

Correlation Study of Student Achievement at Pre-University Level and Their Corresponding Achievement in the Year-One Undergraduate Course of Circuit Theory at UKM

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ABSTRACT

Circuit Theory 1 (KKKL1114) and Circuit Theory 2 (KKKL1124) are two core courses undertaken by students of the Electrical and Electronics Engineering undergraduate study programme. The courses KKKL1114 and KKKL1124 are offered in the first and second semesters for all students in Year One for the undergraduate degree programme in the Department of Electrical, Electronics and Systems Engineering (JKEES), Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia (UKM, 2013). The moderate achievement of students on these courses in the previous semesters triggered the authors, who taught the courses, to examine the factors that influence student performance. Early intervention measures can be taken to help these students to succeed in their studies. Continuing from a previous study, which analysed the students' academic background, this study was carried out to analyse the students' performance in a pre-test conducted at the beginning of the semester and correlated with their performance in the final examination in Circuit Theory 1 and Circuit Theory 2. The study population was students of the intake session 2012-2013 (Group One). Comparisons with the students' achievement for

students of intake session 2013-2014 (Group Two) were also carried out. Furthermore, an analysis on ranking effect on the students based on their final marks for KKKL1114 on Group Two students was done by subdividing them into three subgroups of tutorial sessions. The groups were the low performance group, intermediate performance group

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and high performance group. The analysis of the results of the Cumulative Grade Point Average (CGPA) indicate that the achievement of both groups of these pre-university students is comparable, indicating no significant difference in their pre-university CGPA. However, comparing student performance within the same group shows different performance for KKKL1114 and KKKL1124 as shown by the final marks for the two groups. For all students, only significant correlation between final examination marks for KKKL1114 and the pre-test is observed ($R^2 = 0.47$). For overall student performance, there was no significant correlation between their pre-university CGPA and their achievement for both KKKL1114 and KKKL1124. Student ranking into three tutorial subgroups based on the students' CGPA during pre-university showed a significant finding ($p < 0.05$) of consistent results in their final marks for KL1114. This shows that the students' final marks for KKKL1114 were linked and reflected to their pre-university CGPA. Ranking the students in this way can ease teaching and learning and allow for necessary interventions especially in the case of weak students to improve their study performance.

Keywords: Circuit theory achievement, pre-test, pre-university CGPA, tutorial session

INTRODUCTION

The Circuit Theory 1 (KKKL1114) and Circuit Theory 2 (KKKL1124) courses are first-year compulsory courses in the undergraduate engineering programme offered by the Department of Electrical, Electronics &

Systems Engineering (JKEES) of the Faculty of Engineering & Built Environment, at Universiti Kebangsaan Malaysia (UKM). These courses are also implemented to meet the requirements of programme accreditation by the Engineering Accreditation Council Malaysia (EAC), as stipulated in the 2012 EAC Accreditation Manual. These foundational courses are aimed at equipping the students with the ability to analyse and design electrical circuits. Course content includes fundamental laws; Thevenin and Norton analysis; RLC and magnetic circuits; passive filters and frequency response; AC power analysis; 3-phase power systems; 2-port networks; as well as Laplace and Fourier transforms. In addition, students are also introduced to the electronic design software PSpice via assignments and projects (JKEES, 2014a & 2014b). To ensure standardisation, the implementation of both courses is benchmarked against equivalent courses offered at the University of Malaya, Malaysia and Chulalongkorn University, Thailand (Department of EESE, 2013).

Despite meeting relatively competitive entry requirements into the programme, student achievement in both of these first-year courses, as measured in their final grades, are less than sterling. This triggered the authors to undertake a study to determine possible root causes. Of particular interest pertaining to the study was to quantitatively determine if there was a statistically significant relationship between the students' pre-university academic achievements (matriculation, HSC, A-level, college diploma) and their final grades in the KKKL1114 and KKKL1124 courses. Bais

et al. (2013) recommended that if a strong correlation existed, certain early intervention measures could be put into place to identify potentially problematic students and provide them with focussed and supplementary tutoring.

However, the investigation into such relationship is not straight-forward because there are multiple entry routes, each having different entry requirements into the electrical engineering programmes at UKM. While the majority of the students enrol straight out of matriculation programmes run by the Ministry of Education, a small number of students are also enrolled via the relatively more extensive Malaysian Higher School Certificate (HSC), A-levels and diploma programmes, each with its own, different syllabus and assessment methods. Using a systematic approach of population sampling, competency assessments under a controlled environment and statistical data analysis, this study sought to determine the statistical correlation between students' achievement at pre-university level and their corresponding achievement in the Circuit Theory courses at UKM.

METHODOLOGY

In this section, subject population, data gathering method and statistical data analysis procedure are explained and elaborated on.

Subject Population

The study evaluated the data for the student intake session of 2012-2013 (Group One) and the intake session of 2013-2014 (Group Two). For the intake session of 2012-2013,

the total student admission was 50 while for the intake session of 2013-2014, the total student admission increased to 103. However, only 48 students participated in answering the pre-test for the 2012-2013 session and 90 students for the 2013-2014 session.

Data Gathering Method

For intake session 2012-2013 (Group One), the students' pre-university CGPA scores were collected and used to serve as the students' academic background. Students' pre-university CGPA scores were extracted from the data for all the students in the Undergraduate Affairs Unit, FKAB. Apart from the students' pre-university CGPA, data were also collected from the students' pre-test achievement results. Questions in the pre-test were designed to evaluate students' knowledge in the field of science and mathematics, in general and the principle of physics and electricity, in particular. More information about the pre-test can be referred to in Bais et al. (2013). For this intake, the pre-test was conducted during the first week of the academic session without prior notice to the students. Therefore, students needed to answer the pre-test questions based on what they could recall from what they had learnt during their pre-university. Apart from the students' pre-university CGPA and pre-test scores, data were also collected from the final examination marks from Circuit Theory 1 (KKKL1114) taken in Semester 1 and Circuit Theory 2 (KKKL1124) taken in Semester 2 of the academic session. As for tutorials, these students were grouped at random.

For intake session of 2013-2014 (Group Two), data collected were from the same four parameters as for the intake session of 2012-2013 (Group One). The same pre-test questions were given. However, a pre-test was conducted in the second week of the academic session and students were informed in advance about the pre-test. This was to enable the students to make necessary preparations before taking the pre-test. This was to see whether the preparations done by the students prior to the pre-test would be able to help them to answer questions in the pre-test. Students for this intake were also grouped for their tutorial classes based on their CGPA during pre-university to investigate whether the strategy could help them improve their study performance.

Statistical Data Analysis

Data analysis was performed using SPSS Statistical Package for the Social Sciences (SPSS) to get the average and standard deviation, and a *t*-test was performed to test significant differences ($p < 0.05$) between the two groups. In addition, R^2 correlation tests were conducted to obtain the correlation between the two parameters studied. Connections between the students'

achievement in the pre-university and the students' achievement in year one in JKEES were seen through the strength of the correlation, while the differences or similarities were seen from the results of the *t*-test. Comparisons were made between Group One of the 2012-2013 intake session and Group Two of the 2013-2014 intake session, in the same group and also among all the students.

RESULTS AND DISCUSSION

The study included students who took only science subjects, including physics in their secondary school final exam known as the Malaysian Certificate of Examination (SPM), which is equivalent to the O-level examination. The examination is considered the marker for their pre-university achievement. By including students who had taken physics, the study took into account that the analysis was done only on students of similar background who already had basic knowledge of electricity, which was introduced in physics class at pre-university level. Statistics of the study groups and *t*-test results of both student groups are shown in Table 1.

Table 1
Statistics and t-test Results for Group One and Group Two Represented as Mean (M) ± Standard Deviation (SD)

	CGPA pre-university M ± SD	Pre-test marks M ± SD (%)	Final marks KKKL1114 M ± SD (%)	Final marks KKKL1124 M ± SD (%)	<i>t</i> -test KKKL1114 vs KKKL1124
Group 1 (N=48)	3.57 ± 0.55	17.1 ± 5.3	34.7 ± 18.8	52.4 ± 18.6	$p < 0.01$
Group 2 (N=90)	3.58 ± 0.28	46.6 ± 14.6	60.7 ± 13.5	59.2 ± 11.1	$p = 0.89^*$
<i>t</i> -test Group 1 vs Group 2	$p = 0.96^*$	$p < 0.01$	$p < 0.01$	$p = 0.03$	

Analysis between Groups

The statistical results show that student background as seen through the achievement of the pre-university CGPA scores of Group One and Group Two showed no difference ($p > 0.05$) between the two groups (Figure 1a). Comparing the scores on the pre-test prior to taking the course KKKL1114 for both groups of students showed that the pre-test scores for Group One were significantly lower compared to that of Group Two, which was 17.1 ± 5.3 versus 46.6 ± 14.6 (Figure 1b). Obviously, the pre-test scores for students of Group Two were higher than the pre-test

scores for Group One students. This finding is most likely due to prior notice having been given that there would be a test; this obviously triggered the students of Group Two to do the necessary revision before taking the pre-test. Group One students, on the other hand, had not been notified of the coming pre-test; consequently, they were unprepared and obtained poor scores on the pre-test. The final marks for both KKKL1114 and KKKL1124 are also significantly lower for both Group One (34.7 ± 18.8) versus Group Two (60.7 ± 13.5) (Figure 1c) and Group One (52.4 ± 18.6) versus Group Two (59.2 ± 11.1) (Figure 1d).

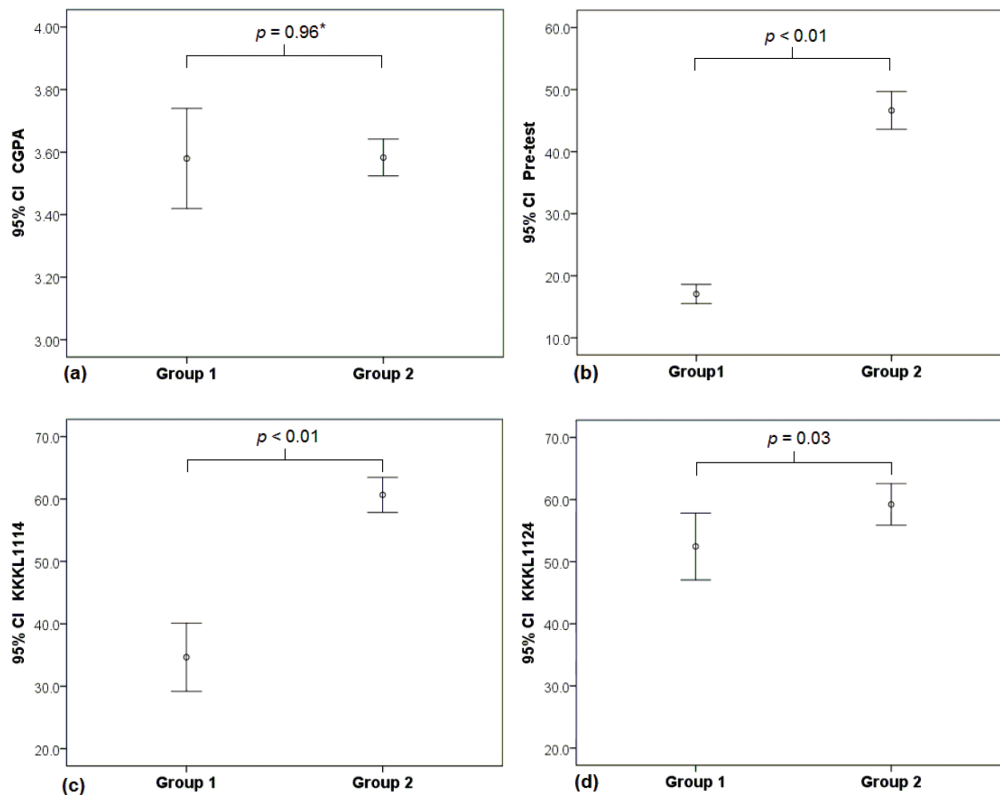


Figure 1. Comparison between group one and group two for (a) CGPA of pre-university, (b) pre-test, (c) final marks for KKKL1114 and (d) final marks for KKKL1124.

Analysis within Groups

The results of the analysis within the same group are shown in Figure 2. Obviously, the final marks for KKKL1124 were significantly higher than the final marks for KKKL1114 for Group One (52.4 ± 18.6 versus 34.7 ± 18.8). However, the final marks for KKKL1124 and KKKL1114 for Group Two were not significantly different (59.2 ± 11.1 versus 60.7 ± 13.5).

The analysis of the final marks for KKKL1114 for Group Two, who were segregated into three groups of tutorial classes based on the students'

pre-university CGPA, namely, high performance, intermediate performance and low performance is shown in Table 2. All three categories of tutorial groups achieved significantly different final marks for KKKL1114 (as shown in Figure 3). Nevertheless, the students of Group One were divided into tutorial class groups randomly and not based on their pre-university CGPA. Thus, similar analysis of tutorial groups based on their pre-university CGPA against their finals marks for KKKL1114 could not be done.

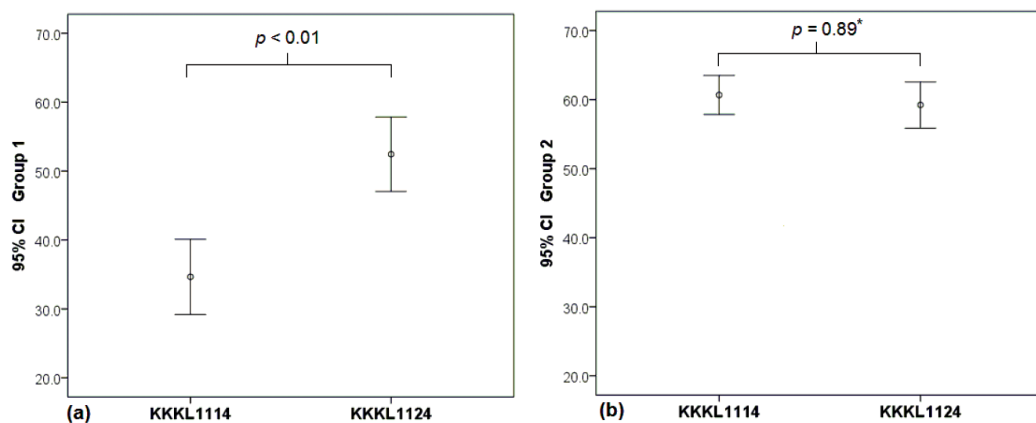


Figure 2. Final marks for KKKL1114 and KKKL1124 for (a) Group One and (b) Group Two.

Table 2

Analysis of CGPA Pre-University and Final Marks for KKKL1114 in Group Two (2013-2014) Between Three Tutorial Groups Using ANOVA. Data Represent Mean ± Standard Deviation

Total N = 90	CGPA pre-university M ± SD	Final marks KKKL1114 M ± SD
High performance group (n = 13)	3.91 ± 0.13	69.7 ± 9.9
Intermediate performance group (n = 67)	3.57 ± 0.22	59.7 ± 13.8

TABLE 2 (continue)

Total N = 90	CGPA pre-university M \pm SD	Final marks KKKL1114 M \pm SD
Low performance group (n = 10)	3.13 \pm 0.09	55.4 \pm 8.3
ANOVA	p < 0.01	p = 0.02

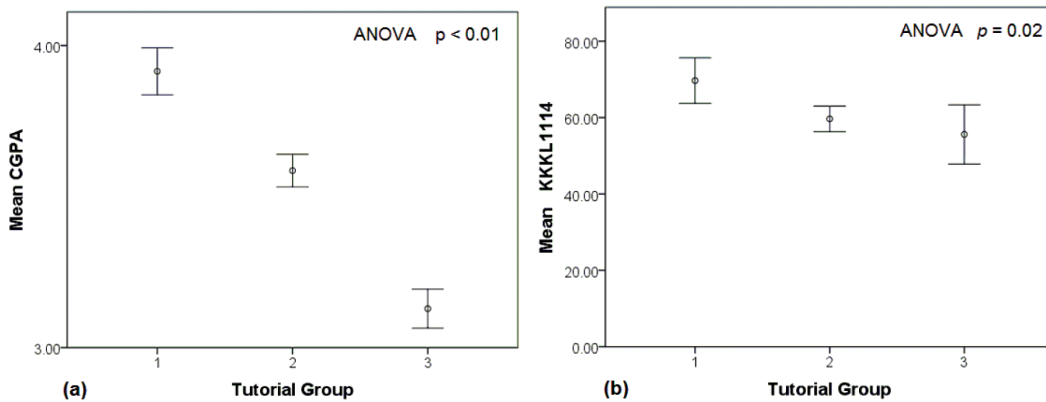


Figure 3. Students' tutorial group (a) CGPA scores in pre-university and (b) final marks for KKKL1114 for Group Two, where Group 1 = high performance, Group 2 = intermediate performance and Group 3 = low performance.

Analysis on Total Study Population

The results of analysis to find the correlation between two parameters for the whole group of students regardless of which group they belonged to, Group One or Group Two, with a simple Pearson correlation test for R^2 are shown in Figure 4. The results show that only a moderate association is observed between the final marks of KKKL1114 and the pre-test score with a correlation $R^2 = 0.47$ (Figure 4a), whereas a very weak correlation can be seen between the final

marks of KKKL1124 and the pre-test scores (Figure 4b), the final marks of KKKL1114 and the CGPA scores (Figure 4c) and the final marks for KKKL1124 and the CGPA scores (Figure 4d). The pre-test scores and the CGPA scores of students in pre-university does not reflect the level of their basic understanding in KKKL1124. Therefore, the pre-test scores and pre-university CGPA scores do not serve as predictors for the students' achievement in KKKL1124 but could be a predictor for KKKL1114.

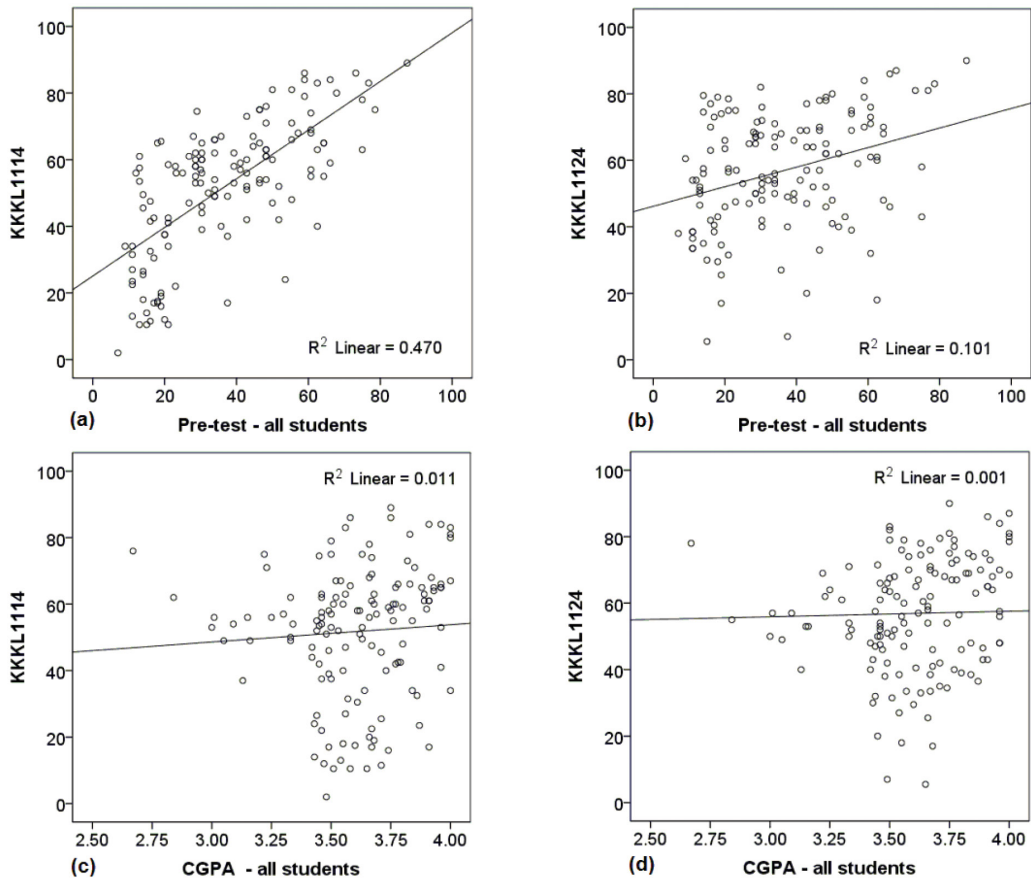


Figure 4. The correlation between two parameters among all students (a) KL1114 and the pre-test, (b) KKKL1124 and the pre-test, (c) KKKL1124 and CGPA and (d) KKKL1124 and CGPA.

Finding the correlation between student achievement in pre-university and their achievement in Circuit Theory courses taken in their first year at university is indeed only the first step in finding the root cause of the problem. The findings of this study are important for us to help students improve their academic performance especially that of weak students as early intervention can be better planned for them in the future. Early intervention measures can be taken

to help these students to succeed in their studies during the remaining years at university. Overall, we discovered that there was almost no correlation between pre-university CGPA and Circuit Theory courses, as shown in Figure 4. However, grouping the students based on their pre-university CGPA scores for Circuit Theory I (KKKL1114) produced significantly segregated final marks for Circuit Theory I (KKKL1114) that were connected to their pre-university CGPA scores. In other

words, the students' pre-university CGPA scores were coherent with their final marks for Circuit Theory I (KKKL1114). Theoretically, tutorial sessions can be conducted to help students learn and pick up knowledge that they could not grasp during lectures. This theory has been proven true in a study conducted by Sharma et al. (2005), where tutorial sessions conducted for students highly encouraged them to solve physics problems and structured worksheets with exercises based on first-year university level questions. The results proved that the students who attended the tutorial sessions regularly were able to improve their examination marks noticeably. Another study discovered that an important factor such as active learning, which was not investigated in our study, also played a crucial role in improving students' academic performance (Freeman et al., 2014). In the future, we will investigate specific aspects of teaching approaches to access the factors that influence student performance in Circuit Theory courses.

CONCLUSION

The findings of this study showed that student achievement in the subjects KKKL1114 and KKKL1124 had no significant correlation with their pre-university CGPA scores, which suggested that students with good grades in pre-university would not necessarily do well in the subjects KKKL1114 and KKKL1124 and vice versa. Furthermore, the students' pre-university CGPA scores were obtained from the total score of various subjects

undertaken during pre-university. Thus, in future work it would be more relevant to use the marks from subjects such as mathematics and physics, which are more directly related to the courses KKKL1114 and KKKL1124. In addition, it was also found that the formation of tutorial groupings based on pre-university CGPA scores contributed to the significant improvement in student performance in their final marks, as observed in Group Two of 2013-2014. This is because teaching and learning can be conducted during tutorial sessions to cater for each student's capabilities.

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