DYNAMIC TEACHING RATIO PEDAGOGIC MODEL

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ABSTRACT

This paper outlines an innovative pedagogic model, Dynamic Teaching Ratio (DTR) Pedagogic Model, for learning design and teaching strategy aimed at the postsecondary technical education. The model draws on the theory of differential learning, which is widely recognized as an important tool for engaging students and addressing the individual needs of all students. The DTR model caters to the different abilities, interest or learning needs of students and provides different learning approaches based on a student's learning ability. The model aims to improve students' academic performance through increasing the lecturer-to-student ratio in the classroom setting. An experimental case study on the model was conducted and the outcome was favourable. Hence, a large-scale implementation was carried out upon the successful trial run. The paper discusses the methodology of the model and its application through the case study and the large-scale implementation.

Key words: *dynamic teaching ratio, differential learning, ability grouping, flexibility*

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1. Introduction

No one would ever say that all students are the same. Yet in schools, we often treat students as if they were, even though all those faces look so different (Gayle & Carolyn, 2002). The traditional teaching pedagogy often adopts a one-tier learning approach with a fixed learning pace and environment for all students. All students, regardless of learning ability and pace, are provided with the same delivery approach and learning resources. However, the three principles from brain research, which are emotional safety, appropriate challenge, and self-constructed meaning, suggest that a one-size-fits-all approach to classroom teaching is ineffective for most students and harmful to some (Tomlinson & Kalbfleisch, 1998).

Therefore, recognizing the differences among students and providing appropriate teaching and learning strategies to different groups of students are important aspects that educators should address and act upon. Consequently, it follows that although essential curriculum goals may be similar for all students, methodologies employed in a classroom must be varied to suit to the individual needs of all students, i.e. learning must be differentiated to be effective (Priscilla, 2004).

Differential learning is an important tool for engaging students and addressing the individual needs of all students. Differentiating instruction means creating multiple paths so that students of different abilities, interests or learning needs experience equally appropriate ways to absorb, use, develop and present concepts as a part of the daily learning process (Priscilla, 2004).

Theoretically, differentiation is a philosophy that enables educators to plan strategically in order to reach the needs of the diverse learners in classrooms today to achieve targeted standards (Gayle & Carolyn, 2002). Grouping learners according to their ability increases their achievement by reducing the disparity in their ability levels. Besides, it also increases the likelihood that teachers can provide instruction that is neither too easy nor too hard for most students. The assumption is that ability grouping allows the teacher to increase the pace and raise the level of instruction for academically stronger students, and to provide more individual attention, repetition and review for academically weaker students. The academically stronger students benefit from more advanced learning activities that give them more in-depth knowledge, and the group of students who need more attention from the teachers does not need to compete with their more able peers and they can obtain more personal guidance and assistance from the teachers. Through differentiation, we give all these students the opportunity to learn to their full potential (Gayle & Carolyn, 2002).

Many theories have been proposed to explain the apparent effectiveness of this kind of grouping in promoting academic excellence. Bandura and Walters's (1963) social learning theory explains the increased performances of academically stronger students in the class grouping context. Glass's (2002) discussion on Slavin's (1986) meta-analysis of studies on this kind of grouping has provided indisputable evidence that it has indeed benefited this particular group of students. Based on the social learning theory, this group of students tends to model the behaviour of other high achieving students and as such is motivated to engage in more challenging tasks, like more projects and competitions (Glass, 2002). As for the academically weaker students, studies by Slavin (1986) have shown that such grouping may also favour these

students because teachers are better able to give them more attention and design more appropriate activities to suit their abilities.

In brief, this paper sets out to help educators design and deliver lessons to suit the student's ability more effectively by utilizing the theory of differential learning and providing a practical design methodology, the Dynamic Teaching Ratio (DTR) Pedagogic Model. The objective of this multi-tier pedagogic model is to enhance students' academic performance and potentials, so as to equip them with the skills and knowledge for employability in a global economy and progression to higher education.

2. Methodology Of Dynamic Teaching Ratio Pedagogic Model

The DTR pedagogic model is an active intelligence learning strategy that facilitates differential learning. It creates an active learning environment and caters to the different learning abilities of students. It is introduced to 1st year students studying *National ITE Certificate* (*Nitec*) or *Higher National ITE Certificate* (*Higher Nitec*) courses in the Institute of Technical Education (ITE), Singapore. Students go through the profiling process during the first three months of study and are categorized as Learner Group 1 (LG1), Learner Group 2 (LG2) or Learner Group 3 (LG3) based on their learning needs and learning pace. The reason for grouping the students into three groups instead of two or four (or even more) groups is in consideration of the student's profile and the amount of resource needed to provide the different instructional materials. Grouping the students into two groups may not reflect the actual profile of the students and may result in too much diversity in each group as the academic profile of the students spreads over a considerably wide range. Categorizing into four or more groups requires much more resources to develop the different instructional materials, which is not feasible in practice.

The profiling process includes two stages. The first profiling is based on students' previous academic results from their secondary schools and is done at the beginning of the semester when students are enrolled into the courses. Students' academic results from their secondary schools are based on their academic grades from Singapore-Cambridge General Certificate of Education (GCE) Ordinary Level (O-Level) or Normal Level (N-Level) examinations. The Singapore-Cambridge GCE O-Level and N-Level examinations are annual examinations conducted in Singapore (Singapore Examinations and Assessment Board [SEAB], 2010). The O-Level examination is taken by students at the end of their fourth year for express stream or fifth year for normal academic stream in secondary school. The N-Level examination is taken by students after four years in the normal academic or normal technical stream in secondary school. The level of achievement in each subject is indicated by the grade obtained, with A1 being the highest achievable grade and F9 the lowest. As illustrated in Table 1, each grade has a point value respective to it, for example, with grade A1 being 1 point and F9 being 9 points. Thus, the fewer the points are obtained; the better the score will be (SEAB, 2010).

Table 1. Grading system of GCE O-Level and N-Level examinations

Grade	Grade Point
A1	1
A2	2
B3	3
B4	4
C5	5
C6	6
D7	7
E8	8
F9	9

A study was carried out based on randomly selected graduates to examine the correlation between students' academic grades from the O-Level or N-Level examinations and their cumulative Grade Point Average (GPA) when they graduated from ITE courses. In this study, the sum of the points of the best four subjects from the O-Level or N-Level examination was the first variable. And student's GPA was the second variable. The correlation coefficient between these two variables was computed and the result showed that there was a moderate correlation between them. As shown in Table 2, the negative correlation coefficient indicated that as the sum of the best four subjects decreased, the cumulative GPA increased. In other words, students with better academic results from their secondary schools were likely to continue to achieve better academic performance in ITE.

Table 2. Correlation between students' academic profile and cumulative GPA

Course Name	Class	Number of Students	Correlation Coefficient
Electronics	Class 1	38	-0.858
	Class 2	38	-0.628
Multimedia Technology	Class 3	38	-0.622
	Class 4	38	-0.677
Info-Communications Technology	Class 5	38	-0.549
	Class 6	34	-0.742

The second profiling is based on teacher's recommendation, with reference to 1st theory assessment result if available. The time allocated for this process is three months to allow teachers to have a better understanding on the profile of the students. The key evaluation factors are student's academic performance and class attendance. Different pedagogy styles are provided to different groups of students based on their learning abilities after the profiling process.

Learner Group 1 requires the shortest time to complete their coursework, with little or no guidance. They have better academic performance and are able to learn independently. Therefore, these students are released early from the scheduled lesson on completion of lesson requirements. They will move on to non-supervised out-of-

classroom discovery learning, which prepares them for polytechnic courses or competition projects.

Learner Group 2 is the middle group of students who are less dependent on teachers, but need more practice to enhance their understanding. Therefore, they will move on to non-supervised in-classroom directed learning with supplementary learning materials to further enhance their learning on completion of lesson requirements.

Learner Group 3, who needs the most guidance, will be given focus coaching from lecturers as the amount of guidance needed by the rest of the students has been reduced.

Figure 1 illustrates the ability grouping within a class. The percentages of learner groups are for illustration purpose and the actual percentage varies depending on the profile and learning ability of learners in each class. When LG1 and LG2 move on to advanced or supplementary learning with less guidance, the number of students in the class will be reduced significantly, and lecturers are able to focus their attention on LG3. Thus, the lecturer-to-student ratio will increase without increasing the number of lecturers.

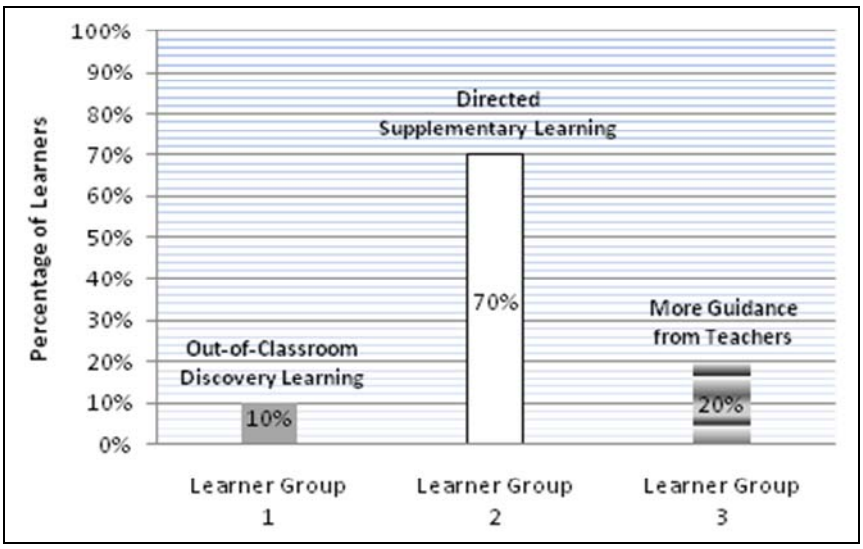

Figure 1. Ability grouping within a class

Lecturers certainly find it easier to teach students with similar academic ability and therefore are able to design activities more appropriate for them. They will be able to attend to students' problems, which are expected to be less diverse than those found in heterogeneous groupings. Lecturers of heterogeneous classes have problems giving attention to all students within the limited time because of the diverse learning needs of students.

In summary, student's learning process is optimized when different learning approaches are being applied based on their individual learning ability.

3. Design Of Experiment

The methodology of the DTR pedagogic model explains the concept underpinning the model. A small-scale experimental case study of this DTR model was conducted to evaluate the effectiveness of the model in 2009. There was an improvement of student performance from the case study. Therefore, a large-scale implementation was carried out from Jan to Jun 2010.

3.1. Case Study

The case study was based on IT Essentials & PC Support, a year one module of the 2 year *Nitec* in Info-Communications Technology course. In this module, students learn to assemble, configure and test microcomputer system. The study involved participation of 17 to 19 year old students attending the course in ITE. The sample of 83 students were drawn from the same pool who were admitted to the same course from the same intake. The students were further broken down into two groups, a control group (C Group) consisting of 41 students and an experimental group (E Group), consisting of 42 students. A t-test is commonly used to examine differences between two groups measured on an interval/ratio dependent variable (Frederick, 2006; Wiersma & Jurs, 2005). Hence, an equal variances t-test, carried out to assess the equivalence of the groups in terms of academic ability, showed no statistically significant difference between the mean GCE N-Level mathematics and science grades of the C Group and the E Group students, $t(81)= 0.508$, $p = 0.6126$, $d = 0.26$ as indicated in Table 3. Mathematics and science grades were chosen as there is intensive amount of course content that requires the knowledge of mathematics and science.

Table 3. Results of *t*-test on the GCE N-Level grades for the C Group and E Group students

	Mean	**Standard Deviation**	**t-test* (df = 81, p < 0.05)**
C Group (n=41)	6.05	2.35	*t = 0.508* *p = 0.6126* *d = 0.26* Not Significant
E Group (n=42)	6.31	2.35	
*assumption on equal variances tested			

Whilst the C Group went through the normal route of lecture and laboratory activities, the DTR model was applied on the lessons of the E Group students over a period of 16 weeks. The implementation was carried out in four stages as illustrated in Figure 2: stage 1 involved the profiling of students; stage 2 implemented the DTR model; stage 3 required the close monitoring of progress; and in stage 4 evaluation tools were applied to assess the outcome of the study. Although it is easier to describe the process here in four stages, in practice stage 2 and 3 happened concurrently, as close monitoring is crucial in ensuring the quality learning of students.

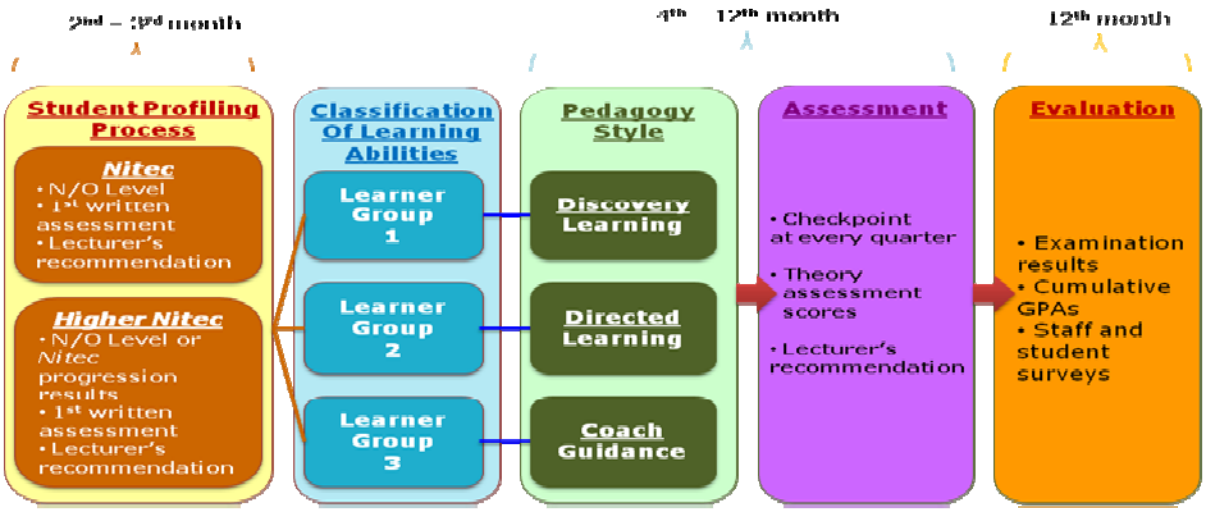

Figure 2. Implementation framework of DTR model

Stage 1: Profiling of students

As discussed above, profiling of students is the first and most important step in the entire model. The E Group students were categorized as Learner Group 1, Learner Group 2 or Learner Group 3 based on their academic profile (sum of mathematices and science grades of GCE N-Level examination). Only Learner Group 1 was aware that they would be given additional and advanced learning activity, while the grouping of Learner Group 2 and 3 was not made known to the students so as to avoid negative stereotyping.

For the purpose of result comparison and discussion, the C Group students were also categorized into three groups accroding to the same guideline. No intervention was acted upon this group and students were not aware that they were in a control group excluded from a support intervention. The categorization of learners is shown in Table 4.

Table 4. Categorization of learners (academic profile)

Groups	Sum of Mathematics and Science Grades of GCE N-Level Exam	Number of Students	
		C Group	E Group
Learner Group 1	2	4	4
Learner Group 2	≥ 3 and ≤ 7	29	28
Learner Group 3	≥ 8	8	10

Stage 2: Implementation of the DTR model

In the implementation of the DTR model, the module delivery consisted of one lecture and three practical laboratory lessons every week. The E Group students attended the same lecture as the C Group students. The following learning activities were implemented during practical laboratory lessons:

Learner Group 1 was released 1 hour earlier from the scheduled lesson after they completed the coursework. With the available time and space, they took up additional and advanced online learning under the supervision of another lecturer. The students had also gone the extra mile to meet up with the lecturer during their free time for further learning and discussion. The additional learning activity was based on students' current curriculum and gave extra knowledge and practice to build up a stronger foundation. When the students were competent in their fundamentals, they moved on to the development of in-house or on-going competition projects.

Learner Group 2 mostly finished their coursework 30 minutes ahead of the lesson schedule. Since this group of students required less guidance from the lecturer, they were provided with PC and Internet access and given online learning materials to revise their lessons. The comprehensive e-learning materials, containing lecture notes, diagrams, simulation videos and quizzes, provided an excellent platform for students to further enhance their learning.

Learner Group 3, who needed the most guidance, were given more attention from the lecturer as the amount of guidance required by the rest of the students had been reduced. The lecturer was able to revise the lesson topics with this group of students and demonstrate the practical labs in a small group setting. With more help and support available, students were motivated to learn and complete their assignments on time.

Before the DTR model was introduced, there were lecturers assigned to guide students for the development of in-house or on-going competition projects. As such, with this DTR model, there was no additional manpower requirement to supervise Learner Group 1 for technology projects. The lecturer-to-student ratio was 2:42 at the beginning of the lesson. When the four students from Learner Group 1 were released from the lesson to take up advanced learning, the ratio increased to 2:38 without additional manpower involved. Furthermore, when an approximate number of 10 students from Learner Group 2 took up e-learning and required less guidance, the ratio was further increased to 2:28 dynamically and more attention was given to Learner Group 3, who needed the guidance most.

Stage 3: Monitoring of progress

At this stage, students' in-course performance was monitored closely by the research team. Bi-weekly assessments were conducted and reviewed to monitor the progress of the students. If there was a deterioration in any of the individual performances, module lecturer would obtain feedback from the student to ascertain the root cause and advise the student accordingly. If necessary, the student would be re-catogorized to the lower grouping. This regular monitoring approach also identified potential lower academic performers and helped to ensure the quality learning of students.

Stage 4: Evaluation of outcome

The final stage involved evaluation of students' performance and assessment of the effectiveness of the model. Class test scores from the C Group and the E Group students were analyzed. The maximum score for all the tests mentioned in the paper was 100. An equal variances t-test was conducted and the result showed that there was a statistically significant difference between the mean class test scores of the C Group and E Group students, $t(81) = 2.473$, $p = 0.0155$, $d = 8.14$ as indicated in

Table 5. The E Group students obtained a higher mean score of 63.17 compared to 55.02 in Group C.

Table 5. T-test results of class test scores for the C Group and E Group students

	Mean	**Standard Deviation**	**t-test* (df = 81, p < 0.05)**
C Group (n=41)	55.02	14.33	*t = 2.473* *p = 0.0155* *d = 8.14* Significant
E Group (n=42)	63.17	15.62	
*assumption on equal variances tested			

The second comparison was done between the exam scores of the C Group and E Group students. The result showed that all the three groups of students from Group E achieved better performance than Group C in terms of passing rate and average mark, as shown in Table 6.

Table 6. Comparison of exam performance for the C Group and E Group students

		C Group	**E Group**
Learner Group 1	Passing rate	100%	100%
	Average mark	71.5	81.0
Learner Group 2	Passing rate	59%	57%
	Average mark	52.6	55.2
Learner Group 3	Passing rate	50%	70%
	Average mark	50.8	54.3
Overall	Average mark	54.1	57.5
	Passing rate	61%	64%

In addition, categorization of students was done again to study students' progression based on exam scores. The guideline for categorization and the changes in grouping are given in Table 7. The E Group students achieved better progress in their performance as compared with the C Group students. 21.4% of students from Learner Group 2 progressed to Learner Group 1, and 60% of students from Learner Group 3 progressed to Learner Group 2.

Table 7. Categorization of students (exam results)

Groups	Exam Results	Number of students	
		C Group	E Group
Learner Group 1	≥ 80	2	9
Learner Group 2	> 50 and < 80	19	23
Learner Group 3	≤ 50	20	10

3.2 Large-Scale Implementation

From the case study, there was a significant improvement in the performance of lower academic performers. Furthermore, it enriched the learning experience of higher academic performers by engaging them in project works and competitions. Hence, with the successful case study, a large-scale implementation at the school level was carried out from Jan to Jun 2010.

The target population for the implementation was first year students from School of Electronics & Info-Comm Technology at ITE College East. In this study, a sample of 502 students from the 2 year *Nitec* in Info-Communications Technology and *Nitec* in Electronic Engineering courses were chosen.

The DTR model was applied on the lessons of the two core modules that the students undertook in the first semester over a period of 6 months. The implementation process was same as the case study described in the preceding section. The categorization of learners after the profiling process was shown in Table 8.

Table 8. Categorization of learners (academic profile)

	Percentage of Learners
Learner Group 1	8.0%
Learner Group 2	63.0%
Learner Group 3	29.0%

After the 6-month implementation, evaluation was conducted based on students' cumulative GPA at the end of the semester and results are discussed in the next section.

4. Results And Discussion

Students' performance was evaluated and their grouping was reviewed based on the guideline given in Table 9.

Table 9. Guideline for categorization of learner groups

	Cumulative GPA
Learner Group 1	GPA ≥ 3.5
Learner Group 2	2.0 ≤ GPA < 3.5
Learner Group 3	GPA < 2.0

4.1. Analysis of Learner Group 3

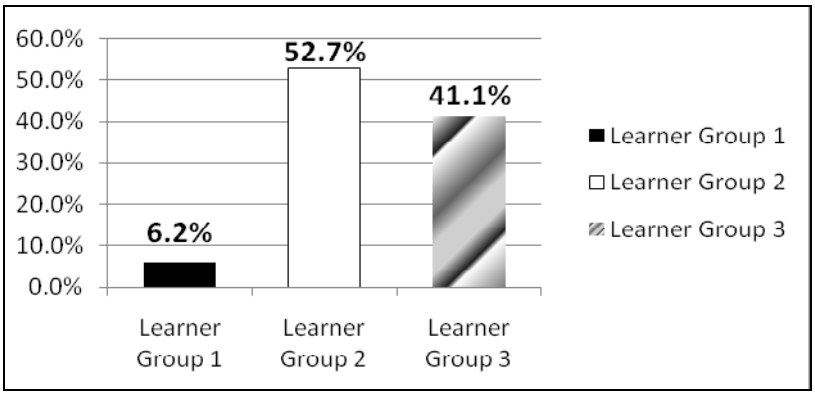

Figure 3. Movement of learner group 3

From Figure 3, 6.2% (9 students) of Learner Group 3 (146 students) moved up to Learner Group 1 and 52.7% (77 students) moved up to Learner Group 2. 41.1% (60 students) remained in the Learner Group 3. A more detailed study showed that these movements were due to the greater attention given by the lecturers to Learner Group 3.

4.2. Analysis of Learner Group 2

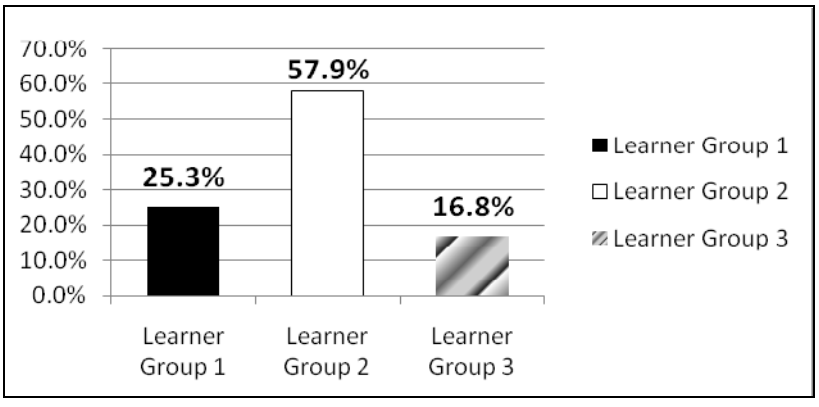

Figure 4. Movement of learner group 2

From Figure 4, 25.3% (80 students) of Learner Group 2 (316 students) moved up to Learner Group 1 and 57.9% (183 students) remained in the Learner Group 2. The movement is due to the provision of supplementary materials, which provides more examples for the Learner Group 2. On the other hand, 16.8% (53 students) moved to Learner Group 3. The findings for this movement were: firstly, there was no correlation between GCE O-Level or N-Level results and student learning ability for certain cases; secondly, some students, especially foreigners, could not understand the lesson due to language proficiency; lastly, there were other factors such as peer influence that could affect student performance.

4.3. Analysis of Learner Group 1

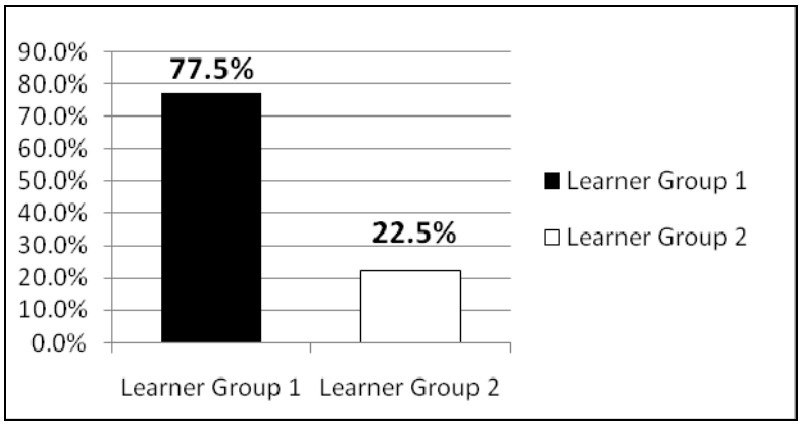

Figure 5. Movement of learner group 1

From Figure 5, 77.5% (31 students) of Learner Group 1 (40 students) remained in Learner Group 1, and 22.5% (9 students) moved to Learner Group 2.

4.4. Survey Findings

The findings from the staff and student feedback survey on the DTR model were encouraging. Table 10 and Table 11 listed the questions included in the survey. All the lecturers indicated that the model had helped them manage and engage students better, and more than 90% of the students confirmed that they had benefited from the model.

Table 10. Staff survey questions

Question Number	Question
1	The Dynamic Teaching Ratio (DTR) pedagogic model helps me manage my class better, in terms of student behavior and attendance.
2	The DTR model helps me have a better understanding on students' learning process.
3	The DTR model doesn't affect the schedule of module delivery.
4	Does the DTR model help you conduct less extra lessons?
5	The DTR model helps me engage students better and my students benefit from the learning activities.

Table 11. Student survey questions

Question Number	Question
1	Are you currently on - Option 1: Polytechnic enrichment learning/projects? - Option 2: Self-learning in class with supplementary learning materials? - Option 3: Small-group learning?
2	The learning activities have helped me on my studies.
3	I am able to improve my academic performance.
4	I am able to carry out the learning activities with minimum amount of guidance from teachers.
5	I would like to continue the same type of learning activities.

5. Conclusions

Substantial advantages have been gained from the implementation of the DTR model. Lecturers have been able to identify the diverse learning needs of students and provide various learning activities to the different groups of students after the students have gone through the same coursework. This has allowed the matching of expectations between lecturers and students and helped students learn at their own pace and improve their performance.

Further evaluation of the model is under way, but it can be concluded at this stage that the use of the DTR model has not only enriched higher academic

performers by engaging them in learning of more advanced topics, but also improved the performance of lower academic performers. The dynamic change of lecturer-to-student ratio has been made possible through the model. This innovative pedagogic model offers a useful tool that can easily be used by lecturers to design lesson delivery that caters to the different learning abilities of students and optimizes the learning process.

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