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# Assessment schemes in engineering courses using spectral techniques*

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*This paper studies assessment schemes with regard to attitudes and understanding in engineering undergraduate and postgraduate courses at Griffith University, Australia. A survey was conducted consisting of eight typical assessment schemes: seminar, open-book mid-semester test, closed-book mid-semester test, problem-based assignment, presentation, multiple-choice question, closed-book final examination and open-book final examination. F-test, Relative Important Indices (RII), and rankings of each scheme are estimated. An additional insight into the student responses is given by using a novel spectral technique of computing the power spectrum of the data. Detailed comparisons are made. Recommendations are given. Further work is also outlined.*

**Keywords:** relative important index; F-test; toward attitude assessment; toward understanding assessment; power spectrum

## INTRODUCTION

UNDERSTANDING THE DIFFERENCES in students' motivation, attitudes toward learning, and responses to different classroom environments and instructional practices helps lecturers to meet student needs [1]. The teaching assessment should also clearly define the purpose of evaluating the teaching effectiveness and, from that, further improvements can be achieved [2]. In addition, this should be done in the context of published goals, measurable performance criteria, and agreed forms of evidence. The evidence should come from a variety of sources, including learning-outcome assessments, student end-of-course ratings, student surveys, focus groups or interviews, retrospective student evaluations of courses and instructors, alumni and peer evaluations, and self-assessments. While it is impossible to customise classes to match each student's needs, it is possible to provide a balanced teaching approach that will meet the needs of the majority of students and therefore improve the students' experience in the classroom [3].

One of the students' main concerns is how to pass a course and still enjoy their time in the classroom. For example, for a particular course such as Physics, most students consider a grade of Credit to be enough for their own personal satisfaction. However, a small number of students in the class may aim for High Distinction. As such, assessment schemes, which tell students how to score marks contributing towards the final grade, play a key role. Further, achieving a high grade for a course, which means that students theoretically understand the subjects and concepts taught in the course, does not always mean that the students are satisfied with the course. Students usually consider further explorations using the knowledge that they have learnt in the course to apply to real-world problems such as how to use their knowledge to find a job, design a small circuit, or build a bridge. Thus, on the one hand, assessment schemes need to be carefully designed and experimented with to meet the students' needs and, on the other hand, the schemes need to ensure that the students are able contribute to their profession upon graduating [4]. This can be considered the single most important aspect of the assessment. From the lecturer's perspective, it should also be noted that assessment schemes are designed and arranged so that the marking and feedback-giving processes are not too time-consuming. This ensures that the teaching process is productive and, by meeting these criteria, the teaching process can be considered effective and satisfactory [5].

The most effective way of measuring the effectiveness of assessment schemes is to conduct surveys where students have a chance to voice their opinions [6–9]. From these, possible improvements can be made. The objectives of this paper are as follows:

- to conduct surveys on the attitudes and understanding of students towards different assessment schemes;

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- to show and analyse the results of the survey using F-tests, RII values and spectral techniques; and
- to give recommendations on improving the assessment schemes.

## CORRELATION BETWEEN ASSESSMENT SCHEMES AND STUDENT ATTITUDES

In this paper, the correlation between effective assessment schemes and student attitudes is described by evaluating the scores that students give to each scheme in the survey. The scores can then be used to adjust the schemes appropriately and hence improve them. It should also be stressed that this correlation is the most important information that can be used to further improve assessment schemes, even for well-established schemes, because quantitative analyses using the F-test or spectral methods can be performed. Together with qualitative analyses on the student feedback, actions can be taken to strengthen weak assessment schemes, i.e. to make them more relevant to students and so motivate their learning, and to maintain the high standard of the stronger schemes. At Griffith University the correlation between assessment schemes and student attitudes has been considered to be an integral part in improving teaching and student learning since 2005. Surveys are regularly conducted, sometimes twice per semester for some courses, to ensure that the teaching quality and student satisfaction are met. Additional training courses for lecturers and teaching staff are offered to help achieve this ambitious goal. This paper has been written with the aims of improving teaching quality and, more importantly, improving student learning via the survey that has been recently promoted at Griffith University.

## RESEARCH METHODOLOGY

To examine the attitude and understanding about different assessment schemes, a survey was conducted. The questionnaire was sent to 200 undergraduate engineering students and 83 postgraduate engineering students, of which 69 and 37 responses were received from undergraduate and postgraduate students respectively, with the overall response rate of about 37%. The programmes that the responding students were undertaking are shown in Table 1.

About 33% and 50% of the responding students are in the first and third year respectively of their programmes, and 9 from the second year and 9 from the fourth year. About 85% of the responding students, corresponding to about 90 students are male and 16 are female. All the responding students are in the age range 19–40. About 17%, 10% and 13% of the responding students are in the age groups 19, 20 and 21 respectively. About 58% of the total number of students in most Australian universities, including Griffith University, is local students. From the responding students, 61 were local, 5 from Africa, 14 from Asia, 22 from The Middle East and 4 from other countries.

The students were asked to rank different assessment schemes as regards to their attitude and understanding in helping them to fulfil their study needs and aiding the learning process. Each assessment scheme is given a weighting factor by the students ranging from 1 to 5 in which '1' was the least important and '5' the most important. Eight assessment schemes typically used at the engineering school at Griffith University are given in the survey: (1) Seminar, (2) Closed-book mid-semester test, (3) Open-book mid-semester test, (4) Problem-based assignment, (5) Presentation, (6) Multiple-choice question test, (7) Closed-book final examination, and (8) Open-book final examination.

### *F-test*

The F-test has been commonly used to analyse the results of opinion surveys [10–19]. There are four major categories in the survey: (i) Programme, (ii) Gender, (iii) Age, and (iv) Ethnicity. Each category is divided into different groups that can then be analysed using statistical software. In the course programme category, there were two major groups: (1) Bachelor programmes and (2) Master programmes.

For the Gender category, there are two groups: (1) Male and (2) Female. For the Age category, there are three age groups: (1) 19–22, (2) 23– 31, and (3) 35–40. The Ethnicity category has two major groups: (1) Local and (2) Overseas.

The data collected from the survey are analysed

Table 1. Number of students on courses who responded to questionnaire.

| | |
|---|---|
| 62 | Bachelor of Engineering |
| 1 | Bachelor of Engineering Technology |
| 2 | double-degree programme of Bachelor of Engineering and Bachelor of Business |
| 2 | double-degree programme of Bachelor of Engineering and Bachelor of Information Technology |
| 2 | double-degree programme of Bachelor of Engineering and Bachelor of Environmental Science double-degree programme of Bachelor of Engineering and Bachelor of Environmental Science |
| 22 | Masters of Engineering and Project Management |
| 9 | Masters of Engineering in Structural and Construction Management |
| 4 | Masters of Engineering in Engineering Management |
| 2 | Masters of Construction Engineering and Management |

using the Statistical Package for Social Sciences (SPSS) Version 14.0 for Windows. The mean values of the data are numerically estimated and tested among the groups. F-tests are performed with a demarcation level of significance of 0.05. The tests are used to assess the similarity of opinion among the groups on the assessment schemes given in the survey.

*Relative importance index*

To determine the relative ranking of the assessment schemes, the scores entered in the survey by students are transformed to RII values using Equation (1) [20–23]:

$$RII = \frac{\sum_{i=1}^{N} w_i}{AN}, \quad (1)$$

where $w$ is the weighting given to each factor by the responding students, ranging from 1 to 5, $A$ the highest weight, in this study $A = 5$, $N$ the total number of samples, and $RII$ is the relative important index, $0 \leq RII \leq 1$.

*Spectral techniques*

The Fourier Transform

The Fourier transform is a useful and powerful tool employed to study 'frequency' components of signals and discrete data, which are usually recorded in the time domain. After transforming the data into the frequency domain using the Fourier transform, the signal energy distribution at different frequencies is revealed. Effectively, the Fourier transform can be considered as a prism where white light can be split into its individual spectra. For the case of the Fourier transform, the signal energy is split over the signal's spectrum, which consists of a number of frequencies at which the frequency components are displayed. Mathematically, the Fourier transform $X(f)$ as a function of the frequency $f$ is given as [24]:

$$X(f) = \int_{-\infty}^{+\infty} x(t)e^{-j2\pi ft}dt, \quad (2)$$

where $j^2 = -1$ is a complex constant, $\pi \approx 3.1415$ and $x(t)$ the input signal or data. The input data or signal is usually a 1-D array or 2-D matrix.

To recover a time signal from its Fourier transform, the inverse Fourier transform is employed; this is mathematically given as:

$$x(t) = \int_{-\infty}^{+\infty} X(f)e^{+j2\pi ft}df. \quad (3)$$

Frequency is normally defined as the number of repetitions over time; the concept of 'frequency domain' is believed to be new in studying educational surveys. Frequency is inversely proportional to time, which means the larger the time, the smaller the frequency and vice versa. Using the concept of frequency and time it can be said that data that have a long time span have densely-concentrated spectra over a short frequency range and vice versa. The magnitude of the frequency components that are displayed over a frequency range or spectrum is said to be proportional to the signal energy. Signals that are continuous and periodic in time have densely concentrated energy spectra. For example, the Fourier transform of a constant signal that is continuous from $-\infty$ to $+\infty$ is an impulse whose energy concentration is theoretically perfect. The survey data are discrete and it is clear that the discrete Fourier transform is employed in this case. It should be stressed that the discrete Fourier transform is more common than the continuous Fourier as practical signals are mostly discrete. However, the theory of the continuous Fourier transform is discussed here to give a fundamental framework on the Fourier transform. The discrete Fourier transform can be performed in MATLAB via the command 'fft'.

Power spectrum

To further study the correlation among the assessment schemes, the power spectrum is employed. The power spectrum $P(f)$ of a data set $x(t)$ is given in Equation (4) as:

$$P(f) = |X(f)|2, \quad (4)$$

where $X(f)$ is the Fourier transform of the data or input signal. It is evident that the power spectrum is proportional to the square of the magnitude of the input signal's Fourier transform as expected because the signal energy is directly related to its magnitude squared. It is important to stress that energy plays an important role in determining data characteristics, i.e. periodic, aperiodic or chaotic, detecting transitions from one state to another, i.e. a transition from periodicity to chaos or from periodicity to transient, and to work out the energy weighting at different frequencies [24] that can be achieved by estimating the power spectrum of the input data. The power spectrum can be used to classify different types of data including periodic, chaotic, transient and noise by interpreting its shapes and frequency range [25]. This method has also been successfully employed in the field of construction management [26–31] and is now used to analyse opinion surveys in the field of engineering education.

*Interview discussions*

After completing the survey, 14 students showed an interest in further discussions. The research team interviewed these students, who came from different student categories and groups as defined above. The interviews were intended to gather further comments and provide elaboration and interpretation of the results obtained from the

survey. In general, all interested students were selected for further discussions, at least one student from each category and group was selected so that a broader overview on the assessment schemes could be gathered. The interviews were independently and confidentially conducted with each student. Student feedback was also recorded for further reference and clarification. The outcomes of these further discussions are then qualitatively analysed, combined with the quantitative analyses performed using the F-test and spectral methods to yield an in-depth understanding of the students' attitudes towards the assessment schemes and on how to improve them.

## RESULTS AND DISCUSSIONS

*F-test*

For the F-test, results of various groups participating in the survey, if the significance value of a scheme is below 0.05 then there are variations between the responding students' views of the scheme. In the attitude and understanding assessment schemes, there is variation in the presentation assessment scheme under the course Programme category with significance values of about 0.041 and 0.009 respectively.

For the presentation assessment scheme, regarding attitude, the approximate mean values of the groups are: (1) 2.53 and (2) 3.13. The overall mean value is about 2.92. It is clear that group (1) Bachelor programmes possesses a lower mean value and group (2) Masters programmes possesses a higher mean value. From the interview, it was found that Masters students usually prefer non-exam assessment schemes such as presentations as they consider themselves independent and mature in their studies and have a high confidence level. This explains why the mean value of group (2) is higher than that of group (1). The Masters students who were interviewed stressed that the presentation scheme improves their communications skills, job finding and confidence. From the interviews with the Bachelor students who responded, it was common that the engineering students usually did not prefer the presentation scheme because of unfamiliarity, shyness, lack of confidence and motivation. Engineering undergraduate students tend to focus more on the technical know-hows, such as laboratory, assignments, tests and exams. However, from experience, engineering students focus more on the presentation scheme in the penultimate year of their programme. The same argument can be applied to the presentation scheme in the understanding scores obtained in this survey with the approximate mean values of the groups are: (1) 2.62 and (2) 3.36, with an overall mean value of about 3.10.

In the Ethnicity category, for attitude scores, the seminar, open-book and closed-book mid-semester test, and presentation are significant. The approximate mean values for the seminar scheme of the groups are (1) 2.93 and (2) 3.48, with an overall mean value of about 3.15. Generally, the mean values of group (1) are compatible with those of group (2) with overseas countries possessing the largest value. From the interview discussions with the responding students, this is mainly because the seminar scheme had not been employed in these countries. This further motivates the students from these countries to eagerly participate and to explore the scheme. Some of the interviewed students also emphasized that they wanted to practise their English so that they would be better off in the subsequent years of their programme. A small number of these students felt nervous because their confidence level was low because of their limited English. The same argument can be applied to the presentation scheme scores in attitude and in understanding with the approximate mean values of the groups being (1) 2.42 and (2) 3.50 with an overall mean value of about 2.83 in attitude. In understanding, the approximate mean values are (1) 2.62 and (2) 3.68 with an overall mean value of about 3.06.

In attitude and in understanding, the open-book and closed-book mid-semester test scheme scores are significant with an approximate mean value of the groups being (1) 3.00 and (2) 3.59, with an overall mean value of about 3.13 for the open-book mid-semester test scheme score in attitude. For the open-book mid-semester test scheme score in understanding, the approximate mean values are (1) 2.91 and (2) 3.54, with an overall mean value of about 3.38. For the closed-book mid-semester test scheme score in understanding, the approximate mean values are (1) 2.89 and (2) 3.35, with an overall mean value of about 3.14. It is clear that group (2), representing the overseas students, possessed higher mean values than group (1) for this scheme in attitude and in understanding on the mid-semester test scheme. This shows that the overseas students possess practical skills and a willingness to tackle more challenging problems than the students in group (1). From the interview discussions, the overseas students tend to work hard because they are determined to stay permanently in Australia and to establish their career. This is a major motivation factor that pushes the overseas students toward new horizons and boundaries where they have never been.

*RII values*

Undergraduate students

The RII values of all assessment schemes are shown in Table 2 and plotted in Fig. 1 and Fig. 2. The RII values are used to rank the assessment schemes in attitude and understanding. The *problem-based assignment*, *multiple-choice question test* and *open-book final examination* are ranked first in attitude assessment schemes by undergraduate students because they are directly related to what the students have learnt in class. The presentation

Table 2. Assessment schemes in student attitude and understanding

| | Toward attitude | | | | | | Toward understanding | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Undergraduate | | Postgraduate | | Overall | | Undergraduate | | Postgraduate | | Overall | |
| Assessment method | RII value | Ranking | RII value | Ranking | RII value | Ranking | RII value | Ranking | RII value | Ranking | RII value | Ranking |
| Seminar | 0.59 | 7 | 0.72 | 4 | 0.63 | 6 | 0.58 | 7 | 0.75 | 3 | 0.63 | 6 |
| Closed-book mid-semester test | 0.68 | 5 | 0.56 | 6 | 0.64 | 5 | 0.68 | 5 | 0.54 | 8 | 0.63 | 6 |
| Open-book mid-semester test | 0.72 | 4 | 0.56 | 6 | 0.67 | 4 | 0.69 | 3 | 0.58 | 6 | 0.66 | 3 |
| Problem-based assignment | 0.74 | 1 | 0.75 | 3 | 0.74 | 2 | 0.74 | 1 | 0.81 | 1 | 0.76 | 1 |
| Presentation | 0.49 | 8 | 0.76 | 2 | 0.58 | 8 | 0.53 | 8 | 0.80 | 2 | 0.62 | 8 |
| Multiple-choice question test | 0.74 | 1 | 0.78 | 1 | 0.76 | 1 | 0.66 | 6 | 0.66 | 4 | 0.66 | 3 |
| Closed-book final examination | 0.66 | 6 | 0.55 | 8 | 0.62 | 7 | 0.69 | 3 | 0.58 | 6 | 0.65 | 5 |
| Open-book final examination | 0.74 | 1 | 0.69 | 5 | 0.73 | 3 | 0.70 | 2 | 0.64 | 5 | 0.68 | 2 |

assessment method is ranked last as most students are not very familiar with this style of assessment. From the interviews with the responding students, most students even considered this assessment method as a waste of time. The interviewed students also highlighted that another reason why this assessment method is ranked last is because it normally carries only 10% of the total mark in most courses at Griffith University.

For undergraduate students, in understanding, problem-based assignment, open-book and closed-book final examination assessment schemes are ranked first, second and third respectively. It is clear that these assessment schemes are directly related to what students have learnt in class. From the interviews with the responding students, the *problem-based assignment* scheme helped improving their knowledge on particular subjects and concepts taught in the course. The *open-book final examination* scheme rather than the *closed-book final examination* scheme is preferred because there are usually many practical details and fact sheets that students need to master before sitting the final exam. Having an open-book final examination eases the pressure of memorising these sheets and also has the benefit of being able to bring the necessary books and notes into the examination. One drawback of the open-book final examination scheme is that it is harder than the closed-book final examination scheme. Despite this, the *open-book final examination* scheme is still effective from the student point of view.

From Table 2, it should be noted that the presentation and problem-based assignment assessment schemes are ranked last and first respectively both for attitude and for understanding assessment from undergraduate students due to the reason explained earlier. The problem-based assignment assessment scheme is usually preferred over other schemes because of its direct relations to student knowledge and learning. The *presentation* and *seminar* schemes usually involve either the surface

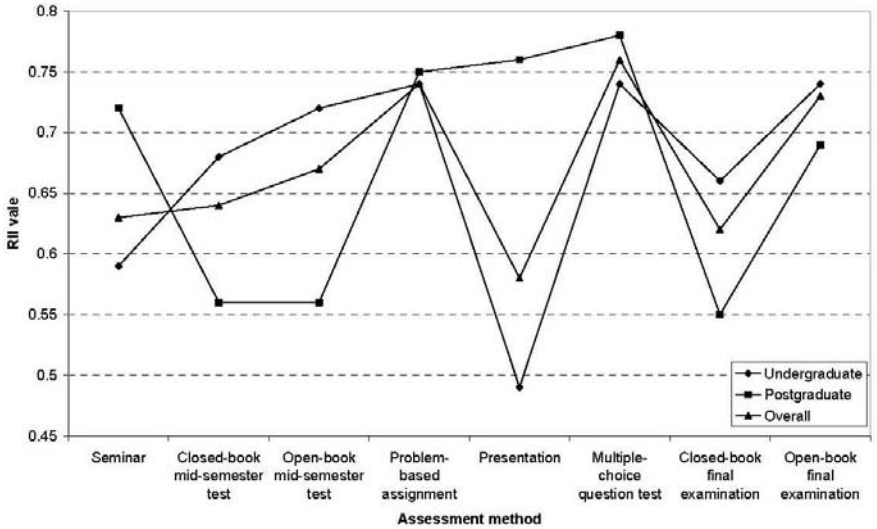


Fig. 1. Assessment schemes in student attitude.

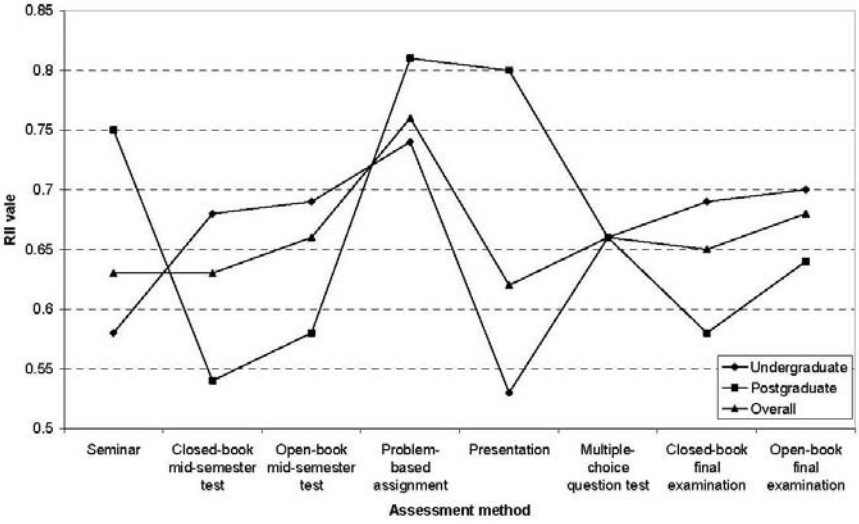


Fig. 2. Assessment schemes in student understanding.

approach, the deep approach, or both. For the first case, the surface approach is usually not strongly related to the course content and carries a small number of marks. Therefore, students do not want to pay too much attention on this particularly assessment item. For the second case, the assessment item involves the deep approach learning and therefore is more complicated than the first case. The third case is considered to be the most complicated with both surface and deep approaches. An example of the first case is an introductory seminar presentation. Examples for the second and third cases are final-year thesis seminars, which usually combine deep- and surface-approach learning. In addition, students are also required to process effective communication skills to achieve satisfactory scores for this assessment item. From interviews with the responding students, most students admitted that they did not possess effective communication skills, and the deep approach learning in the presentation and seminar assessment schemes is quite challenging.

Postgraduate students

For postgraduate students, to further examine the effectiveness of different assessment schemes given in the survey, the RII values of the rankings are also tabulated in Table 2 and plotted in Fig. 1 and Fig. 2. From these, for the attitude learning process, *multiple-choice question test* scheme is ranked the most popular in all assessment schemes and the *closed-book final examination* scheme is the most unpopular. This is mainly because for the multiple-choice assessment scheme, students could make 'educated guesses'. In addition, they are very familiar with this type of assessment, which is commonly employed in the first year of most Bachelor degree programmes. The close-book final examination assessment scheme is ranked last because psychologically students have to endure pressure and long-hour preparations for the final examination, which made it the most unpopular. This means that summative assessment schemes are not highly regarded by postgraduate students because they are unable to receive direct feedback from the lecturer even though they carry more marks than other assessment items for the course. From the conducted interviews, it should be noted that postgraduate students usually possess a high confidence level having successfully completed their Bachelor degree programmes. Thus, the *closed-book final examination* scheme is usually regarded as 'boring', instead they would prefer a lighter assessment scheme such as *presentation* or *problem-based assignment,* which is more practical and closer to reality. Even though the *closed-book final examination* scheme carries the highest number of marks, the majority of students prefer to get a better understanding of the course material and learning concepts, which will be more useful for them when they enter the workforce than simply achieving a high final grade.

In the understanding scores of the postgraduate students, the *problem-based assignment* and *presentation* schemes are ranked first and second instead of third and second respectively under the attitude learning approach. This indicates that postgraduate students regard these assessment schemes highly as being effective for their understanding of the course and materials. In other words, formative assessment schemes are highly regarded by postgraduate students because they are able to receive direct feedback from the lecturer, and from that they can make possible improvements to achieve better marks in the future. According to the interviews with the responding students, postgraduate students fully understand the importance of having effective communications and leadership skills, which are crucial when entering the workforce. Thus, they usually consider the presentation assessment scheme as a pre-trial for job hunting upon graduation.

Overall

Overall, from Table 2, Fig. 1 and Fig. 2, for in both attitude and understanding learning processes, postgraduate students prefer continuous assessment schemes where feedback is given directly to the students rather than 'one-off' assessment schemes, such as the final examination. This is evidenced in the low ranking of *closed-book mid-semester test*, *open-book mid-semester test* and the *open-book and closed-book final examinations* assessment schemes. In contrast, continuous assessment schemes such as the *problem-based assignment*, *presentation* and *seminar* are highly regarded as being effective for student learning outcomes because direct feedback can be received from the lecturer. From that, self-improvements can be made. The students also believe that the exercises set out by the continuous assessment schemes will prove very beneficial when they enter the workforce.

Overall, it has been found that undergraduate students prefer the problem-based assessment scheme, whereas postgraduate students prefer the seminar and presentation schemes to improve their communications and leadership skills. Undergraduate students prefer the exam-related assessment schemes, but the postgraduate students prefer the non-examination related assessment schemes. This shows the general difference between the two major student groups. Further, the postgraduate students tend to adopt the deep approach to learning whereas most of the undergraduate students tend to use the surface approach to learning.

*Power spectral techniques*

This section estimates the power spectra of all the assessment schemes as can be seen in Fig. 3 and Fig. 4. By examining the power spectra, it is possible to determine the response type of the data obtained from the survey. There are four main data types: (1) periodic—the most common data type exhibiting sharp peaks or harmonics at repeating intervals, (2) transient—decaying spectrum expressing decaying characteristics in the data, (3) transition to chaos—showing signs that the data are in the transition to chaos, the power spectrum in this case becomes smoother than in the previous two cases, and (4) chaos—the power spectrum is the smoothest of the four main types of data. Harmonic peaks cannot be detected in this case.

From Fig. 3, for attitude, it is clear that the power spectra of all assessment schemes possess discrete harmonic peaks, which mean that the student responses were mainly 'periodic', spanning the entire student responses. This shows that the data are uniform and thus carry the useful information. However, there is the tendency towards uncertainty as some groups of students tend to participate more often than other groups. For example, for the presentation assessment scheme, there is less energy concentrated in the middle of the student responses, but more energy toward the sides, which means that positive student responses were received at the beginning of the survey and toward the end, not in the middle of the survey. The same argument can be applied to the other

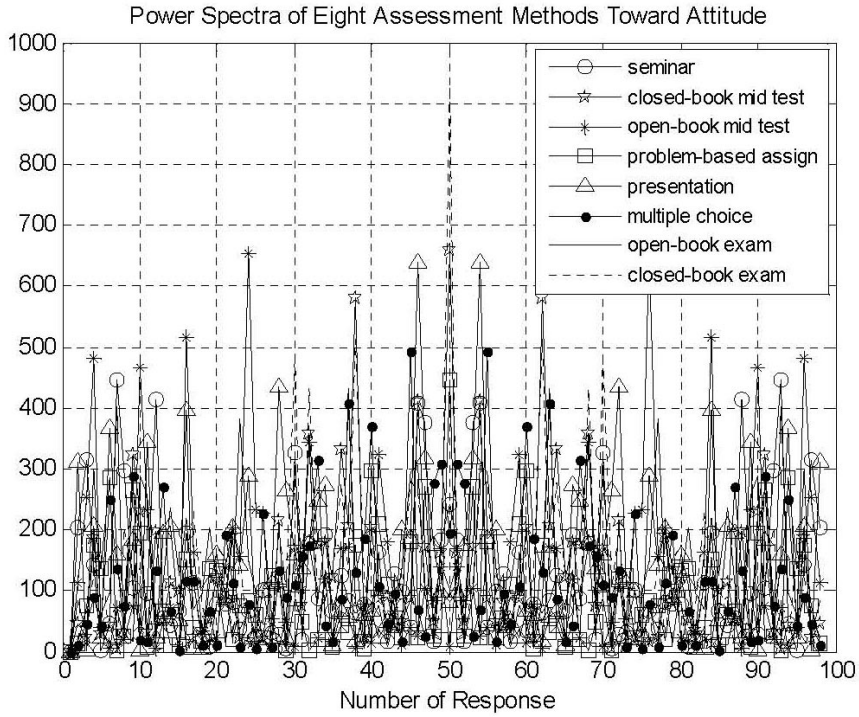


Fig. 3. Power spectra of eight assessment schemes for attitude, the same legend is used in Fig. 4. The vertical axis shows the magnitude of the spectrum.

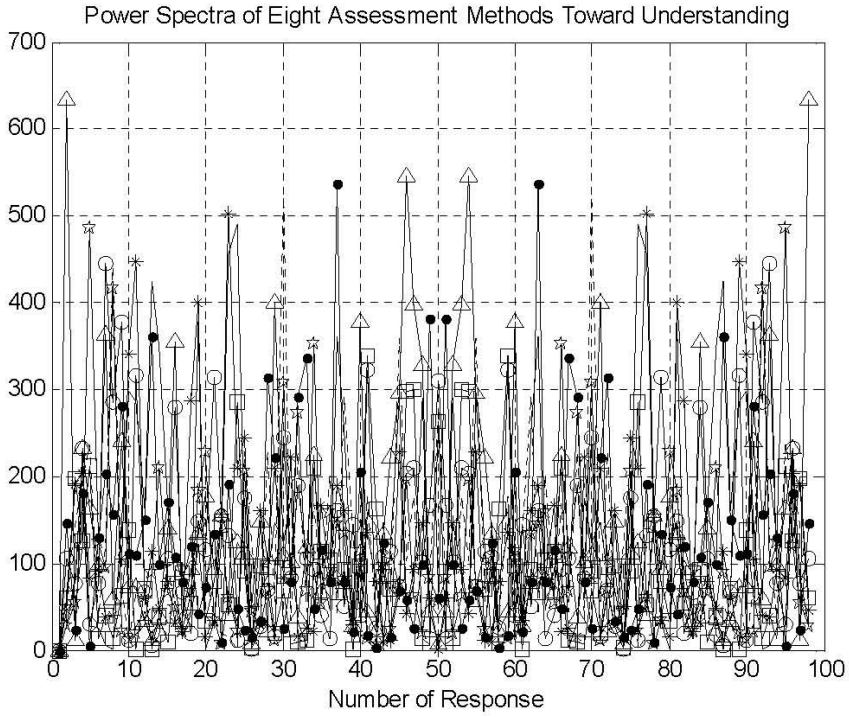


Fig. 4. Power spectra of eight assessment schemes for understanding, with identical legend as in Fig. 3. The vertical axis shows the magnitude of the spectrum.

schemes. This information is vital in obtaining a more uniform response distribution for the next survey so that more useful information can be obtained.

From Fig. 4, the power spectra of all the schemes are more uniform than those for attitude presented in Fig. 3. Positive responses were obtained at regular intervals and therefore the objectives of the survey were more fulfilled. In addition, it is clear that the responding students participating in the survey were certain about what they will be learning and their final outcomes in terms of understanding are clearer than in terms of attitude. This shows that studying student attitude in assessment schemes remains a challenge and opens new directions of research about this topic.

*Comparisons with other studies*

Work on improving student attitude toward assessment schemes has been conducted in the literature. From the work reported [6–9, 32–34], a problem-based learning with a formative assessment scheme has been suggested for improving student attitude, which is consistent with the findings in this paper. It should also be noted that communications skills acquired by giving presentations and seminars are also essential and must not be ignored as these can successfully help students and graduates finding jobs in the workforce. In addition, inviting guest lecturers, conducting field trips and writing short essays on cutting-edge research topics also significantly helps in sharpening students' thinking, analytical and overall skills, and making them more competent, which is the key ingredient to being successful in the work force. In brief, the findings of this paper are different from those reported in the literature because practical and insight analyses were conducted together with quantitative analyses obtained using the F-test and the spectral method to devise an optimal combination of 'weak' assessment schemes such as seminar and presentation, and 'strong' schemes such as exams to improve student learning. More detailed recommendations are given in below.

## RECOMMENDATION

According to the findings of this paper, the *seminar*, *presentation* and *problem-based assignment* are the most effective assessment schemes from the students' point of view. Thus, to improve the teaching and learning processes, the followings are recommended:

- enhancing student understanding by arranging more problem-based sessions in class. The style of problem-based learning can also be varied by giving students a current topic of interest and initiating topic debates. Real-world case studies are also encouraged;
- inviting guest lecturers to give lectures on real-life experience, something which is usually lacking in the academic environment;
- engaging students to research cutting-edge

topics and sharpen their communications and leadership skills by setting group assignments, team debates and site visits;
- encouraging undergraduate students to participate in seminar and presentation assessment schemes. The same concept is applied to postgraduate students for problem-based assignments and examination schemes;
- encouraging the use of sophisticated techniques such as power spectrum to more thoroughly study survey data and to determine data correlation that can be used to maximise a surveys' efficiency and effectiveness;
- assigning more marks toward other weaker assessment schemes outlined in Table 2 such as closed-book and open-book mid-semester tests to achieve a balance among all assessment schemes in the course; and
- arranging more continuous assessment schemes in the course to meet student needs and to improve the student learning process.

## CONCLUSION

This paper examines eight typical assessment schemes used in engineering courses at Griffith University: (1) seminar, (2) closed-book mid-semester test, (3) open-book mid-semester test, (4) problem-based assignment, (5) presentation, (6) multiple-choice question test, (7) closed-book final examination, and (8) open-book final examination. A survey was conducted to investigate the eight assessment schemes with regard to attitude and understanding for undergraduate and postgraduate students. It should be noted that undergraduate students focus more on the problem-based assignment assessment scheme, rather than the presentation. On the other hand, postgraduate students focus more on the presentation assessment scheme, rather than the final examination. It can be concluded that postgraduate students are more independent than undergraduate students, thus they prefer continuous assessment schemes such as presentation, seminar and mid-semester tests. They also prefer to receive feedback from different assessment schemes during the semester, which can help improve their future job-seeking related skills such as communication skills and technical knowledge. The power spectrum of the received data has been calculated for the first time to assess the effectiveness and efficiency of the data collected from the survey. From that, possible improvements to improve the engineering programmes can be made. Recommendations are also given to improve the existing assessment schemes for undergraduate and postgraduate students.

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