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Teaching Strategies Based on Multiple Intelligences Theory among Science and Mathematics Secondary School Teachers

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Abstract

Instructions in science and mathematics required various teaching strategies to ensure successful teaching and learning process. Science and mathematics teachers can optimize the effect of teaching when they realized the strengths of multiple intelligences they possess and how they can apply them in their teaching. Thus, the primary objectives of this study are to investigate: 1) the multiple intelligences profile of science and mathematics secondary school teachers 2) the teaching strategies based on multiple intelligences that are applied by science and mathematics teachers and 3) the relationship between multiple intelligences profile of science and mathematics teachers with the teaching strategies based on multiple intelligences applied in the classroom. 174 respondents were chosen randomly from various secondary schools in peninsular Malaysia. Questionnaires were used to investigate the level of multiple intelligences and teaching strategies. Correlation analysis was applied to investigate the relationship between multiple intelligences and teaching strategies. Teaching strategies based on multiple intelligences suggest teaching science and mathematics in multiple ways. Teachers' profiles of multiple intelligences assist them to obtain a better understanding of their potential intelligences and interests in enhancing their teaching strategies.

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1. Introduction

Research has shown that teaching and learning style have a significant effect on the quality of instruction. Research on the role of teachers and students in the teaching and learning of mathematics and science has become an area of research focus in science and mathematics education in the past decade. Studies have indicated that teachers need to equip themselves with more flexible approaches (Galton & Eggleston, 1979; Nelson, 1996) in the teaching of mathematics and science. These alternative teaching methods strive to cater to the needs of these varied learners by establishing a conducive learning environment for students. The teaching and learning of science and mathematics is no longer regarded as only a simple and technical procedure involving teaching objectives and learning outcomes. Teachers are encouraged to adopt progressive teaching styles to accommodate the varied abilities of students, so as to enable these students excel in their learning

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One of the main issues in the teaching of science is that students are constantly exposed to isolated facts and missing central concepts which are ‘the big ideas’ that make sense in science learning (Olson, 2008). Students

become disconnected with their experiences and lose interest in learning science (Aikenhead, 2006). Comprehensive and careful planning of instruction is crucial in the teaching of scientific concept. Students are encouraged to engage in the learning and sense-making process through their preferred learning styles. Teachers in the classroom play an important role and is a significant factor in creating a conducive learning environment. These varied teaching styles all contribute to the effectiveness and efficiency of the delivery of science lessons. According to Tytler, Waldrip & Griffiths (2004), one of the pathways to describe the effectiveness of a science lesson is through the description of the set of skills and techniques that good teachers embrace, referring to the repertoire of teaching styles and strategies adopted by teachers in the classroom. Sanders and Horn (1998) in Johnson, Kahle & Fargo (2007) also agreed on the notion that teachers are the significant factor in facilitating the desirable progress of students in mathematics and science.

For mathematics teaching and learning, students are not only required to have knowledge of numerical facts, but also good in problem solving abilities that are adjustable in accordance with their individual strength and weaknesses (Jones & Tanner, 2002). Lessons in mathematics should be structured into three parts: a mental and oral introduction, the main teaching and activity and a conclusion. Effective teaching of mathematics do not depend on a fixed structure of instructional strategy but involves lively and interactive two-way process in which students play an active part by answering questions and discussion, explaining and demonstrating their methods to others in the class where a rich set of teaching strategies is required from the teachers to ensure the effectiveness of the lesson.

The change and modification of mathematics and science teaching approaches is predominantly to enhance students’ performances in mathematics and science and to broaden access in both fields so as to increase mathematics and science literacy of students in general. Hence one of the approaches is to change the emphasis of teacher-directed teaching which is also known as teacher-centred approach of lecturing to more students-oriented (student-centred) approaches that involve a higher degree of students’ active participation in the teaching and learning process (Qualter & Abu-Hola, 2000). Creativity plays a fundamental role in the design of student-centred activities as well as the key element in the building of scientific knowledge (Innamorato, 1998). Creativity could be regarded as an innate ability, however it can be enhanced through activities in the classroom to assist students in learning mathematics and science (Park & Seung, 2008). The use of games and simulations (Foster, 2008) which is an alternative creative approach in the teaching of mathematics and science, deviating from traditional approaches are proven to be effective and extensively used in the science education. Therefore, based on literature it is evident that by using nontraditional approaches in teaching mathematics and science, teachers were able to reach groups of students who have been hardest to reach with standard pedagogy (Nelson, 1996).

With the gradual emphasis on novel and creative teaching methods and approaches in contemporary classroom, many educators and teachers began to adopt the Multiple Intelligence (MI) approach in the teaching styles where it highlights the idea of individual differences for both teachers and students. The MI approach to teaching allows teachers to incorporate the element of creativity in their instructional design where student-centred activities could be conducted in eight different forms based on the eight types of multiple intelligences proposed by Howard Gardner (1983), reaching students with various abilities and styles in learning. In the MI model, it is proposed that every individual has their own intelligence profile which consists of the eight intelligences: visual/spatial, verbal/linguistic, musical/rhythmic, logical/mathematical, bodily/kinaesthetic, interpersonal, intrapersonal and naturalistic. Individuals are found to be stronger in certain type of intelligences and weaker in some. *Visual/Spatial Intelligence* involves the ability to manipulate and create mental images as well as remember facts best by visualizing; *Linguistic Intelligence* involves having a mastery of language, learners are sensitive to the meaning of language and words; *Musical/Rhythmic Intelligence* involves the ability to recognize non-verbal sounds in the environment, sensitive to pitch, melody, tone and rhythm; *Logical/Mathematical Intelligences* involves the ability to notice numerical or logical patterns.; *Bodily/Kinesthetic Intelligence* involves the ability to express themselves physically and excel in the area of sports; *Interpersonal Intelligence* involves the ability to understand and relate well to other people; *Intrapersonal Intelligence* involves the ability to identify and understand one’s own feelings

and emotions; *Naturalistic Intelligence* involves the ability to relate to the natural environment and is good in identification and observation.

Helping students learn effectively is a challenge to teachers. Teachers must realize that one type of teaching method is not sufficient (Suriati Sulaiman & Tajularipin Sulaiman, 2010). Effective teaching strategies are essential in ensuring successful teaching and learning process. Individual qualities within each teacher had been recognized as a major influence on their capacity and ability in creating opportunities for their students to learn effectively (Ball & Perry, 2009). Identifying effective teaching strategies whereby teachers are comfortable in their teaching and students learn in joyful and relaxed environment will be beneficial for education. It is vital that all learning materials should include opportunities for students to develop their strengths and strengthen their weaknesses in each particular intelligence area (Lash, 2004). Therefore, it is necessary to assess the effectiveness of our current teaching style and consider innovative ways to improve our teaching to enhance the teaching and learning effect (Delaney & Shafer, 2007).

Based on the MI approach, it was proposed that every individual have their very own unique set of intelligence profile where optimum learning occurs when content is being delivered in their dominant intelligences. According to Heikkinen, Pettigrew & Zakrajsek (1985), teachers themselves too have a preferred method in perceiving and processing information and it is logical that teachers will communicate and deliver their lesson that is most compatible with their learning style. The study conducted by Nergüz Bulut Serin et al. (2009) which examines the relationship between teaching styles and MI profile of primary school teachers in Izmir and Lefkosa also yielded similar findings where variables such as the spatial/visual, naturalistic and interpersonal intelligences play a predictive role on the teaching strategies of teachers. Therefore, the objective of this study is to examine the correlation between intelligence profile and teaching styles of mathematics and science teachers.

2. Objective of study

This study aims to investigate:

- 1) the multiple intelligences profile of science and mathematics secondary school teachers
- 2) the teaching strategies based on multiple intelligences that are applied by science and mathematics teachers and
- 3) the correlation between multiple intelligences profile of teachers and the teaching strategies based on multiple intelligences applied in the classroom.

The objectives of this study are as follows:

- 1) To determine the different levels of multiple intelligences among science and mathematics secondary school teachers in Malaysia.
- 2) To investigate the teaching strategies based on multiple intelligences applied in teaching among science and mathematics secondary school teachers in Malaysia.
- 3) To examine the correlation between the teachers' profile of multiple intelligences and teaching strategies based on multiple intelligences among science and mathematics secondary school teachers in Malaysia.

3. Research questions

- 1) What are the levels of multiple intelligences among science and mathematics secondary school teachers in Malaysia?
- 2) What are the teaching strategies based on multiple intelligences applied in teaching among science and mathematics secondary school teachers in Malaysia?
- 3) What is the relationship between the teachers' profile of multiple intelligences and teaching strategies based on multiple intelligences among science and mathematics secondary school teachers in Malaysia?

4. Research Methodology

This study applied a descriptive design. It adopted the descriptive survey approach in which questionnaires are used for the purpose of data collection. Correlation based techniques are used to determine the relationship as well as the magnitude among multiple intelligences.

Part I of the questionnaire investigates the teachers' profile of eight Intelligences and Part II of the questionnaire investigates the teaching strategies based on multiple intelligences. Each variable consists of 6 items. All items are assessed using a 5-point likert-scale instrument ranging from (1) strongly not agree (2) Not Agree (3) Less Agree (4) Agree (5) Strongly agree. The respondents in this study consisted of 174 teachers who teach at secondary schools from 2 states (Selangor and Negeri Sembilan).

5. Results and Finding

The background of the respondents is shown as below. 82.2% of the respondents were female while 17.8% were male (Table 1).

Table 1: Frequency and Percentage distribution by Gender

Gender	Frequency	Percentage (%)
Female	143	82.2
Male	31	17.8
Total	174	100

Table 2 shows the distribution of teachers from urban and rural schools in this study. There were 80 teachers (46%) from urban and 94 teachers (54%) from rural schools.

Table 2: Frequency and Percentage distribution by location

Location	Frequency	Percentage (%)
Urban	80	46
Rural	94	54
Total	174	100

Table 2 shows the subjects teach by respondents. 47.1% of the respondents were teach science and 52.9% were teach mathematics.

Table 3: Frequency and Percentage distribution by Subject

Subject	Frequency	Percentage (%)
Science	82	47.1
Mathematic	92	52.9
Total	174	100

In terms of teaching experience, there are four groups of respondents. 27.6% of the respondents were teachers with teaching experience less than 5 years. Teachers with teaching experience from 5.1- 10 years is 32.2%. Teachers with teaching experience from 10.1 – 15 years is 16.6% and the teachers with teaching experience that more than 15 is 23.6% (Table 4).

Table 4: Frequency and Percentage of Teaching Experience

Teaching experience	Frequency	Percentage (%)
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Less than 5 years	48	27.6
5.1 – 10 years	56	32.2
10.1 - 15 years	29	16.6
More than 15 years	41	23.6
Total	174	100

SD : 7.25

The frequency and percentage of academic qualification are shown in Table 5. Teachers with Master/PhD qualification is 7.5%, Bachelor degree is 90.2%, and Diploma in Teaching 2.3%.

Table 5: Frequency and Percentage of Academic Qualification

Academic achievement	Frequency	Percentage (%)
Master/PhD	13	7.5
Bachelor degree	157	90.2
Diploma in Teaching	4	2.3
Total	174	100

Among the eight Intelligences, mean intrapersonal is the highest ($M=3.96$, $SD=0.45$), followed by interpersonal intelligence ($M=3.76$, $SD=0.50$), logical-mathematical is after the interpersonal intelligence ($M=3.64$, $SD=0.57$), followed by naturalistic intelligence ($M=3.25$, $SD=0.71$), kinesthetic intelligence ($M=2.97$, $SD=0.65$), musical intelligence ($M=2.91$, $SD=0.95$) spatial intelligence ($M=2.89$, $SD=0.60$), and linguistic intelligence ($M=2.83$, $SD=0.62$) is the lowest.

Table 6: The Level of Multiple Intelligences of Science and Mathematics Secondary school's teachers

Intelligences	No of respondents	Maximum Score	Minimum Score	Mean	standard deviation
mean_linguistic	174	5	1	2.83	.62
mean_logical-math	174	5	1	3.64	.57
mean_spatial	174	5	1	2.89	.60
mean_musical	174	5	1	2.91	.95
mean_kinesthetic	174	5	1	2.97	.65
mean_interpersonal	174	5	1	3.76	.50
mean_intrapersonal	174	5	1	3.96	.45
mean_naturalistic	174	5	1	3.25	.71

Table 7 shows that mean of teaching strategies based on multiple intelligences theory. The study shows that intrapersonal ($M=3.68$, $SD=0.60$) and logic-math intelligences ($M=3.68$, $SD=0.64$) are the highest, followed by interpersonal intelligence ($M=3.48$, $SD=0.63$).

Table 7: The Level of Teaching Strategies based on Multiple Intelligences

Intelligences	No of respondents	Maximum Score	Minimum Score	Mean	standard deviation
mean_linguistic	174	5	1	2.53	.66
mean_logical_math	174	5	1	3.68	.64
mean_spatial	174	5	1	3.15	.66
mean_musical	174	5	1	2.10	.82
mean_kinesthetic	174	5	1	3.05	.64
mean_interpersonal	174	5	1	3.48	.63

mean_intrapersonal	174	5	1	3.68	.60
mean_naturalistic	174	5	1	2.89	.83

The correlations between the science and mathematics teachers' profile of multiple intelligences and teaching strategies based on multiple intelligences were measured using Pearson's product-moment correlation coefficient (r.) which is presented in the Table 8.

Table 8: The Correlation between profile of multiple intelligence and teaching strategies

Intelligences	No of respondents	Spatial	linguistic	naturalistic	logical_math	intrapersonal	Interpersonal	musical	kinesthetic
Spatial	174	.351**	.459**	.222**	.321**	.102	.212**	.371**	.367**
linguistic	174	.394**	.587**	.253**	.206**	.127**	.224**	.290**	.420**
naturalistic	174	.312**	.428**	.262**	.202**	.177*	.226**	.275**	.392**
Logic math	174	.345**	.371**	.392**	.451**	.302**	.271**	.155*	.261**
intrapersonal	174	.349**	.376**	.276**	.442**	.401**	.323**	.210**	.326**
interpersonal	174	.379**	.405**	.282**	.274**	.282**	.268**	.194*	.318**
musical	174	.375**	.472**	.132	.167*	-.026	.075	.443**	.394**
kinesthetic	174	.350**	.489**	.257**	.372**	.149	.191*	.261**	.442**

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

Table 8 indicates that there is a significant and positive correlation between the mean of multiple intelligences profile and the teaching strategies based on multiple intelligences. Logic math teaching strategies is significantly correlated with mean of logic math intelligences ($r=0.451$), followed by intrapersonal teaching strategies significantly correlated with mean of logic math intelligence ($r=0.442$). There are strong correlations between teachers' profile of linguistic and teaching strategies of linguistic intelligence ($r=0.587$), followed by kinaesthetic teaching strategies ($r=0.489$), teaching strategies based on musical ($r=0.472$), spatial ($r=0.459$) and naturalistic ($r=0.428$). The result of the study shows that teaching strategies based on musical strategies are rarely applied by the teachers.

6. Conclusion

The awareness of the different intelligences and the different teaching strategies can optimize learning motivation and enhance memory in accelerating the learning process. It also permits a more enlightened search for remedies of difficulties in teaching and learning in science and mathematics as well as suggests alternative routes to an educational goal like learning mathematics via spatial relations; learning music through linguistic techniques etc. Teachers should be aware that there is no single and absolute method in any teaching and learning process (Serin, Serin, Yavuz & Muhammedzade, 2009). Multiple intelligence theory provides a platform and guidance to teachers to use integrated strategies and instructional activities to cater to the different needs of students in terms of intelligence profiles, learning styles and learning preferences. Hence, it is evident that to ensure successful and effective learning, educators, students and society in general will need to redefine the role of a student, the remedy of effective teaching and learning as well as the types of knowledge, skills and strategies deemed important (Sellars, 2008). The relationship between intelligences and teaching and learning process should be a fundamental element in coming up with ways to promote higher academic performances, learner success and lifelong learning (Özdemir, Güneysu & Tekkaya, 2006),

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