

# The Impact of Gagné, Vygotsky and Skinner Theories in Pedagogical Practices of Mathematics Teachers in Brunei Darussalam

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## Abstract

Pedagogy in a classroom is not just for the sake of teaching but it also embodies the learning process where appropriately correct conceptual knowledge is being transferred to the learners. Educational theories that we currently come to know play an important role in the effectiveness of the teaching and learning processes. In this study, the teaching practices of three Mathematics teachers in one of the secondary schools in Brunei Darussalam were observed and examined based on the work of three educational theorists, Robert Mills Gagné, Lev Semyonovich Vygotsky and Burrhus Frederic Skinner. The observational vantage points of the research focused on the learning conditions of the lesson, students' interaction with their teachers and peers, and the teachers' responses to their learners' behaviour during the lesson. The qualitative reports indicated that the most commonly "not seen" events by the three teachers were gaining students attention, assessing the performance and enhancing retention and transfer; social interactions for example, discussions were absent in all three observed lessons; and all the three teachers gave some kind of reinforcements, such as praises and extra activities, during their lessons.

**Keywords:** educational theories, secondary mathematics, teaching and learning processes, Brunei Darussalam

## 1. Introduction

Ebert and Culyer (2011) referred pedagogy as the art and science of teaching children. The art of teaching is concerned with a teacher's philosophy, style and attitude toward providing education experiences for learners while the science of teaching involves an understanding of the psychology behind the task of providing appropriate education. Pedagogy or teaching method in a classroom is not just for the sake of teaching but the learning process where knowledge is being transferred to the learners. Educational theories play an important role in effective teaching and educators tend to forget the importance of the theories. Educators need to familiarise with the theories so that the learners will benefit from the teaching and learning process.

In this study, three classical theories are considered in the investigation of Mathematics teaching practices in Brunei Darussalam. The three theorists are Robert Mills Gagné, Lev Semyonovich Vygotsky and Burrhus Frederic Skinner.

### 1.1 Gagné—Conditions of Learning Theory

Gagné's conditions of learning theory consider human learning as an activity that involves simultaneous operation of three components: the learner, stimulus and the response (Gagné, 1985; Puri, 2006). The learner represents the internal conditions in the form of previous knowledge; the learning situation presents the stimulus and the interaction of these two results in the learning response, which is part of the human behaviour. Meanwhile, Driscoll (2005) described that Gagné's theory incorporates three major components: taxonomy of learning outcomes, learning conditions required for the attainment of each outcome and the nine events of instruction. There are five major categories of learning outcomes:

- 1) Verbal information—stating previously learned material.
- 2) Intellectual skills—equivalent of procedural knowledge and divided into hierarchically ordered subcategories: discrimination, concrete concepts, defined concepts, rules and higher order rules.

- 3) Cognitive strategies—employing personal ways to guide learning, thinking, acting and feeling.
- 4) Attitudes—choosing personal actions based on internal states of understanding and feeling.
- 5) Motor skills—executing performances involving the use of muscles.

The learning conditions influence the learning outcomes by providing the foundation for describing how the conditions of learning apply to each category represented by internal and external conditions (International Centre for Educators' Learning Styles, 2014). The internal condition is the learner's previous knowledge and the external condition is the learning situation. The nine events of instruction are the external conditions that help the learning process to occur. The nine events of instruction according to Moallem (2001) are given below.

- 1) Gaining attention—present a good problem, a new situation or a novel idea to gain students' attention.
- 2) Informing learners of the objectives—the kind of performance students should know.
- 3) Stimulate recall of pre-requisite—previously acquired capabilities before new learning takes place.
- 4) Presenting the stimulus material—stimuli that are to be displayed that reflect the learning.
- 5) Providing learning guidance—amount of hinting or promoting depending on learners' capabilities and objectives.
- 6) Eliciting performance—having learners to show that they can carry out the task.
- 7) Providing feedback—feedback concerning the degree of correctness or appropriateness of the learners' performance.
- 8) Assessing performance—teacher gathers formal and convincing evidence regarding the learners' performance.
- 9) Enhancing retention and transfer—varieties of new tasks assigned to enhance the learners' understanding and to assure the transfer of learning.

Hence, the teaching and learning process can be enhanced by focusing our attention to the nine events of instruction for effective learning and retention. In this study, the nine events of instruction will be considered in the classroom observations.

### *1.2 Vygotsky—Social Interactions*

According to Ebert and Culyer (2011), Vygotsky's (1978) idea of learning is an exercise in social interaction because information is acquired from another individual. While Moore (2012) viewed Vygotsky's idea of learning and teaching as essentially social activities that take place between social actors in socially constructed situations. Both views suggest that Vygotsky's theory focuses on the interactions within the classroom where teaching and learning process takes place. There is a transfer of knowledge from one individual to another through verbal communication and perhaps also through demonstration. In a classroom, the teacher is expected to be the knowledgeable one but the other students can also have some knowledge and understanding that can help their peers who are in need of explanation and more understanding of the subject matter. Ebert and Culyer (2011) invited teachers to adopt strategies that are not only student-centred but also create spaces for students to verbally elaborate developing concepts that involve a teacher and create a partnership between a teacher and students.

Vygotsky's theory of zone of proximal development (ZPD) is one approach to ensure that students have the opportunity to make meaningful contribution to the class community of learners. Vygotsky described ZPD as the gap between the actual developmental levels as determined by independent problem solving under guidance or in collaboration with more capable peers (Small, 2012; Vygotsky, 1978). Whether it is during the knowledge instruction or during classroom task, a teacher and students can help the low ability students to close the gap. Teachers are not using the educational time optimally if there are teaching beyond a student's ZPD or are providing tasks to student already outside his or her ZPD (Small, 2012). According to Blake and Pope (2008), the expected uses of Vygotsky's theory in a classroom are: scaffolding, small groups, cooperative learning, group problem-solving, cross-age tutoring, assisted learning and/or alternative assessment. Scaffolding is the adult assistance to solve a problem or a task beyond the learners' capability. In other words, with the help of adult guidance or peers, a learner will be more capable in attaining knowledge and skills acquired.

### *1.3 Skinner—Reinforcement*

Skinner's theory is known as the Operant Conditioning where an individual will perform a particular behaviour depending on the consequences of that behaviour (Ebert & Culyer, 2011). Operant conditioning is the use of

consequences to modify the occurrence and form of behaviour (Tuckman, 2009). If a student behaves well in a classroom, the teacher will reward the student such as by giving a gold star, sweets or simply by praising the student. The presentation of a positive stimulus or reward is called Positive Reinforcement. Negative reinforcement is when a teacher takes away something that the students dislike such as reducing the number of tasks or calling out a student name to answer a question when there are no volunteers.

Additionally, Skinner believed that students would learn the behaviours that are followed by certain reinforcements. The reinforcements must follow a response immediately and must be presented only if the desired response occurs (English, 2006). The reinforcement should be given immediately in response to the good behaviour. The other type of operant conditioning is Punishment where a stimulus is applied to reduce the undesired behaviour. Some examples of punishments are students being scolded, yelled, a time out or being sent to the Principal's office. Reinforcement and punishment shape learning and should be used by educators to create desired behaviour and prevent unwanted behaviour (Merriënboer & Bruin, 2014).

#### *1.4 Research on Teaching and Learning Mathematics in Brunei Darussalam*

The learning of Mathematics and associated poor performance in the subject has always been one of the academic problems consistently challenging Brunei students at all levels of education from primary, through secondary, to post-secondary level (Abdullah et al., 2014; Ahmad & Shahrill, 2014; Ang & Shahrill, 2014; Daud & Shahrill, 2014; Go & Shahrill, 2014; Hamid et al., 2013; Mahadi & Shahrill, 2014; Matzin et al., 2013; Mundia, 2010a, Mundia, 2010b; Mundia, 2012a, Mundia, 2012b; Nor & Shahrill, 2014; Ong & Shahrill, 2014; Pungut & Shahrill, 2014; Salam & Shahrill, 2014; Sarwadi & Shahrill, 2014; Shahrill, 2009; Shahrill & Abdullah, 2013; Shahrill, Mahalle et al., 2013; Shahrill et al., 2014; Suhaili et al., 2014; Wahid & Shahrill, 2014; Yatab & Shahrill, 2014a, 2014b). In view of these challenges, it is vital for Mathematics teachers to be equipped with strong Mathematics subject matter knowledge and pedagogical content knowledge, especially on the year levels that they are teaching in order to help raise students' learning outcomes and success in Mathematics (Kani et al., 2014; Shahrill, 2009; Shahrill & Clarke, 2014; Shahrill et al., 2014).

Besides academic problems, Brunei students also have psychological problems which impact on their achievement in a variety of ways (see Mahalle et al., 2013; Mundia, 2010c, Mundia, 2010d; Mundia, 2011a). The assessment of Brunei students' psychological problems has been hampered by many problems that include shortage of skilled psychologists and counselors trained in psychometrics and non-availability of suitable instruments in Malay language (Mundia & Bakar 2010; Mundia, 2011b). Often, Brunei students (like their counterparts elsewhere in other countries) do not know how to resolve these psychological problems (Mundia, 2010e; Shahrill & Mundia, 2014). Another assessment problem experienced by teachers in Brunei schools is the inclusion of disabled learners in regular classrooms under the ongoing SPN21 curriculum reforms. Research suggests that Brunei trainee teachers are only favorable to the inclusion of learners with mild to moderate disabilities but tend to have negative attitudes to those especially with severe or profound disabilities and high support needs (Bradshaw & Mundia, 2005, 2006; Haq & Mundia, 2012). This then implies that more efforts and priorities should be directed at preparing special education teachers for inclusive schools (Tait & Mundia, 2012). In addition, the teacher education programs should help trainees to develop high self-efficacy in special education (Tait & Mundia, 2014). In short, the ideal teacher would be one who can address problems of all categories of learners—e.g. disabled, nondisabled, and gifted - in an inclusive setting (Omar et al., 2014).

#### *1.5 Objectives of the Study*

In the present study, the Brunei National Mathematics Curriculum was reviewed to determine if the theories that constitute the topic of this study were included in the lesson(s). The research questions considered in the present study are listed below.

- What learning conditions are present in the lesson?
- How do students interact with the teacher and other students?
- How does the teacher respond to the learners' behaviour?

## **2. Methodology**

A qualitative field study approach was adopted to investigate the impact of the Gagné, Vygotsky and Skinner theories in the pedagogical practices of Mathematics teachers in Brunei. With the use of convenient sampling, three classes, each from the Year 7, Year 8 and Year 11 levels from one selected secondary school in Brunei were chosen, and one Mathematics lesson from each of the class were observed for this research study. During the observations, the three theories were referred to check whether the three Mathematics teachers from each of the chosen classes practiced any of the theories in their teaching. The instruments used were informal checklists and

anecdotal records were also collected in order to take notes on what was observed during each Mathematics lesson. The checklist consists of the expected outcome for each learning theories. The teachers were then shown the checklists after each of their lessons for validation. In order not to disrupt any of the teachers' flow of their readily planned lessons, they were informed prior to data collection to continue with their lessons as usual. Thus, it should be emphasised here that the Mathematics topic will not be the focus of our investigation and instead, it is their Mathematics teaching practices in general.

### 3. Results

#### 3.1 Observations from the Year 7 Mathematics Lesson

The Year 7 Mathematics lesson was conducted by a local Bruneian (within the age range of 31-35 years old) male teacher with 9 years of teaching experience in the lower secondary. His highest qualification is a Bachelor of Science degree in Education. There were 16 students (6 male and 10 female) present during the lesson, and were seated in pairs of the same gender (for example, boy-boy or girl-girl seating). The topic for his lesson was on Addition and Subtraction of Integers. The lesson started with the teacher reminding the students what they did in the previous lesson, which was number line. He then mentioned that they would add and subtract integers using number line and explained briefly the reason of using number line. A yellow paper was given to each student with eight examples labeled (a) to (h). The example (a) Solving  $2 + (-3)$  from the yellow paper was used to explain the concept. He used the terms "move", "journey", "left and right" and "arrows" to represent addition and subtraction of integers on a number line.

After the explanation, he asked the students to try example (b)  $2 - 3$ . The students quietly tried the example while the teacher walked around to look at their work. He found a common mistake and then explained the correct method on the white board. He emphasised to the students not to start from 0 when adding or subtracting the second integer. The teacher then asked to try the third example, (c)  $-2 + (-3)$  and at the same time to glue the yellow paper into their notebooks. Again, he walked around to check the students' work. During this time, the teacher gave a one-to-one tutoring to those who still could not do the example questions. He then asked some students to try the last two examples (g) and (h). He said that the students could try the last two examples if they were confident enough to try them. The last instruction of the lesson was to ask the students to do some exercises from the Mathematics Year 7 textbook.

#### 3.2 Observations from the Year 8 Mathematics Lesson

In the Year 8 Mathematics lesson, the topic was on Combination of Transformation. There were 18 male and 11 female students present during the lesson, and they were seated in pairs of the same gender. The lesson was taught by a local Bruneian (within the age range of 36-40 years old) female teacher with 11 years of experience in teaching lower secondary. Her highest qualification is Higher National Diploma in Finance and Business. This was a continuation of the previous lesson where students were taught the topic on reflection, translation and rotation. The teacher recapped the lesson by mentioning to the students that they did reflection line, translation vector and centre of rotation in the previous lesson.

Subsequently, she then gave the students worksheets that consisted of example questions similar to the national Year 8 Mathematics examination questions. The teacher asked one student to draw and label a triangle PQR with the given vertices in the worksheet. Then she asked another student to draw the line of reflection at  $y = -1$ . Here the student needed help and the teacher assisted the student by pointing out where to draw the line. The other students also helped the student in accomplishing the required task. The process continued until the all the images of reflection and translation were drawn. The teacher used a red marker and gave ticks for the objects, lines and images to show that the students managed to correctly do the tasks. She also praised the students by saying "very good" and "thank you". The teacher then asked the students to try another set of questions given on a piece of paper.

#### 3.3 Observations from the Year 11 Mathematics Lesson

The Year 11 Mathematics lesson was on Sets, focusing on the topic shading the required regions in a Venn diagram, and was taught by a local Bruneian (within the age range of 41-45 years old) female teacher of 19 years teaching experience. Her highest qualification is Bachelor of Science degree in Education. There were 11 male and 12 female students present, and they were seated differently from the Year 7 and Year 8 classes. The students were seated in groups of maximum of 5 students and some sat alone. The lesson notes were given to the students in the previous lesson and the teacher informed the students that they would continue with shading regions in a Venn diagram. The teacher recapped the lesson by drawing Venn diagrams of one set and two sets. She continued with a challenging question where the students would tell her the notations of a shaded Venn

diagram. The whole class responded with the correct answer. She then proceeded with an example of three sets  $(A \cap B) \cup C$  and emphasised that the students should focus on the sets inside the brackets first and then  $\cup C$ . The teacher then asked if the students understood her example and the students gave a choral response as a whole by replying “Yes!” She then gave another example  $(A \cup B) \cap C$  and asked the students to shade in a Venn diagram.

The teacher walked to check the students’ answers. After a few minutes, she asked one volunteer to go to the front of the class and shade the answer on the whiteboard. A female student volunteered but got stuck when she tried to shade  $\cap C$ . The whole class helped her while the teacher walked around to check the other students’ work. The student shaded wrongly and the teacher went to the whiteboard to correct her answer and emphasised that to look at the overlapped pattern when shading.

The lesson continued with “subset” and recalled by asking the students if they remember what is meant by  $A \subseteq B$ . The students responded “A *sebahagian* (or part of) B”. The teacher then gave an example that a classroom is part of a school. She then asked the students to take out their textbooks and asked them to try the exercises. She told the students to ask for her help if they did not understand. While the students were doing the exercise, a boy raised his hand for help. The teacher walked to him and helped him with the task. At the same time, two boys were talking and laughing. The teacher raised her voice and told them not to talk. A few minutes later, a girl raised her hand for help and the teacher approached her immediately.

#### 4. Discussion of Findings

Based on the research questions given earlier as our guide in analysing the collected field data, Table 1, Table 2 and Table 3 below show the summaries of what were observed according to the theories of Gagné’s nine events of instructions, Vygotsky’s social interactions and Skinner’s reinforcement.

Table 1. Summary of the nine events of instructions observed in the three Mathematics lessons

	Year 7	Year 8	Year 11
1. Gain students attention	Not seen	Not seen	Not seen
2. Inform students of the objectives	Seen	Not seen	Seen
3. Recall pre-requisite learning	Seen	Seen	Seen
4. Present stimulus learning	Seen	Not seen	Seen
5. Provide learning guidance	Seen	Seen	Seen
6. Elicit the performance	Seen	Seen	Seen
7. Feedback to the performance	Seen	Seen	Seen
8. Assess the performance	Not seen	Not seen	Not seen
9. Enhance retention and transfer	Not seen	Not seen	Not seen

From Table 1, the three teachers did not manage to cover all nine events of instruction and the most common “not seen” events were gaining students attention, assessing the performance and enhancing retention and transfer. The teachers did not have any visual or demonstrations to gain the students’ attention in the three lessons. In assessing the students’ performance, a short test or quiz should be given to find out if the students managed to cover the objectives of the lesson. This would have given the teacher information on what aspect of teaching needed to be adjusted during the lesson. Teachers often overlook the potential of formative assessment in improving their teaching techniques and students’ learning (Rashid & Jaidin, 2014). To enhance retention and transfer of knowledge, the teacher could give a project or other activities related to what they have learned. An example of a project work is asking the students to collect data about their favourite food, sports or rock band and draw a Venn diagram from the data collection. The activities should be based on real-life situation so that the students will be able to relate their knowledge to the problems and this will help them to retain the knowledge.

Table 2. Summary of social interactions observed in the three Mathematics lessons

Year 7	Year 8	Year 11
One-to-one tutoring	One-to-one tutoring	One-to-one tutoring
Whole class explanations due to common mistakes	Peer assisted learning	Peer assisted learning
No discussions	No discussions	No discussions

There were social interactions observed in the three mathematics lessons, which were mostly teacher assisted and peer assisted learning. Scaffolding was observed in the three lessons where the teachers assisted the students individually for better understanding of the lesson.

On the other hand, discussions were absent in all three lessons. The teachers should have used Vygotsky's ZPD in the form of discussions. The discussions should be based on the student's prior knowledge and introduce or transfer the new knowledge during the discussion. Hence, the teacher would deal with the students' ZPD and close the gap of knowledge. From the Year 11 Mathematics lesson, the teacher could easily use discussions in her lesson of shading the Venn diagram. Questions for the discussion should be related to what the students already know (the 2 sets) and the new knowledge (the 3 sets).

Table 3. Summary of reinforcement/punishment observed in the three Mathematics lessons

Year 7	Year 8	Year 11
Reinforcement in the form of extra work	Praising the students  Teacher has good rapport with the students	Punishment in the form of scolding

All the three teachers gave some kind of reinforcement that would help to motivate the students learning. Reinforcements do not necessarily be in the form of praises or gold stars. They can be in other forms that can motivate the students to learn such as giving them activities that the students are interested in. Games or any kind of activities can be considered as reinforcement as long as the desired learning objectives are met. Even though the Year 11 teacher gave a form of punishment (scolding), she was still approached by her students for help with the given tasks. The punishment given during the lesson was necessary in order to stop the students from talking and to proceed with the desired behaviour of doing their work.

## 5. Conclusions

Brunei's general education structure recently underwent a major transformation known as the National Education System for the 21<sup>st</sup> Century or *Sistem Pendidikan Negara Abad ke-21* in the Malay Language, and also better known as the SPN21 (Ministry of Education, 2013). The interim stage of the SPN21 implementation started in 2008 with Year 7. However, the full implementation officially started for Years 1 and 4 in 2009, and for Year 7 in 2012.

In this newly reformed National Mathematics Curriculum, there are several aims and approaches that teachers need to consider in their teaching practice that are related to the three learning theories mentioned. Examples of the aims mentioned in the SPN21 curriculum are:

- Teaching and learning processes should be learner-centred with learners being actively engaged in learning both individually and in groups.
- Provide all learners with the opportunities to learn in ways that are most suited to their learning needs.

Other teaching and learning approaches mentioned in the SPN21 curriculum are:

- Experiential - group work, pair work, simulation, interactive video, field trip, analysis of data or results.
- Reinforcement - model, chart, poster, leaflet, magazine article, newsletter.
- Integrative - conference, forum, seminar.

Based on the first author's personal prior teaching experience, the three theories of learning focused in this study are quite easy to adapt. If a strategic guideline is given or included in the lesson plan, a teacher can execute the necessary criteria in each learning theories. Teachers are therefore encouraged to use any learning theories that they think suitable for effective teaching and learning, not just in the subject Mathematics but also in other subject areas as well. According to the Ministry of Education (2013), teaching effectiveness does not depend solely on teaching methods but with the increased understanding of how learners learn. Jaidin (2009) argued that teaching should start where the learners are, and as such, it is important for teachers to understand what learning means to children in order to ensure effective implementation of teaching strategies. Teachers are also encouraged to cultivate relevant leadership styles and beliefs in the practices of their mathematics classroom teaching (Kani et al., 2014; Morsidi et al., 2014; Shahrill, Kani et al., 2013, Tsang et al., 2014). The students' psychology and behaviour should be considered and having the awareness and knowledge of learning theories are essential in delivering a good and productive lesson.

## 6. Limitations of the Study

This research study has two main limitations. Firstly, it was limited to only one selected secondary school in Brunei. Caution should be taken when interpreting the findings to this particular sample of this study only. Secondly, the Mathematics topic taught was not pre-planned by the researchers but was planned by the teachers, and the topics varied across the levels. The teachers may have many different varieties of ways in conducting their lessons, accordingly to the topics being taught. The diverse pedagogical practices of these topics may have hindered us in gathering the full impact in linking the three theories being investigated.

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