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USING RESPONSE SYSTEM THROUGH VOTING IN PEER INSTRUCTION FOR LEARNING SUSTAINABILITY

Bosede I. Edwards[a,b], Baharuddin Aris[a*], Nurbiha A. Shukor[a], Hasnah Mohammed[a]

[a]Faculty of Education, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia
[b]Osun State College of Education, Ilesa, Nigeria

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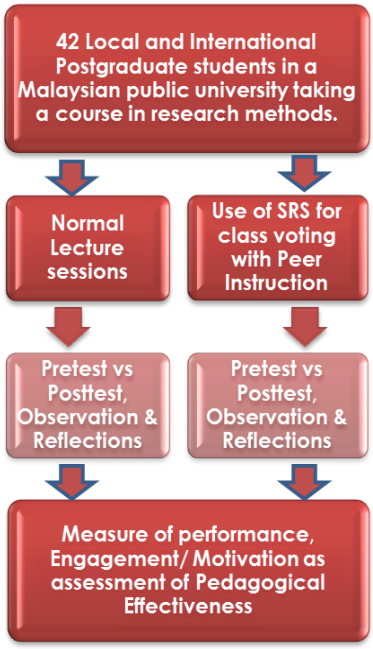
*Corresponding author
bba@utm.my

Graphical abstract



Abstract

Sustainable education must employ strategies that promote lifelong and meaningful learning. Peer Instruction (PI) is an active learning pedagogy specifically designed to achieve this. There are a number of elements involved in the various steps of the PI pedagogy which contributes to its effectiveness. However, most research studies reported in Peer Instruction focused on its use in science education and mainly on the whole pedagogy. The significance of the individual elements of the model have not been fully explored. Reports are also scarce on the use and benefits of PI in non-science classrooms. This study evaluates the pedagogical benefits of one of the elements of the PI model; the use of automated feedback based on students' voting. 42 students in a postgraduate teacher education class were taken through sessions of Peer Instruction and traditional lectures; learning outcomes were compared in terms of student performance and student engagement and motivation. Performance tests (pre-tests and post-tests), live classroom observations and students' reflections were monitored to determine the level of performance and engagement. Results show that students reported increased interest, motivation and engagement and the ability of the voting sessions to foster metacognition. Active learning and learning readiness were also emphasized while the lecture sessions were reported as normal or usual. The result validates the usefulness of voting component of the PI model for fostering improved learning; noting that students are able to benefit more from personal evaluation when voting results are displayed after voting.

Keywords: Peer Instruction, Learning Engagement, Voting, Student Response Systems

1.0 INTRODUCTION

The achievement of a sustainable future, defined as sustaining the present without jeopardizing the future, has as its central issue, the promotion of equality, education and participation in local communities [1], hence, the achievement of sustainable development must have improved or more effective teaching and learning as its central focus. According to a 2005 report [2], effective education has been found to be unamenable to traditional instructional modes. They therefore recommended novel instructional strategies that focus on the development of skills in team work, interdisciplinary reasoning and problem-solving. One way to achieve this is through instructional strategies that promote learner engagement and motivation, possible through leverage on modern technology.

In late 1990s, Eric Mazur of Harvard University developed the Peer Instruction pedagogy as a means of solving the problems of learner disengagement

associated with regular lectures. Finding that his own students were not carried along or benefitting from his lectures, he set out to find a solution to what he called 'the tyranny of the lecture' which is a teacher-focused mode of instruction from which only few students benefit. Peer instruction on the other hand is student-focused. The method employs techniques by which students learn from one another as well as from leveraging on metacognitive strategies promoted by the pedagogy. Peer instruction uses pre-class assignments, concept questions rather than conventional ones, in-class peer discussions and class voting to promote interaction, participation and meaningful learning. The process places a demand on learners to evaluate their own learning in order to provide answers to concept questions

2.0 LITERATURE REVIEW

2.1 Engagement and Motivation in Learning for Sustainable Education

Sustainable education must be the one that delivers of the promise of effective teaching and learning. Hence, it must be focused on not just rote learning, but learning that is meaningful and useful to the learner. That is, sustainable learning must go beyond just passing examinations to the ability to apply the learnt material in novel situation. This is only possible when the learner is able to understand the underlying concept of the learnt materials in order to be able to relate it with real life situations. To achieve this, learner engagement and motivation must be strong.

The concepts of engagement and motivation are related to each other and to achievement. Engaged learners are motivated to learn and motivated learners are engaged with learning. An engaged and motivated learner is focused, active, energised, self-efficacious and can ultimately be an achiever. Among several theories/models that attempted to explain the phenomena are the Engagement-disaffection model [3,4,5] and the Multidimensional model [6] This relationship is described by Mihaly Csikszentmihalyi in his flow theory [7,8,9,10,11]. Hence, increasing the flow experience in learning ought to be the ultimate goal of sustainable T&L [8].

With the importance of learner engagement in education therefore, effort towards sustaining student engagement has become a trend in current educational research. It focuses on creating learning environments that provides the opportunities that instigates and sustains in the learner the desire to learn, increased feelings of self-esteem and control over the learning situation. Student engagement is affected by factors including the student's perception of learner control and the level of relevance of a particular learning activity [12]. Engagement is allowing students to take charge of their learning while the teacher does his expected duty of a facilitator [13].

Learner engagement and performance have been found to correlate. Various measures of performance including increased participation, higher grades and attendance have been found to indicate increased engagement [14]. The traditional perspective of the concept of engagement in learning focuses on variables including, concentration, effort and attention as well as listening, thinking and practicing [12]. Newer definitions of engagement focus on a synthesis of the elements of cognitive, affective and behavioural indices as a measure of engagement with learning [5].

Motivation, from the Latin word 'movere', that is, to move [15], connotes a dynamic situation or a situation of activeness or performance. It is essentially the opposite of 'amotivation' [16] which is capable of leading to poor achievement. Motivation includes 'an energized internal state that results in goal-directed behaviours' and 'the process whereby goal-directed activities are instigated and sustained' [15]. In essence, motivation is prompted, activated or caused (instigated) and has to be maintained (sustained). It involves goals and therefore requires activities; it is also a process rather than a product.

Motivation is directly linked to the quality of education and hence, student achievement [17]. It is observable in students' interest in learning activities, their self-efficacy and how they immerse themselves in learning by staying on tasks, making efforts to succeed and making use of effective learning strategies. Motivation is also directly related to how the learner go about the learning [18]; it is related to learning in a reciprocal manner [19] in that it facilitates increased learning performance which in turn increases motivation, thereby repeating the cycle. Motivation encourages the processes of learning regulation (such as planning, organization, rehearsing) among the students, thereby making them efficient about their learning.

2.2 Peer Instruction Pedagogy for Sustainable Education

Peer Instruction (PI) is a teaching strategy developed by Eric Mazur [20] to address the problems encountered by both students and teachers in teaching and learning through conventional instructional delivery methods which results eventually in poor students' performance. PI engages learners in knowledge sharing as a means of encouraging understanding and improving learning through teaching others. It engages learners to share thoughts on a learning material based on personal understanding; they thereby benefit from personal and peer reviews, evaluations and contributions [21]. The focus of Peer Instruction is to develop an interactive classroom where students are intellectually engaged with the learning material.

A report [22] on the practice of PI in the lecture setting. He identified conceptual understanding of material, peer discussion on new concepts to aid personal understanding and focus on the learning and integration of challenging materials into learners' existing conceptual framework as the major ingredients through which PI promotes deeper and

more effective learning. He also noted that on the part of the teacher, preparing ConcepTests is much less time-consuming than preparing a lecture material for the first time. He further notes that students find class attendance more useful in the PI setting as there is hardly a way of making up for the loss in learning from peer discussions.

Other reports on the advantages of PI in the physics classroom [23,24] pointed to improved performance when PI is used compared with when the regular lecture mode was employed. In an Australian project that focused on laboratory work with pre-service teachers, the researcher [25] found that PI at the beginning of laboratories has the potential to reduce students' cognitive load and thereby foster improved learning.

The benefits of PI lie in its ability to foster engagement and motivation through its procedures. The ConcepTests brings the attention to the underlying concept of the material; this brings learning alive and the task of relating with this motivates the learner, thereby increasing engagement which further increases motivation and the cycle continues. In addition, the voting sessions can be quite interesting and metacognitively beneficial as learners are faced with evaluating their personal understanding in order to provide answers. Furthermore, the peer discussions are quite engaging as learners get the opportunity to validate their personal understanding and learn through contributions from colleagues.

In lieu of the several benefits of PI for improved learning, it is of great advantage to employ the technique in modern classroom for the purposes of sustainable education. Practices that have the potential to foster or promote improved learner engagement especially in an age of distraction are best for supporting meaningful learning that goes beyond copying lecture notes or mere listening to real learning that has applications beyond the classroom.

2.2.1 Implementation of Peer Instruction

PI implementation involves three main procedure including a pre-class, in-class and after-class procedure. Each of these is focused at achieving improved learning through increased engagement with the learning material. This study reports on the in-class procedure which uses the phenomenon of 'voting' on 'ConcepTests'.

2.2.2 ConcepTests in Peer Instruction

ConcepTests are questions specially constructed with a mind to examine learners' understanding of the underlying concept of a particular topic. It focuses on getting learners beyond the 'recall' or rote learning stage into the application and transfer level where learning becomes truly meaningful. For a standard PI procedure based on Mazur [26], the following applies:

i. Students vote on answers to ConcepTests. Based on some pre-determined criteria, the instructor can decide if the test is too difficult or too easy, in which case, there is no need for moving on to the next level. The procedure may require going over the short lecture or moving on to the next topic depending on the outcome of the voting session [26].

ii. Also based on the same criteria, if the instructor thinks it is okay to go on to the next stage, the students get into 'peer groups' to discuss the answer options in a process known as peer discussion. In this way, students are forced to think through the answers, thereby undergoing a personal assessment of their understanding. This enhances deeper learning.

2.2.3 Student Response (Voting) in Peer Instruction

Different kinds of means including flashcards, clickers and other electronic tools are employed to gather students' individual and group response to ConcepTests. Various means of display are also available in form of graphs, histograms, charts, etc. The advantages of electronic response systems over traditional or manual options like raising of hands, use of flashcards or papers, etc. are obvious. Electronic systems are capable of providing immediate and accurate display of responses. The software system can provide charts, graphs and other useful statistics for evaluation in addition to saving class time. Gadget use can bring about motivation and improvement of classroom atmosphere. This is capable of increasing students' interest and engagement. They are therefore recommended for use with class voting.

3.0 OBJECTIVES OF THE STUDY

Although the advantages of PI for learning are frequently discussed, most studies reported in Peer Instruction were conducted in science classrooms and mainly on the PI pedagogy as a whole rather than on the significance of the individual elements of the PI model. Reports are scarce on the use and benefits of PI in non-science classrooms. This study evaluates the pedagogical benefits of the elements of the peer instruction model which is automated feedback based on students' voting in a teacher education class.

Accordingly, this study is carried out to investigate the following:

i. Does the use of student response systems in PI have significant implications for performance and learning engagement?

ii. How do learners perceive the values of student response systems in PI as a means of promoting effective learning in terms of improved learner engagement?

iii. What are the influential factors of improved learning when using student response systems in PI?

iv. How should the use of student response systems in PI be implemented for sustainable education?

4.0 METHODS AND STUDY PROCEDURE

The study employed both qualitative and quantitative methods in a case study approach to assess learning gains and learners' perceptions in a within-subject pre-experimental procedure. The study follows an experimental procedure as shown in Figure 1. Two class sessions using different instructional methods were compared for differences in their ability to foster and promote learner engagement as a means of promoting effective learning.

4.1 Participants

Forty-two postgraduate students were involved in the study. The participants are purposively selected based on their registration in the course. The participants are a mixture of local and international students from varying subject backgrounds across science, engineering and social sciences. All are registered for the Masters in Education programme and are mostly teachers or would-be teachers.

4.2 Instrumentation

The study employed both quantitative and qualitative data collection methods. Performance tests were used to collect quantitative data while qualitative data involved live observations.

4.2.1 Performance Tests

Pre-tests and post-tests were developed based on the course content and validated by both the course lecturer and other experts in the field. The tests provide a measure of learning gains based on the teaching pedagogy employed. They were administered before (pre-test) and after (post-test) instructions. The study focused on testing for immediate recall; hence, the post-tests were administered immediately after the instruction session.

4.2.2 Live Observation

The live observations follow the standardized procedure to ensure the integrity of the data and procedure. An observation protocol was developed based on the objectives of the study. The protocol includes items that focus on student engagement with learning. A total of 36 items were included under 7 codes grouped into 2 sections. Observations followed the time-sample methodology with observations made at 10-minute intervals. 7 observations were made by 2 independent observers whose kappa co-efficient of agreement shows a very good value at 0.9.

4.2.3 Students' Reflections

Self-report from students are important to assess stakeholder perception of the sessions under consideration; hence, student reflections were collected. The instrument employed was a class Facebook group developed by the researcher for the purpose of the study. All participants were added to the group and discussions on the class sections were carried on in the group with the use of prompts intended to elicit the required response from participants.

4.3 Data Collection and Analysis

Data collection was based on the instruments as described in 3.2. The experimental procedure for the study is shown in Figure 1 while Table 1 describes the data collection method, the corresponding attribute being measured and the type of measure or data collected.

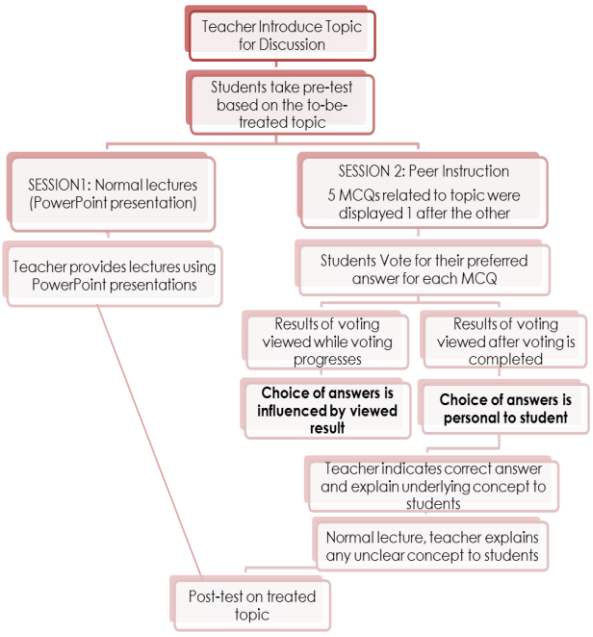


Figure 1 Experimental Procedure

Table 1 Data Collection Methods & Measures Represented by Data

S/N	Data Collection Method	Attribute Measured	Type of Measure
1	Performance Tests[a]		
	a. Pretests	Previous Knowledge	Test Score
	b. Posttests	Learning Gains	Test Score
2	Live Observation	Learner Engagement	Scores on protocol[b]
3	Student Reflection	Perceptions on pedagogical effectiveness	Individual submissions/comments[c]

[a]Tests are based on the topics covered in the experimental procedure. The same test is used for pretest and posttests. No changes were made
[b]Live observations were conducted and recorded at 10mins intervals based on the time-sample methodology; observations are recorded as scores os numerical values between 1-3 with 1=lowest/no engagement, 2=average engagement and 3=strong engagement. Overall engagement is based on the sum of all scores for the observation period. The same length of observation sessions are observed for both instructional strategies.
[c]Participants were asked to subscribe to a class Facebook group as a discussion and sharing platform. Prompts were posted as questions based on the focus of the research to elicit comments from participants.

4.3.1 Qualitative Data Collection & Analysis

For the qualitative study, live observations and students' self-report were employed. Learners' responses for self-reports were sought and collected as personal reflections [27] on their learning experience. Live classroom observations were also made to assess learning engagement based on classroom behaviour. A Facebook group provided the platform for collecting students' reflections while an observation protocol was used for the live observation. The time-sample methodology was employed to ensure standardization. Observations were recorded numerically on the scoring sheet of the protocol and assessed as descriptive statistics. Responses from student reflections were analyzed thematically based on the objectives of the study.

4.3.2 Quantitative Data Collection & Analysis

Quantitative data were based on pre-test and posttests scores of participants. This method provides a means of assessing participants' performance without the complications of individual difference in learning that has the potential to confound regular experimental data. Performance tests are conducted as pre-and post-tests. The same level of difficulty were ensured for the tests used in both sessions to ensure learning gains are not influenced by the ease or difficulty of a set of items as the case may be. Exactly the same test is administered in each pretest and posttest case. Learning gains were designed to test for immediate recall; hence, the posttests were conducted immediately after the sessions. In addition, the 2 pretest scores are compared and the 2 posttest scores are also compared for significant differences.

5.0 RESULTS

Results are presented in 3 formats according to the data collected. Reports include performance tests scores, observation data and students' reflections. The measures represented by each set of data are shown in Table 1.

5.1 Quantitative Results

After the pre-test, the regular lecture procedure involved just normal delivery and it is followed by a posttest to assess immediate learning gains. The voting session on the other hand followed a procedure involving the use of ConcepTests based on the to-be-treated topic. This method also follows two paths; path 1 uses a view-result-while-voting method while path 2 uses a view-result-after-voting method. This is followed by normal lectures after which posttests were taken. The next session reports on the data collection, analysis and results of the experiment.

5.1.1 Results of Performance Tests

Table 2 shows the descriptive statistics based on scores from the 2 class sessions. Participants show slightly higher performance in the Peer Instruction learning session (Mean Score=14. 30) than in lecture learning session (13.85).

Table 2 Descriptive Statistics for Performance Test Scores

	PRETEST1	POSTTEST1	PRETEST2	POSTTEST2
N	42	42	42	42
Mean	9.33	13.85	8.97	14.30
Std. Error of Mean	.350	.36	.36	.32
Median	9.00	14.00	9.50	14.00
Std. Deviation	2.27	2.37	2.35	2.11

A maximum score of 100% (20 marks) is possible for both pretest and posttests. This puts the minimum average score (50%) at 10 marks. The arithmetic means are similar for both sets of pretests (9.3, 8.9) and posttests (13.8, 14.3). The median scores are similar for both tests; the value indicates 50% of students (N=21) scores below and above 9 and 9.5 in the pretests for lecture and voting respectively, while the same number scored below and above 14 in the posttests in both sessions. The standard deviation and standard error of mean are similar across all tests, indicating similar variability of test distribution.

5.1.2 Analysis of Pre-test & Post-test for lecture session

Repeated measures (paired sample) t-test (2-tail) is used to assess participants' performance in lecture sessions. Students' knowledge prior to receiving lecture on the topic was compared to that after the lecture session. Table 3 shows that performance was significantly higher after the lecture session (M= 13.8) than before (M = 9.3) as shown by a significant t-test, $t(41) = -9.91$, $p < .05$. This indicates that there was an improvement in performance that was not likely to be due to chance. Learning gains due to the lecture were thus significant based on immediate recall.

Table 3 Paired Samples Test for lecture session

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRETEST1 – POSTTEST1	4.52	2.95	.45	-5.44	-3.60	-9.91	41	.00

5.1.3 Analysis of Pre-test & Post-test for the Peer Instruction Session

For the peer instruction voting session, the 2-tailed paired-sample t-test shows result similar to that for the lecture session with performance significantly higher after the voting session (M= 14.3) than before (M = 8.9) as shown by a significant t-test, $t(41) = -15.59$, $p < .05$ (Table 4).

Table 4 Paired Samples t-Test for voting session

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRETEST2	8.976	42	2.352	.36306
	POSTTEST2	14.309	42	2.112	.32597

5.1.4 Comparing the Lecture and Voting Sessions in Terms of Mean Differences

The mean difference of 5.3 (M=14.3 vs M=8.9) for the voting session is slightly higher than 4.5 for the lecture session (M=13.8 vs M=9.3) as shown in Tables 3. The difference in mean learning gains for the 2 sessions thus approached closely to significance (.069) as shown by the 1-sample t-test on the learning gains from both sessions in Table 5.

Table 5 1-Sample t-Test for the 2 sessions

	N	Mean	Std. Deviation	Std. Error Mean
LearningGains2n1	42	-.8095	2.81319	.43409

5.1.5 Testing for Significant Difference in Pretests and Posttests Administered In the 2 Sessions

The pretests administered in the 2 sessions were compared for significant difference as indicated by participant scores. The posttests were also compared in the same manner. Table 6 shows the respective paired sample statistics and t-tests for the 2 sessions. The information indicates that the paired sample t-test shows no significant differences in student scores for both pretests (t (41) = 1.64, p>.05) and for both posttests (t (41) = 1. 00, p>.05). This provides an indication of similar difficulty level in both tests and the fact that the posttest scores are not influenced by scores in the pretests. Table 7 is a summary of the t-tests conducted in the study; it provides an overview of the general results.

Table 6 Paired Samples t-Test for the 2 sessions

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair1	PRETEST1 - PRETEST2	.35714	1.41113	.21774	-.08260	.79688	1.640	41	.109
Pair2	POSTTEST1-POSTTEST2	-.45238	2.93176	.45238	-1.36598	.46122	-1.000	41	.323

Table 7 Summary of t-Tests for Quantitative Study

s/n	t-test	P	significance
1	Pretest vs Posttest (Lecture)	0.00	Significant
2	Pretest vs Posttest (PI Voting)	0.00	Significant
3	Learning Gains (Lecture vs Voting)	0.06	Approaching significance
4	Pretests (Lecture vs Voting)*	0.11	Not Significant
5	Posttests (Lecture vs Voting)*	0.32	Not significant

**Tests provide information on whether or not there is a significant difference in the scores of participants during the two sessions. The result underlines the fact that differences in learning gains are not a result of prior significant difference in pretests or posttest scores.*

5.2 Qualitative Results

Qualitative results from the study include the live observation reports and students reflections on the class Facebook group.

5.2.1 Live Classroom Observations

Classroom observations are designed to provide information on the degree of learner engagement with learning based on classroom behaviour measured as response to instructions, activities and distractions. The live observations followed the use of a systematic procedure that uses the time-sample methodology. This method involves the scoring of observations at specified intervals based on pre-determined criteria (in this case, the protocol). The method ensures the standardization of observation scores and ensures that in the case of multiple observers, observers are scoring the same procedure, thereby ensuring the integrity of the observation data.

Two independent observers provided scoring in a 7-stage procedure that records observation based on a 3-category index on a 36-item protocol. Table 8 shows the criteria for scoring of observations as low medium or high engagement.

Table 8 Criteria for Observation Scores for Engagement

Scores	Scores	Description	Designation
Lowest possible score	36	Less than 20% of entire class responding	Low Engagement
Average possible score	72	Up to 50% of entire class responding	Medium Engagement
Highest possible score	108	Entire/almost entire class responding	High Engagement

To provide a measure of engagement and motivation compared for both sessions of the study, the mean of the 7-stage scores of each observer were compared for both sessions as shown in Table 9.

Table 9 Observation Data

	Lecture Session	Voting Session
Observer 1 (average) scoring	63	95
Observer 2 (average) scoring	59	93
Average of Observation scoring	**61	94

Observation results show high engagement in the voting session from both observers while medium engagement is recorded for the lecture session. It is also noteworthy that the medium value recorded is actually at the lowest point of the scale and the pre-average score shows that observer 2 scores shows the lecture session actually records low engagement.

5.2.2 Students' Reflections Data

Stakeholder perception is an extremely important factor in system requirement or quality analysis [28], hence, students' perceptions of the two pedagogies focused in the study were assessed. Participants asked to reflect on their experience in both sessions. Reflections were made on a Facebook group created for the course. Reflection prompts were placed by the course lecturer and students were given a second reminder to login to the group page to add comments. Students' reflections show the following results:

i. All the students were experiencing the voting phenomenon for the first time as indicated in comments like

'this is new method for me since my past studies. For me, it is good and I suggest to continue it for the next class and so on..'

'I like the voting sessions, it is something I have neva experienced..'

'voting sessions was good and interesting and I am hoping that you will bring in again'

ii. Students reported increased engagement, interest, motivation and excitement. This is validated by expressions such as:

'I like the voting session. It is like a game or quiz for me'

'I think it is great fun and I hope it can be implemented again to another class'

'I am enjoying the voting session and also be the first experience to me using the interactive device to give response to the questions given'

'voting system keeps us engaged to the significant details'

iii. Students also reported increased metacognition and focus during the voting session. Example of comments include

''(voting) requires students to think quickly to give the answer'

'suitable to analyze students' understanding compare to power point'

'student will think and do the voting'

'voting sessions made me think to look for answers'

'with the voting session, we have to force ourselves to understand it because we need to choose the answer'

'voting session gave me an overview and impression of certain important points before emb(a)rking in the lecture of the day. I think it is effective in getting students to get ready what we have to focus in the class'

'(it) was fun and attention-grabbing'

iv. The advantages of the voting phenomenon in terms of personal assessment and feedback were reported in statements such as

'it communicates instantly to me concerning my true performance. I was able to define myself secretly'

'normal power point sessions provide a detailed description, while voting sessions made me think to look for answers'

'with the voting session, we have to force ourselves to understand it because we need to choose the answer'

v. Other relevant submissions made by participants include the 'usual' nature of lecture sessions, the appreciation for the anonymity enjoyed by an individual during the voting, the benefits of the interactive element added by the voting to normal class procedures as well as its ability to foster readiness in the learner. Comments in these respects include:

'power point is too normal. all teachers and lecturer also present in normal power point'

'the interactive element make the learning process more effective'

'voting session gave me an overview and impression of certain important points before emb(a)rking in the lecture of the day'

'as it will not show our identities and answers, so I will not feel embarrassed if I answered it wrongly'

'I was able to define myself secretly … my response was purely mine'

6.0 DISCUSSION

6.1 Engagement in PI based on Voting Element

The results of the study shows that students feel more engaged with learning during the voting session compared with the lecture session as seen in the slightly better performance shown in the performance tests. The live observations however emphasizes this as students are found to get more involved with learning during the voting sessions than in the lecture sessions where they are more or less passive observers as observed by Mazur [24]. Students reflections also shows the same results as participants testified to the ability of the voting session to foster as well as promote interaction, focus, engagement, thinking, personal assessment, understanding and metacognition.

6.2 Motivation in PI based on Voting Element

Students are found to also experience increased motivation during the voting sessions. The results of the live observations underscore this. Students self-report through the Facebook reflections also support this finding. Expressions that validate this include those that emphasize the novelty, the increased interest, the unusual-ness and the fun it brings to learning. Participants were ecstatic about the voting session and almost everyone expressed the desire not only to have a repeat of the experience but to also see the phenomenon employed in their other courses.

6.3 Learning Performance in PI based on Voting Element

Though the result of the performance test shows only slight difference in learning gains when both sessions are compared, the results of the qualitative study emphasizes the ability of PI to promote improved performance. Increased engagement with learning has been proven to be associated with improved performance [8, 14, 17]. The result of the quantitative data could actually be due to the limitations of such type of data in providing in-depth information that cannot be captured in numeric form. The fact that the t-test of the learning gains also tends towards significance is also important to note here.

This study adopted a combination of both qualitative and quantitative analysis. This is to provide an opportunity to view the research questions from as varied angles as possible. Quantitative analysis is more amenable to studies involving a large number of people and usually for which prior predictions or past researches can be compared for an interpretation of the results. The method is based on specific and narrow research questions or hypotheses. Instruments use preset questions which put a limitation on the information that could be accessed [28] which is capable of jeopardizing the integrity of findings. In addition, certain types of information cannot be accessed using preset questions, especially in cases like perception studies or studies involving a small purposive sample or a small population [29]. In such cases, quantitative research may not provide the true picture of the situation being examined. A combination of both methods becomes the best option in providing insight on information that otherwise might not be accessible. Findings from the quantitative analysis of this study show that learning gains were significant for both sessions as observable in the t-tests which shows significant values in both cases. However, when the mean difference between learning gains in both sessions were compared, the t-test result was not significant but only approached significance ($p=0.069$).

For the qualitative study, the result of the live observation confirms that learners are more engaged with learning when peer instruction was employed than when the regular lecture was used. Students' reflections also lent support to these finding as participants responses show that they find the voting sessions more engaging and more effective in promoting metacognition, interest, motivation and this has the capacity to result in improved learning.

7.0 CONCLUSION

The study provided assessment of the voting element of peer instruction by comparing students' performance and experience with those in a normal lecture session. Though the performance tests for

immediate recall shows no significant difference for sessions, live observation and students' reflections shows higher level of engagement. In addition to other important advantages, students found the voting quite unique, interesting and something they wish to see in other class sessions. It is obviously a diversion from the usual lecture sessions. The results of the study validates the benefit of the voting element for improving learning based on submissions from previous studies concerning the benefit of increased engagement to improve learning. It also validates the usefulness of PI in a non-science setting.

8.0 RECOMMENDATIONS FOR FURTHER STUDIES

The study validates a single element of the peer instruction model, the voting phenomenon. Other elements of the model including pre-class assignment, JiTT and peer discussion should also be validated. The value of the voting element as regards actual retention should also be assessed especially in terms of the performance test. Tests beyond immediate recalls are required to ascertain this.

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