have undertaken. The focus of this article is on evaluating the level of research efficacy among the undergraduate students based on their teaching and learning experience in a research university environment. This research outcome could dictate the quality of graduates the university produces in terms of research skills based on their teaching and learning experience. Two of the most significant findings from the study suggest the needs for improvement in technical writing skills and the trends towards becoming digital natives.

Keywords: Engineering, research efficacy, science technology, teaching and learning, undergraduate

INTRODUCTION

Universiti Kebangsaan Malaysia (UKM) has been designated as one of the leading research universities in the country. The University, therefore, needs to produce undergraduates that possess a high level of research skill. Hence, to determine the extent of research skills possessed by the undergraduates, the University needs to evaluate whether the students have acquired the basic research skills and efficacy as devised and inspired by it.

Bailey stated that any activity that can increase knowledge could be considered to be research [1]. Research activity is a core activity in universities. It is a systematic investigation of phenomena, problems, issues and questions that will help students to increase their knowledge and understand more about the research that they carry out. Having research skills greatly assists students to critically investigate issues, create and test ideas, theories and hypothesis, and to generate and analyse the resulting data. Research and the subsequent creation, validation and dissemination of knowledge, are fundamental to the operation of a research university, and the material of a research project could come from scholarly journals, conference papers and other sources [2].

A study in 2004 reported that students spend more time doing research on the Web, which means spending less time or no time at all in a library [3]. Consequently, they rarely worked with journals and were unable to differentiate between journal articles and those published on the Web [3].

Talafhah opined that although students have been trained to do research, their research confidence and self-efficacy are major components that will determine whether their research will be a success or a failure [4]. The concept of research self-efficacy is the degree to which a student believes in their ability to perform various research steps, such as hypothesis formulating, collecting data and performing an analysis successfully. To improve the understanding of researchers' psychological and mental characteristics, self-efficacy is an important additional dimension for this reason [5]. Self-efficacy is the term used to describe one's ability and competence to perform the task given to them successfully [4].

Individuals who possess a high level of self-efficacy are more likely to be consistent in their behaviour long enough to allow them to receive positive consequences and further boost their self-efficacy [6]. Although students have been

trained to undertake research from their first day of lectures, confidence and self-efficacy in handling research skills are major factors in determining the students' success or failure.

In order to gain a high level of research efficacy, the students need to possess a high level of research skill. According to Wilson et al, research universities should take full advantage of their skills and expertise, and provide all undergraduate students with research experience that will help them to conduct an effective way of doing research [7].

The students' research skills, experience and knowledge that they have obtained through their teaching and learning experiences at the university will determine whether the research university has produced research competent undergraduates as inspired by the university. The experience and knowledge that the students have gained whist undertaking university research projects are very beneficial, resulting in students that have had better preparation as independent learners with the capacity to utilise their knowledge and skills for their future benefits [7].

This descriptive study was conducted to identify the level of research efficacy among a group of undergraduate students based on their teaching and learning experience in a research university environment. In this study, investigation is also based on whether the students' demographic factors have any impact on their self-efficacy [6]. The focus of this article is evaluating the level of undergraduate students' research efficacy based on their teaching and learning experience in a research university environment.

PROBLEM BACKGROUND

Assessments of research skills are normally considered relevant to academic staff and postgraduate students. There is usually no such assessment by universities to determine the quality of research skills that undergraduates possess upon completion of their studies. The knowledge is important for assessing the extent to which the students applied their research skills in a teaching and learning environment.

Hence, study of research efficacy based on teaching and learning experience at the university, which encompasses engineering and science undergraduates, has been conducted to illustrate the ability of UKM as a research university to produce undergraduates that possess a high level of research skills based on teaching and learning experience. This study also sought to determine whether the lecturers were successful in applying research skills in teaching and learning environment.

METHODOLOGY

A survey questionnaire was constructed, validated and distributed to final year undergraduate students. The respondents involved engineering undergraduates, which represented the Department of Electrical, Electronic and Systems Engineering from the Faculty of Engineering and Built Environment (FEBE), and science undergraduates from the Nuclear Science Programme and Material Science Programme of Faculty of Science and Technology (FST). Students from these faculties were chosen because both faculties share similar basic research skills. Apart from that, hard science students are required to use a lot of research instrumentation, and to develop similar fundamental research methodology skills. Eighty-five final year undergraduates responded.

A questionnaire consisting of 14 related aspects was developed to assess students' research efficacy related to their teaching and learning experience in a research university. Respondents were asked to indicate their level of confidence in performing each task successfully. The level of confidence was measured according to a five-point Likert scale (from *strongly agree* to *strongly disagree*). Prior to the data collection, a pilot study was conducted on a small group of FEBE and FST respondents to verify the reliability of the research instrument. The Cronbach's alpha value was found to be 0.843. The data analysis was undertaken by calculating mean confidence intervals using the SPSS software package.

RESULTS AND DISCUSSION

The 85 respondents expressed their level of efficacy through questionnaire responses. The respondents' demographic data included gender, path to UKM, race, latest CGPA (Cumulative Grade Point Average), parents' highest education level, and the residential area each student grew up in. Demographic factor means were compared by using student's *t*-test and one-way variance analysis at the 0.05 significance level. The analysis was performed to determine whether there were any significant differences in mean values for the demographic characteristics. An independent *t*-test analysis was performed on the gender and residential area factors, because these factors have only two samples to be compared. Other factors that have more than two samples to be compared were performed using one-way variance analysis.

Independent *t*-test analysis of gender and residential area factor was performed. The hypotheses for both factors were as follows:

- Ho1: No difference in mean values between males and females.
- Ho2: No difference in mean values between urban and rural area.

As shown in Table 1, that p-value for both factors was more than 0.05. Hence, it failed to reject both the hypotheses. Therefore, it can be concluded that mean values for male and female are similar, as well as the mean values for urban and rural area. These findings indicate that students are having similar responses, regardless of their gender and residential area.

Table 1: Mean values for the category of gender and residential area.

Demographic Factor	Number of Respondents	Mean Values	Standard Deviation	p-value
Gender:				0.15
Male	44	3.51	0.57	
Female	41	3.66	0.40	
Area:				0.68
Urban	48	3.60	0.56	
Rural	37	3.56	0.41	

*significant *p*-value < 0.05

One-way variance analysis was performed for other factors, which were the path to UKM, race, CGPA and parent's highest education level. The hypotheses for all factors were as follows:

- Ho1: No difference in mean values for path to UKM factor.
- Ho2: No difference in mean values for race factor.
- Ho3: No difference in mean values for CGPA factor.
- Ho4: No difference in mean values for parent's highest education level factor.

Table 2: One-way ANOVA test for the category of path to UKM, race, CGPA and highest education level of parents.

Demographic Factor	Number of Respondents	Mean Values	Standard Deviation	p-value
Path to UKM:				0.66
Matriculation	62	3.55	0.49	
STPM	21	3.65	0.52	
Diploma	1	3.86		
Others	1	4.00		
Race:				0.34
Bumiputera	1	2.86		
Malay	49	3.60	0.52	
Chinese	35	3.58	0.46	
CGPA:				0.77
2.00 - 2.49	5	3.49	0.62	
2.50 - 2.99	37	3.53	0.42	
3.00 - 3.49	33	3.64	0.60	
3.50 - 3.66	5	3.51	0.37	
3.67 - 4.00	5	3.77	0.25	
Highest Education Level of Parents:				0.09
Primary and below	10	3.47	0.43	
SRP/PMR	11	3.92	0.42	
SPM	31	3.63	0.57	
STPM/Diploma	15	3.41	0.42	
Degree and above	18	3.50	0.43	

*significant *p*-value < 0.05

Table 2 shows that the p-value for all factors was more than 0.05. Hence, it failed to reject all hypothesis stated before. Therefore, it can be concluded that there was no significant difference between mean values for the following factors: 1) path to UKM; 2) race; 3) CGPA; and 4) highest education level of parents. These findings indicate that the students have similar responses, regardless of their path to UKM, race, CGPA or their parent's education level.

Descriptive analysis was performed to compare the mean score between students from FEBE and FST. The analysis was performed to determine whether there were any significant differences in mean values for students from FEBE and FST. Table 3 shows that the mean score and standard deviation for students from FEBE and FST are the same. Therefore, one can conclude that both FEBE and FST students have the same level of efficacy.

Table 3: One-way ANOVA test for the category of path to UKM, race, CGPA and highest education level of parents.

Mean Value Average Score		Standard Deviation Average Score	
FKAB	*FST*	*FKAB*	*FST*
3.55	3.55	0.72	0.72

Responses for all items were sorted into two groups: problematic response and non-problematic response. A problematic response was indicated, if the students' responses were biased towards *disagree* (Likert scale close to 3) and a non-problematic response, if the students' responses were biased towards *agree* (Likert scale close to 4). Frequencies of responses expressed as problematic and non-problematic were analysed. The mean score of 3 was determined as a cut-off score criterion to classify items into problematic or non-problematic items. If the items' mean scores were biased towards 3, then, that item was considered to be problematic and, if the items' mean score were biased towards 4, then, that item was considered non-problematic. The most problematic items are as presented in Table 4.

Table 4: Mean score and standard deviation for most problematic items.

Item		Mean Score (3.58)	Standard Deviation
3	*I can motivate myself when the assigned reading is boring.*	3.44	0.919
5	*I can motivate myself to complete writing a thesis chapter when I am tired.*	3.42	0.993
7	*I can refocus to finish writing a thesis chapter on time when I lose my concentration.*	3.47	0.933
14	*I prefer a formal education environment (lectures, tutorials, laboratory).*	3.40	0.990

Table 4 shows the items that have been considered as problematic responses. All the items show mean values that were much lower than the cut-off mean score. These findings indicate that the respondents showed a low level of motivation to continue writing their thesis when they felt tired, bored or had lost their concentration. Therefore, it can be concluded that these respondents possess a low level of self-efficacy. This is because self-efficacy is a major factor in increasing or decreasing the level of motivation [5].

These findings revealed that most of the respondents gave least preference towards conventional (lecture, tutorial, laboratory) teaching and learning environments (mean score: 3.40). Most of the students least preferring a conventional education environment felt that formal education did not give them sufficient research skills that could assist them in carrying out their final year project. Apart from that, the way that some lecturers conduct a lecture by reading through slides rather than by explaining them in an understandable language style sometimes seems unattractive to the students.

Table 5 shows the items that have been considered as non-problematic responses. From the findings, it is revealed that most of the respondents demonstrated a high level of confidence in revising their technical written draft clarity (mean score: 3.93). This is due to the students' lack of confidence in their technical writing skills and, thus, they need to revise their thesis draft so that it will be clearer to the reader. This may suggest that even in a research university, training in technical writing should be improved, while the latter finding suggests that the respondents trend towards the digital native generation.

Table 5: Mean score and standard deviation for non-problematic items.

Item		Mean Score (3.58)	Standard Deviation
2	*I can understand a particular paragraph by visualising the meaning of it.*	3.67	0.746
9	*I will revise my thesis draft so that it will be clear to the reader.*	3.93	0.651
10	*I can find a way to write well organised thesis chapter.*	3.62	0.756
13	*I can motivate myself for continuous learning process.*	3.79	0.818

CONCLUSIONS

Based on the survey data, it was found that the final year undergraduate students of the Faculty of Engineering and Built Environment (FEBE) and the Faculty of Science and Technology (FST) exhibit highest confidence level in revising their technical written draft clarity, while giving least preference towards conventional teaching and learning environments. This may suggest that even in a research university, training in technical writing should be improved.

In order to enhance students' research efficacy based on teaching and learning experience, Webb et al suggest strategies for successfully linking teaching and research [2]. Such strategies would provide a guide for incorporating research skills development into courses and programmes to help student to enhance their research skills. One of the strategies is to incorporate current research directly into the curriculum as the focus of an entire course.

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BIOGRAPHIES

Rosdiadee Nordin received his Bachelor of Engineering (BEng) degree from Universiti Kebangsaan Malaysia in 2001 and his PhD from the University of Bristol, in the United Kingdom in 2011. He is currently a senior lecturer in the Department of Electrical, Electronic and Systems Engineering at Universiti Kebangsaan Malaysia. His main research interest focus on the wireless physical layer, such as Multiple-Input Multiple-Output (MIMO), Orthogonal Frequency-Division Multiple Access (OFDMA), resource allocation, green radio, intercell interference and indoor wireless localisation. He has also developed an interest towards action research related to engineering education.

Faizal Mohamed obtained his Bachelor's degree in the field of applied physics, majoring in nuclear science in 2001 from the National University of Malaysia. He spent four years at Exeter University, UK, for his PhD, focused mainly on work revolving around radiation biophysical research. His early scientific publishing on research efficacy among science and technology undergraduates has accelerated his interest in further understanding the importance of action research, focusing on evaluation of research skill and efficacy.