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Rafidah Othman, Masitah Shahrill,
Lawrence Mundia, Abby Tan
Brunei
Miftachul Huda
Brunei & Malaysia

Investigating the Relationship Between the Student's Ability and Learning Preferences: Evidence from Year 7 Mathematics Students

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Abstract

In the last decade, the emergence of diverse students in a streamed class based on the mathematical ability brought upon challenges for the teacher to find an approach which could accommodate all students. This study aims to investigate the connection of students' ability with their learning preferences in mathematics by applying differentiated instruction using tiered assignments and parallel tasks. This qualitative approach was used for this study from a sample of year 7 mathematics students within *Pengukuhan Kemahiran Asas* programme (PEKA) (the Basic Skills Strengthening programme), which revolved upon low ability for students with very weak numeracy skills. The findings in general revealed that there is an improvement in their performance.

Keywords: *ability, learning preferences, mathematics, differentiated instruction*

Introduction

In the last few decades, the emergence of diverse students in tracking the entire school population is assigned to refer streaming and setting, which has also been a challenge particularly related to the students' mathematical ability (Ireson et al., 2002). This leads the teacher to find out an approach to cover in accommodating the students' ability, mainly in mathematics referring to their learning preferences. Differentiated instruction is taken to use in providing appropriateness into diverse students with different abilities in learning. This comprises content absorbing by the students and developing materials and assessment (Anderson & Kilduff, 2009). In this case study, students will be exposed to different types of tasks in learning mathematics to connect with their ability and their learning preferences. It aims at producing students who are not only mastering the procedural knowledge but also in the conceptual knowledge to help improve their prior perceptions on mathematics, mainly enhancing the literacy and numeracy skills among students who pass only one or two subjects in their primary school assessment. This study is designed to assess a program which has a similar feature to differentiated instruction to investigate the student's ability and learning preferences.

Between students' ability and learning preferences

Since learning has been defined as an act of acquiring a modification of the knowledge and behaviour skills, the main part of academic achievement is how to absorb the knowledge from which it is acquired learning (Orrell, 2006). In this regard, the student would have a chance to acquire knowledge with a unique and different ability to achieve. Among those are passions (Kutnowski, 2005), learning preference (Fürnkranz, & Hüllermeier, 2011) and learning skills which enable the student the act of acquiring and modifying the existing knowledge to transform behaviours and values (Boud, 2013). These components can influence synthesizing divergent types of information shaped into knowledge (Argote et al., 2000). The ability to learn may be possessed to follow the learning style, which can be viewed as a process to factual and procedural knowledge (Riding & Sadler-Smith, 1997). In particular, students' ability could create opportunities in the tracking system, where the entire school population is assigned to classes according to whether the students' overall achievement is above average, normal, or below average. Students attend academic classes only with students whose overall academic achievement is the same as their own. Moreover, learning preferences refer to the person's characteristic patterns of strengths, weaknesses and preferences in taking in, processing, and retrieving subject matter (Mayer & Massa, 2003). This characteristic can be seen as students show their reaction during and within classroom process, involving the various kinds of preferences in terms of verbal/written, visual/graphic, active/reflective, aural/auditory/oral, (Fürnkranz & Hüllermeier, 2011).

Differentiated Instruction

Differentiated instruction is a learning approach that requires the teacher to be flexible in their teaching and modify their methods of presenting information to students rather than making the students fit into the curriculum (Subban, 2006). It will result in positive achievement in connecting the students' ability with their learning preferences (Sternberg, 2002). The implementation of the differentiated instruction can enhance the learning process and improve students' achievements through processing and constructing different avenues to learning in the classroom and making sense of ideas, so that although there are differences in their ability, they can learn effectively in the classroom (Valiande et al, 2011).

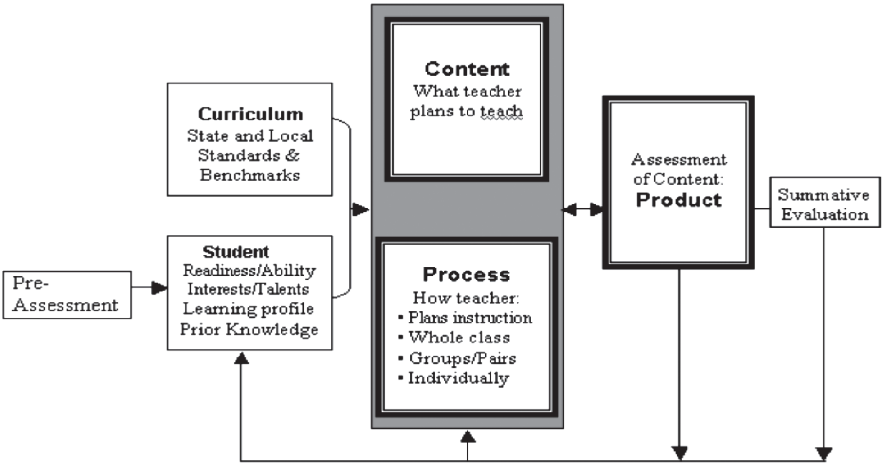

Figure 1. The learning cycle of differentiated instruction adapted by Oaksford and Jones (2001, as cited in Hall, 2002)

In addition to conducting this approach, it is necessary to first investigate students' background knowledge, readiness, language, learning style and interests by giving a pre-test or pre-interviews (Ernest et al., 2011). To achieve this, we conducted a series of formative assessments.

Formative Assessments

Formative assessment, widely known as assessment for learning, is an ongoing assessment through the use of observations and other forms of measurement that informs teacher instruction and provides students with feedback on a daily basis (Frey & Fisher, 2013). In this study, we conduct two types: tiered assignment and parallel tasks. Tiered assignment is designed to address students' needs at different levels of readiness (Levy, 2008). It consists of three different levels that coincide with students' readiness: high, medium and low. Parallel task is another approach used as a differentiated learning task created based on the prior diagnosis of students' needs (Entwistle & Ramsden, 2015).

Research Design

The data collected were analysed appropriately and based on the findings, the researchers then assigned students with the corresponding tasks. The researchers adapted the learning cycle of differentiated instruction as seen in below.

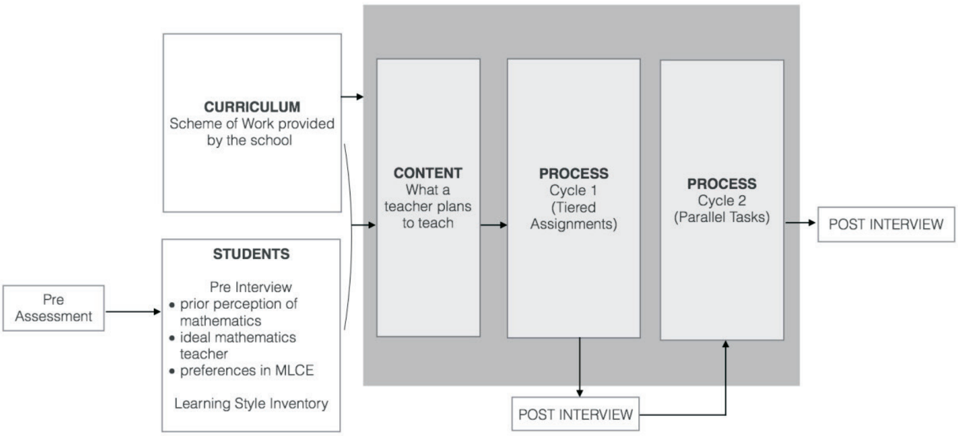

Figure 2. The design framework for the research

One pre-interview, one learning profile and one pre-assessment were given to the students, prior to the first cycle. This was then followed by lesson intervention, i.e., differentiated instruction in using tiered assignments. This cycle ended with a post interview. The second cycle began with a lesson intervention, i.e., differentiated instruction in using parallel tasks. Just as before, this cycle also ended with a post-interview. Both cycles were taught on the topic called the order of operations on whole numbers. This topic was taken as convenience. In both interventions, the lessons were recorded using a video recorder and the analyses of the recordings were included in the findings.

Research Question

This study was conducted with the use of pre-assessment, pre-interview, learning profile (figure) and post-interview. There were two main research questions:

1) Does connecting "students' ability" with "their preferences" change their "perceptions in learning mathematics"?
2) Does differentiating the "process of learning" give "positive outcome" to students' performance?

Pre-Assessment

Pre-assessment was given to the students to investigate their prior knowledge on the convenient topic, using operations on whole numbers. The researcher handed out a paper-and-pencil test instrument, which contained 20 items. The amount of time given to complete the pre-assessment was 45 minutes.

	ITEMS																				
STUDENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	4
3	1	1	0	0	1	1	0	1	1	1	0	0	1	1	0	1	1	1	1	1	14
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	1	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	5
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4	2	0	1	4	1	0	1	2	1	0	0	2	2	0	1	2	1	1	1	26

Figure 3. The results of the pre-assessment for each student in each item

According to Figure 3, a student (3) getting the highest score among his peers proves that the student can represent a very strong foundation in calculating the four operations. Meanwhile, those who scored 0 in all of the questions, e.g., students 8 and 9 did not show any attempt at all except in item 1, whereas the work samples of students 4, 5 and 7 showed that they did not know how to compute accurately to questions that contained at least three random numbers with two operations.

Learning Style Inventory

The 'learning style inventory' (Beatrice, 1995) contained 14 items modified and used by the researcher to help identify the students' learning styles, i.e., whether they are visual (V), auditory (A) or kinaesthetic (K) learners. The analysis in this particular survey was conducted by adding the number of V, A and K.

Table 1. Results of the Learning Style Inventory

Learning Styles	Students
Visual (V)	4
Auditory (A)	2, 3, 5, 9
Kinaesthetic (K)	1, 6, 7, 8, 9

According to Table 1, the majority of the students are kinaesthetic learners. Each student was classified with one learning style except for student 9, who has two types of learning styles, which are auditory and kinaesthetic. Only student 4 has the visual learning style. This proved that streaming students of equal ability does not necessarily constitute the students to have the same learning method.

Students' Learning Preferences in a Mathematics Classroom

This interview, involving 9 students, was conducted individually before the implementation of the differentiated instruction. The interview concerned their perceptions in mathematics, their learning preferences and their ideal mathematics teacher.

Researcher: Imagine you are doing your work right now. One of your classmates started to make noises. What do you think about that?

Student 2:	I don't mind.
Researcher:	So what you're saying is that it doesn't bother you?
Student 2:	Nope. For me ... as long as they don't disturb me in my work, I'm okay with it. They make noise because they are learning.
Researcher:	What do you mean by that?
Student 2:	Sometimes the teacher gives work and we can't do it without help. So we have to talk with our friends to ask them if they know how to do the work.

According to student 2, there were two types of noises that could happen in a mathematics class. One of those noises was a 'learning' noise, e.g., talking with their peers about the work, whilst the other was its counterpart, 'disturbing', such as distracting a peer from completing his/her work. Although claiming that a noisy classroom did not affect him, he was very specific that the noise itself must be strictly due to other students' learning process. Meanwhile, student 3 specifically requested that the only time the classroom must be quiet was when the teacher was teaching or giving instructions. With regard to the students' preferences on grouping, only students 2, 3 and 9 have a preference on doing their work individually. When probed further, student 3 stated that he preferred to do the work on his own first before seeking help either from his peers or the teacher. Meanwhile, student 2 claimed that he worked well on his own whereas student 9 acknowledged that she was very shy to interact with other students if she was assigned to work in a larger group. However, during both cycles, students 2 and 9 did not follow their initial statement. Instead, both of them worked with partners to complete the exercises.

Cycle 1

Analysis on Tiered Assignments

In this cycle, the researcher had control in deciding which of the three different levels of exercises were to be given to the students in respect to their ability as noted from the results of the pre-assessment (cf., Table 2).

The result is that all the students, except for student 3 who was categorized as a high ability student, worked together with a partner. Throughout the lesson, it was observed that the low ability students were struggling to answer the questions regardless of having a partner. Hence, the students often sought help from the researcher in how to answer the questions. In one occasion, the researcher used

Table 2. Students categorized as Low (L), Medium (M) and High (H) ability students

Ability	Students
Low (L)	4, 6, 7, 8, 9
Medium (M)	1, 2, 5
High (H)	3

the first question as a guide for these students and hence, prompted them to do their own work. Meanwhile, the medium ability students managed to work out the questions fairly quickly. Hence, due to the poor responses from both abilities, the researcher decided to revise the questioning of the assignment (cf., Appendix 9) and hence, the researcher revised the categorization of their abilities as well (cf., Table 3).

Table 3. Students categorised as Low (L), Medium (M) and High (H) ability students (revised)

Ability	Students
Low (L)	1, 2, 4, 5, 6, 7, 8, 9
Medium (M)	None
High (H)	3

As shown above, none of the students was labeled as a medium ability student. Therefore, using the revised assignment, the researcher was able to observe a change in the behavior of the students. Just like the previous assignment, the students were given a choice on whether to work on their own or work with one of their peers. Table 4 shows the students' response in this respect.

Table 4. Students' preferences in pairing for cycle 1 (revised)

Students	Individual or Partner
1, 2, 3, 4, 5	Individual
6, 7	Partner
8, 9	Partner

Table 4 shows that the students' preferences in the grouping differed from the previous one. Coincidently, all the boys decided to work individually whereas the girls remained working with a partner. This shows that some of the students had gained some confidence after being exposed to the same questions for the second time. During this lesson, the difference in the students' behavior was apparent; they were more independent and much more eager to complete their own work before seeking direct help from the researcher. However, among those who worked with a partner, it could be seen clearly that one student was more dominant than the other. For instance, student 6 was dominant in dictating the work whereas student 7 did more computing than her partner. A dominant player within a group tends to influence the product of the groups' work (Anderson & Kilduff, 2009). In addition, it was found that peer group study had a positive impact on learning mathematical concepts (Othman et al., 2015).

Tiered Assignments

The students were interviewed at the end of the revised cycle 1. The students were firstly questioned upon their opinion on how the assignment itself had changed their perceptions in learning and understanding mathematics. Only students 1 and 4 found the assignment to be straightforward and for them it was easy to understand the concept of BODMAS using the step-by-step method. Meanwhile, students 2 and 5 struggled mainly because of their admittance that they were weak in the calculation. However, by using the tally method taught by the researcher, the students succeeded in finding the solution. While the boys found the assignment to be worthwhile, the girls found it very difficult. Below is an excerpt taken from the interview with student 6.

Researcher:	How did you find the exercise?
Student 6:	Erm...(nervous laugh)...difficult.
Researcher:	Which part did you find difficult?
Student 6:	... the BODMAS. I don't know where to write the answer.
Researcher:	Do you mean this? (researcher pointed out the attempted work done by student 6 on question 6)(cf., Figure 7)
Student 6:	Eh... is that wrong?
Researcher:	Do you not see the mistake you made?
Student 6:	(shakes head)

According to Figure 4, student 6 used a rectangle shape to indicate which of the operations she wanted to calculate first according to BODMAS. However, when she reached the third line, she made a mistake. It was apparent that she followed the

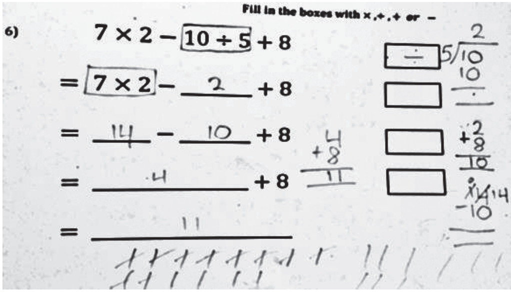

Figure 4. Student 6's response to question 6

BODMAS rule where addition comes first before subtraction. When the researcher pointed out the mistake, it took her a while to notice that when you calculate an expression consisting only of the addition and subtraction operations, you must calculate the operations from left to right. This applies to multiplication and division, as well. When the girls were further questioned on how their choices of having a partner improved their learning, the dominant ones claimed that it did not help at all because they were equally weak in their basic computation. It confirms the saying "the blind leading the blind". Hence, streaming students of equal ability, in this case, the low ability students did have negative effects on their learning (Kilgour, 2009).

Cycle 2

Analysis of the Parallel Task

In this cycle, the students were given a choice of whether to work on easy questions (green card) or challenging questions (purple card) (cf., Appendix 10a and 10b respectively). All the students, except for student 3, chose to do the questions included in the green card. Similarly to the previous cycle, the students could either work individually or with a partner that had chosen the same task. One student from each group was instructed to draw one random question from a box containing 10 different questions. Once they had answered the question, they were to find the card which contained the solution, and consequently, copied the next question that appeared on the card. The cards were pasted all over the classroom. At the end of the lesson, the students should have had 10 different questions answered.

Video Recording

The researcher observed that all the students decided to work with a partner for this lesson except for student 3, who had no choice but to do it alone. Some of the students were dividing the task among themselves, i.e., one student looked for the solution whilst the other one solved the problem. Again, this raised the issue of teamwork. However, there were students who did not delegate any work. Instead, they decided to work together in finding the solution. In other words, more footwork appeared to be played in this cycle. It was also apparent from the video recording that the researcher played a minimum role in the lesson.

Post-Interviews: Parallel Tasks

When the students were questioned if they had enjoyed the lesson, all of them agreed that they had. Even though some of them claimed that it was very tiring to walk around the classroom, they also found it refreshing to learn mathematics in a way different from that they usually did, which was to sit and do work quietly. The students were further inquired whether the two cycles had improved their perceptions in mathematics or not. Below is an excerpt taken from the interview conducted with student 2.

Researcher:	How did you find the exercise?
Student 2:	I finally understood it, cher.
Researcher:	Which part do you mean by that?
Student 2:	...the step by step we did before, helps a lot! Looking for the answer made me more confident that I was doing it right.
Researcher:	That's great. Do you think you will be able to do it without a partner?
Student 2:	Before...maybe not. But now...yeah.

("cher" is a short form for teacher)

All the boys echoed student 2's response where they all agreed that using the step-by-step method that they had learnt in cycle 1 had boosted their understanding in using BODMAS during cycle 2. However, the girls, even after being exposed to two cycles, still claimed that they needed much simpler questions to help them understand the concept behind the computation.

In line with having a partner of their choice, only the girls found it pointless as student 7 stated that working with the same student just as in cycle 1 had not helped to improve her standings towards the subject. Instead, she expressed her disappointment that she had not been allowed to pair with a boy or at least given the permission to have more than one partner. Otherwise, she claimed that her situation would have improved. Meanwhile, when student 3 was asked about doing the challenging questions on his own, he wished that he had had a partner to tackle the questions with, as it was apparent that he had not been able to finish the work on time.

Conclusion

The present study demonstrates the learning preferences and students' ability using small convenient samples of students at a secondary school located within the Brunei-Muara district, mainly one class of year 7 students of PEKA. Although there are a few limitations to this study, namely differentiating all the content, process and product of the curriculum adopted (Tomlinson, 2000) and differentiating all three tasks to take a lot of time in the process of learning. Based on the analyses of the data collected, there are two main concluding remarks.

In cycle 1, the researchers connected the students' ability with their learning preferences in terms of grouping. Meanwhile, in cycle 2, the researchers had given the allowance for the students to decide on the grouping as well as on which of the two levels of tasks (easy or challenging) they preferred to do. Hence, through both these cycles the researchers successfully confirmed the criteria of the first research question, which connects the students' ability with their preferences. However, the above action brought upon conflict responses on whether their perceptions in learning mathematics had changed or not. Coincidentally, these conflicts were split according to their genders.

In addition, the research would give feedback to teachers in benefitting from new knowledge on how to accommodate students who are at risk of failure. However, due to the limited time the researcher had, there is a need for further study to find out if there is any room for revision to help improve students' performance, especially because the researcher was not able to find out if gender affected students' performance in a low ability class. Therefore, it is advisable to conduct similar research in several cycles in order to study all students' needs and attitudes based on gender, especially those of low ability.

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