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The effectiveness of the brain based teaching approach in enhancing scientific understanding of Newtonian physics among form four students

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The aim of this study was to assess the effectiveness of Brain Based Teaching Approach in enhancing students' scientific understanding of Newtonian Physics in the context of Form Four Physics instruction. The technique was implemented based on the Brain Based Learning Principles developed by Caine & Caine (1991, 2003). This brain compatible strategy involves specific attention and consideration towards seven main steps; (i) Activation, (ii) Clarify the outcome and paint big picture of the lesson, (iii) Making connection, (iv) Doing the learning activity, (v) Demonstrate student understanding, (vi) Review for student recall and retention and (vii) Preview the new topic. The effectiveness of the teaching approach within the targeted context would then be assessed in a quasi experimental research approach involving 100 students from two Secondary Schools in the northern peninsular Malaysia. Data collected from the Questionnaire of Subjective Items of Newtonian Physics were analyzed qualitatively to investigate the patterns formed. The findings of the research showed that the teaching approach was effective in enhancing students' scientific understanding of Newtonian Physics. It was found that a majority of students from the group that followed the Brain Based Teaching Approach possessed a better scientific understanding of Newtonian Physics compared to the group that received conventional teaching method.

Keywords: Brain based teaching approach, physics education, scientific understanding

Introduction

Research has shown that a majority of students in Malaysia feel that Physics is a 'difficult' subject (Khalijah, 2004). In addition, most of them also regard Physics teaching as being "too academic" (Robiah, 2003). Therefore, it is unsurprising that Physics has always been thought as one of the most difficult subjects to understand and, not to say the least, a dull subject in school. There are still a lot of weaknesses in the process of Physics teaching in the schools. The methods currently used have been seen to be clearly inadequate to cater to the needs of a majority of the students (Robiah, 2003; Sulaiman et al., 1996).

In this regard, the level of success in the subject of Physics among students in this country is still relatively very poor. Research has shown that most students in the introductory Physics courses are still having problems understanding the basic concepts of Newtonian Physics 'scientifically'. A study by Yusof (1994) on 175 form five students in Kulai and Kota Tinggi,

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Johor, has found that about 99 percent of students are unable to correctly answer the Hestenes Conceptual Test, supposedly designed to test students' understanding of the Newtonian Physics concept. A survey conducted by Lee et al. (1992) on 485 students from ten secondary schools in the state of Perlis, Kedah and Penang, also showed that more than 50 percent of the respondents have had problems understanding the tested Physics concepts. Similar results were obtained in a study on form four students' understanding of the concepts related to kinematics done by Normah (1997) and Sharifah Feton (1996), a study by Khalijah et al., (1991) on higher learning institution students, including trainee teachers, of the concepts related to 'Force and Motion", as well as study by Lilia (1998) and Lilia et al. (2001) on the higher learning institution trainee teachers' understanding of Physics pedagogical contents.

Results obtained from these researches show that Malaysian students do not demonstrate enough scientific understanding of concepts in Physics. They lack accurate scientific understanding on how to apply the knowledge acquired from Physics into their daily lives and are often unable to provide scientific cause-effect explanations of the different phenomena they encounter.

Due to these facts, it is therefore advisable for us to improve the methods of teaching and learning Physics, especially at the secondary school level. The Brain Based Teaching Approach can be seen as appropriate for school students, as this technique is more learner-friendly as compared to the conventional methods (Caine & Caine, 1991; 2003). Each learner is seen to have a huge potential and should be given the opportunity to learn in an optimum environment.

The Brain Based Teaching Approach

The Brain Based Teaching Approach is a strategy implemented based on the Brain Based Learning Principles developed by Caine & Caine (1991, 2003) via three instructional techniques associated with these principles. The Brain Based Learning Principles are:

1. The brain is a parallel processor.
2. Learning engages the whole physiology.
3. The search for meaning is innate.
4. The search for meaning comes through patterning.
5. Emotions are critical to patterning.
6. The brain processes wholes and parts simultaneously.
7. Learning involves both focused attention and peripheral perception.
8. Learning always involves both conscious and unconscious processes.
9. We have at least two types of memory: A spatial memory system and a set of systems for rote learning.
10. We understand and remember best when facts and skills are embedded in natural, spatial memory.
11. Learning is enhanced by challenge and inhibited by threat.
12. Each brain is unique.

(Caine & Caine, 1991, 2003)

The three instructional techniques associated with brain-based learning are:

(i) Orchestrated Immersion - creates a learning environment that fully immerses students in many educational experiences;

(ii) Relaxed Alertness - eliminates fear in the learners while maintaining highly challenging environments; and,

(iii) Active Processing - allows the learner to consolidate and internalize information by actively processing it.

(Caine & Caine, 1991, 2003)

Unlike traditional methods of schooling, which is often said to inhibit learning by ignoring the brain's natural learning processes, the Brain Based Teaching Approach is believed to boost learning due to its holistic approach towards the learners. It is an approach to learning which favors the brain's best natural operational principles, with the goal of attaining maximum attention, understanding, meaning and memory (Jensen, 1996).

Contrary to the previous understanding that learning involves only the "upper part of the human body", this approach adheres to the notion that learning involves the whole physiology of a human being (Caine & Caine, 1991, 2003; Jensen, 1998). Students will learn best if learning is "authentic", in the sense that it deals with real world problems and applications. (Caine & Caine, 1991, 2003; Sousa, 1995, 1998; Jensen, 1998). As brain development and growth is dependent on an individual's experiences, the challenge, really, is for teachers to vary their methods of teaching and shift the paradigm from a "one fits all" to an "enriched environment" for each and every student (Caine & Caine, 1991, 2003; Jensen, 1998; Evan, 2007). The role of teachers is to provide the appropriate classroom climate, which emphasizes on instructions that accommodate how the brain learns, that will enhance brain functionality in processing and constructing data properly, according to the individual learner's level. Although there have been a number of arguments regarding this approach, powerful insights that are significant to classroom learning have emerged from this brain science strategy. They include: 'learning experiences *do* help the brain grow, emotional safety *does* influence learning, and making lessons relevant *can* help information to stick' (Benard, [Online]).

Research Objectives

The aim of this study was to assess the effectiveness of the Brain Based Teaching Approach in enhancing students' understanding of the concept of Newtonian Physics. In particular, this study was conducted determine the pattern of understanding of Newtonian Physics formed among the students enrolled in Brain Based Teaching Approach (BBTA) compared with those receiving conventional teaching method (CTM). Thus, the research questions are:

(i) What is the pattern of understanding of Newtonian Physics formed among the students enrolled in BBTA?

(ii) Is there any difference between the pattern of understanding of Newtonian Physics formed among the students enrolled in the BBTA and those in enrolled in the CTM?

(iii) Does the BBTA effective in enhancing form four students' understanding of Newtonian Physics?

Research Methodology

The research was conducted using the design of quasi-experimental approach involving 100 students: 50 in an experimental group, and the other 50 in a control group. These students were randomly selected from two equivalent schools to represent the population of form four secondary school students in the northern peninsular of Malaysia. Teachers with approximately equal educational levels and teaching experience were chosen to teach each group. They were trained on how to teach using the Brain Based Teaching approach over a six hour session, prior to the intervention. The experimental group was then given the Brain Based Teaching Approach while the control group followed the conventional teaching method, in learning the topic of 'Force and Motion', according to the current Form Four Physics syllabus.

The achievement of Newtonian Physics understanding among students was measured before and after the intervention through the Subjective Test of Newtonian Physics, in order to determine the effectiveness of the implemented Brain Based Teaching Approach. The development of the test is done by adopting the required items from the relevant reference materials such as text books and reference books. The Subjective Test of Newtonian Physics covers five items from the three basic concepts of Newtonian Physics, namely the Principle of Newton's First Law; the Principle of Newton's Second Law and the of Principle Newton's Third Law. This test requires students to describe their understanding of the tested concepts in a more detailed manner, based on the situations presented. Data (students' answers of the Subjective Test of Newtonian Physics) collected were then analyzed qualitatively. The data were first transcribed, read carefully and then segmented into meaningful analytical units (coding) based on the responses obtained.

Implementation of Brain Based Teaching Approach

The Brain Based Teaching Approach in this research was generally implemented based on the integration of 'Brain Based Learning Principles' (Caine & Caine, 1991, 2003; Sousa 1995; Jensen, 1996) through seven brain compatible instructional phases (Sousa, 1995; Smith 2003): *(i) Activation; (ii) Clarification of the outcome and painting the big picture of the lesson; (iii) Making the connection; (iv) Doing the learning activity; (v) Demonstration of student understanding; (vi) Review of student recall and retention;* and *(vii) Previewing the new topic*. Optimal learning state integrating relaxed alertness, orchestrated immersion and active processing instructional techniques is the main feature of this approach. In particular;

- *(i)* *Activation* is the phase where we activate students' memory processor system (prior knowledge) in order to stimulate their learning transfer process.
- *(ii)* C*larify the outcomes and paint the big picture* is the phase where students affirm for themselves their personal performance target, activate the right brain processor prior to the left brain, and alleviate anxieties over the accessibility and relevance of the material.
- *(iii)* *Making connection and develop meaning* is the stage where the topic or unit of work about to be completed is connected to what has been done before with what is yet to come. It builds on what the learners already know and understand and helps them assimilate and integrate new information. These three phases of teaching activities are thought to be able to create "relaxed alertness" among students.
- *(iv)* *Doing the learning activity* is the stage for digesting, thinking about, reflecting on and making sense of experience utilizing visualization, auditory, kinesthetic in multiple contexts as well as to access all of the multiple intelligences. Here, students were encouraged to be in the state of "orchestrated immersion", which immerses them in multisensory experiences.
- *(v)* *Demonstrating students' understanding* is the stage for brain-active processing. This phase allows students to consolidate and internalize information effectively when they are actively engaged with the knowledge itself.

(vi) *Review for students' retention* is the activity that stimulates working memory to summarize the lesson, which helps to strengthen the transfer process.

(vii) *Preview the next topic* is the experience that helps the brain pre-processor and the reptilian brain to focus on the new lesson. This is important to prepare the brain for the new learning activities.

(Sousa, 1995; Smith, 2003)

Basically, for the purpose of this research, students are assured to; (i) be actively involved in all the seven brain compatible instructional phases listed above, (ii) have fun learning (multiple respresentation such as slide show, video, minds on and hands on activities), and, (iii) learn in their context and related to their existing knowledge (learning activities organized based on the students' everyday experiences, such as students' own experience on the concept of inertia, force, action and reaction, et cetera) to explore the idea of Newtonian Physics concepts. The implementation of this teaching approach took about three months to be completed. The pre and pos-test were administered towards the sample before and after the intervention.

Findings

Students' Conceptual Understanding of Newtonian Physics before the intervention

Below are the results of the analysis of the Subjective Test of Newtonian Physics administered before the intervention.

Newton's First Law
There are two identical buckets (bucket A is filled with sand and bucket B is empty) hanging from a ceiling. When they are oscillating, which bucket is harder to be stopped? Explain your answer.

Expected answer:
Bucket A, it has larger inertia due to more mass.

Studets'answers:
Bucket A, it is heavier / lighter / empty / filled with sand.

The purpose of this item is to explore students' initial understanding of the concept of inertia, based on Newton's First Law. Students were asked about the problem of which bucket (bucket A is filled with sand and bucket B is empty), when they are oscillating, is harder to be stopped. Analysis shows that no one has given the correct answer as required. All students, 50 in the group that follow that Brain Based Teaching Approach (BBTA) and 50 in the group that receive conventional teaching method (CTM), were found to answer this question either based on their daily experience, or simply guessed.

Second question

Newton's Second Law
A brick accelerates when it is pushed by the force of a hand. Give your comment about the brick's acceleration if the brick is doubled (pushed by the same force). Explain your answer.

Expected answer:

Acceleration is halved, because the brick is doubled. From F=ma, the larger the mass, the less acceleration is produced if F is constant.

Students’ answers:
Acceleration is doubled / increased / decreased / constant because the brick is doubled / two bricks are used /bricks are heavier.

The purpose of this question is to explore students' initial understanding of concepts related to Newton's Second Law in relation to the effects of force. Students are required to provide comment about the brick’s acceleration if the brick is doubled (pushed by the same force). Analysis shows that no one has given the correct answer as required. For the group that was required to follow BBTA, it was found that 26 students did not answer the question and 24 others gave the answer that is either based on their daily experiences or speculation. For the group that received the CTM, it was found that 24 students did not answer the question and 26 others gave the answer that is either based on their daily experience, or a wild guess.

Third question

Newton’s Second Law
Why does the gymnast need to bend his knees while landing? Explain your answer.

Expected answer:
To extend the time so that the impulsive force is reduced.

Students’ answers:
To stabilize his body / avoid from injury / make sure he is safe / it is the rule of doing the sport.

The purpose of this question is to explore students' initial understanding of concepts related to Newton's Second Law, namely in relation to the impulse. Students are required to explain about why does the gymnast need to bend his knees while landing. Analysis shows that no one has given the correct answer as required. For the group that was required to follow the BBTA, it was found that 27 students did not answer the question and 23 others gave the answer that is either based on their daily experiences or speculation. For the group that has received the CTM, it was found 24 students did not answer the question and 26 others gave the answer that is either based on their daily experiences or just guessed.

Fourth question

Newton’s Third Law
Explain the forces acting on a trolley stays at rest on the floor.

Expected answer:
Gravitational force acts downward and normal reaction force acts upward.

Students’ answers:
Gravitational force / friction force / no force

The purpose this question is to explore students' initial understanding of concept related to Newton's Third Law, in relation to the balance of force. Students are required to explain the forces acting on a trolley that stays at rest on the floor. Analysis shows that no one has given the correct answer as required. For the group that followed the BBTA, it was found that 20 students did not answer the question and 30 others gave the answer that is either based on their daily experiences or speculation. For the group that received the CTM, it was found that 25 students did not answer the question and 25 others gave the answer that is either based on their daily experiences or just plain guesses.

Fifth question

Newton's Third Law
When the ping pong ball is dropped onto the table, it bounces back up. Why?

Expected answer:
The ping pong ball exerts a force to the table, and as a reaction, the table exerts the same force to the ping pong ball in the opposite direction

Students' answers:
Ping pong ball is light / elastic / has energy / The table surface is hard / Because of force from hand / energy from hand / reaction with table / reflection / natural phenomenon.

The purpose this question is to explore students' initial understanding of a concept related to Newton's Third Law, in relation to the balance of force. Students are required to explain why when the ping pong ball is dropped to the table, it bounces back up. This question requires an understanding the concept of the action and reaction of forces. Analysis shows that no one has given the correct answers as required. For the group that was required to follow the BBTA, it was found that 34 students did not answer the question and 16 others gave the answer that is either based on their daily experiences or speculation. For the group that received the CTM, it was found that 27 students did not answer the question and 23 others gave the answer that is either based on their daily experiences or just plain guesses.

Summary of the analysis before the intervention

Results from the test showed that generally, there is no student who managed to give the correct answers, as required, relating to the concepts tested. Students have either not answered or answered incorrectly the questions asked, based on either their everyday experience or speculation. It was also found that there was no significant difference between the pattern of answers provided by the group of students that were required to follow the BBTA and the group of students that were required to follow the CTM. The results showed that students generally do not have a conceptual understanding of the concepts tested. Based on these findings, it can be concluded that students have no idea or have an alternative conception of Newtonian Physics concepts prior to the intervention.

Students' Conceptual Understanding of Newtonian Physics after the intervention

Below are the results of the analysis of the Subjective Test of Newtonian Physics administered after the intervention

First Question

Newton's First Law
There are two identical buckest (bucket A is filled with sand and bucket B is empty) hanging from a ceiling. When they are oscillating, which bucket is harder to be stopped? Explain your answer.

Expected answer:
Bucket A, it has larger inertia due to more mass

Students answers:

(i) *Bucket A, it has larger inertia due to more mass****
(ii) *Bucket A, it has more mass***
(iii) *Bucket A, it is heavier / larger force acting on it / it has larger air resistance**
Indicator: *** Scientific Conception, ** Conception combination, * Alternative conception, # No idea

The purpose of this item to explore students' initial understanding on the concept of inertia based on Newton's First Law. Students were asked about the problem of which bucket (bucket A is filled with sand and bucket B is empty), when they are oscillating, is harder to be stopped. Based on Newton's First Law, which states that a body will continue to maintain its initial state either at rest or moving, if there is no other force acting on it, the answer should be given by the student is bucket A that is filled with sand is harder to be stopped compared to bucket B that is empty. This question requires students to have a conceptual understanding that inertia is directly proportional to the mass. The inertia is large if the body mass is large, and vice versa.

Analysis shows that for the group that followed the BBTA, 30 students were found to have a scientific conception by providing the correct answers, as required; 11 students have a combination conception (scientific and alternative) by giving a correct answer that is incomplete; and nine others are still maintaining their alternative conceptions based on either their everyday experience or just a wild guess. In the same context, for the group that received the CTM, 24 students were found to have a scientific conception, 12 students have a combination conception, and 14 others have alternative conceptions. Compared to the CTM group, more students from the BBTA group possess a scientific understanding of *Newton's First Law* concept.

Second Question

Newton's Second Law
A brick accelerates when it is pushed by the force of a hand. Give your comment about the brick's acceleration if the brick is doubled (pushed by the same force). Explain your answer.

Expected answer:
Acceleration is half, because the brick is doubled. From F=ma, the larger the mass, the less acceleration is produced if F is constant.

Students' answer:
i) *Acceleration is halved. From F=ma, the larger the mass, the less acceleration is produced; Acceleration is half when mass is doubled ****
(ii) *Acceleration is decreased when mass is increased***
(iii) *Acceleration is increased when mass is increased; Acceleration is doubled when mass is doubled**
(iv) (No answer) #

Indicator: *** Scientific Conception, ** Conception combination, * Alternative conception, # No idea

The second item is to explore students' understanding of concepts related to Newton's Second Law in relation to the effects of force. In this question, students are required to estimate the acceleration of an object if the force is doubled. To answer this question, students should have a conceptual understanding related to the formula derived from Newton's Second Law, F = ma, where F = force, m = mass and a = acceleration. With regards to this formula, if m remains, a is doubled if F is doubled.

Analysis shows that for the group that followed the BBTA, 24 students were found to have a scientific conception by providing the correct answers as required where acceleration is doubled when the force is doubled with the necessary reasons; ten students were found to have combination conception by giving a correct answer but incomplete, such as acceleration is doubled; eight students have alternative conceptions by giving incorrect answers as to whether the acceleration is increased or decreased when the force is doubled; and the remaining eight students are considered to have no idea of the proposed concepts for not answering the question. In the same context, for the group that received the CTM, 15 students were found to have a scientific conception, 13 students have a combination conception, 13 students have alternative conceptions and nine students are regarded as having no idea of the concepts tested. Compared to the CTM group, more students from the BBTA group possess a scientific understanding of *Newton's Second Law* concept.

Third question

Newton's Second Law
Why does the gymnast need to bend his knees while landing? Explain your answer.

Expected answer:
To extend the time so that the impulsive force is reduced.

Students answers:
(i) *To extend the time to reduce the impulsive force****
(ii) *To reduce impulsive force; To reduce the effect of force ***
(iii) *To stabilize / balance the body; To reduce force, to avoid injury **
(iv) (No answer) #
Indicator: *** Scientific Conception, ** Conception combination, * Alternative conception, # No idea

As a second question, the third question is also associated with the Newton's Second Law. The purpose of this question is to explore students' conceptual understanding in relation to the concept of impulse. At a glance, this question seems simple, but students must complete this question from the Physics point of view. Students were asked several questions about why does the gymnast need to bend his knees while landing. In the context of Physics, an impulse is defined as the product of the force, F with time t and impulse is equal to the change in momentum, namely Ft = mv - mu. Based on this equation, if there is a change in momentum, the force, F acting on the gymnast can be minimized if the value of t that is the time taken for landing is extended. And to that end, the gymnast needs to bend his knees while landing.

Analysis shows that for the group that followed the BBTA, 18 students were found to have a scientific conception by giving the correct answer as required, namely to extend the time in order to reduce the impulsive force; 15 students have a combination conception by writing of an incomplete correct answers such as to reduce the impulsive force; 11 students maintain their alternative conceptions by giving the incorrect scientific answer that the reason why the gymnast bends his knees is to prevent injuries; and 6 other students are regarded as having no idea of the concept tested when they are not able to provide any relevant answers. Meanwhile, in the same context, for the group that received the CTM, only 10 students have a scientific conception, 13 students have a combination conception, 15 students have alternative conceptions and the remaining 12 students had no idea who is considered relevant. Compared to the CTM group, more students from the BBTA group possess a scientific understanding of *Newton's Second Law* concept.

<u>Fourth question</u>

Newton's Third Law
Explain the forces acting on a trolley stays at rest on the floor.

Expected answer:
Gravitational force acts downward and normal reaction force acts upward.

Students' answers:
(i) *Gravitational force acts downward and normal reaction force acts upward****
(ii) *Gravitational force and normal reaction force***
(iii) *Gravitational force / friction force / no force etc**
Indicator: *** Scientific Conception, ** Conception combination, * Alternative conception, # No idea

The purpose of the fourth item is to explore students' understanding of the concept related to Newton's Third Law, in relation to the balance of forces. In this question, students were asked to describe the forces acting on a trolley stays at rest on the floor. In this situation, the forces involved are gravitational force acting downward and balanced by the normal action force acting upwards.

Analysis shows that for the group that followed the BBTA, 24 students were found to have a scientific conception of being able to give the correct answer as required, stating the complete type of forces and their directions; 10 students have a combination conception, providing incomplete answer which does not reflect the direction of forces involved; 9 students have alternative conceptions, stating that the trolley is either acted upon only by gravitational forces, frictional force or no force involved; and 7 more are regarded as having no idea of the concept tested when they are unable to provide any relevant answers. For the group that received the CTM, 15 students were found to have the scientific conception, 11 students have a combination conception, 14 students have alternative conceptions and ten students are still considered as having no idea of the concept. Compared to the CTM group, more students from the BBTA group possess a scientific understanding of *Newton's Third Law* concept.

Fifth question

Newton's Third Law
When the ping pong ball is dropped onto the table, it bounces back up. Why?

Expected answer:
The ping pong ball exerts a force to the table, and as a reaction the table exerts the same force to the ping pong ball in the opposite direction

Students answers:
(i) *Ping pong ball exerts a force onto table and as a reaction the table exerts the same force onto the ping pong ball in the opposite direction. Ping pong ball reacts due to Newton's Third Law****
(ii) *Ping pong ball reacts due to Third Newton's Law. Every action has an opposite reaction***

(iii) *Inelastic collision between ping pong ball and the table / Air resistance / Gravity force reacts upon it / Force /Energy cause ping pong ball to bounce more**
(iv) (No answer) #
Indicator: *** Scientific Conception, ** Conception combination, * Alternative conception, # No idea

Much like the fourth item, the purpose of the fifth item is also to explore students' understanding of Newton's Third Law, in relation to the balance of forces. Students were required to explain the phenomenon of bounces ping-pong ball when it is dropped on the floor. According to Newton's Third Law, for every action, there is a similar reaction in the opposite direction. Thus, for this phenomenon, the ping pong ball has exerts a force on the floor when it is dropped, and in response, the floor also exerts the same force in the opposite direction to the ping pong ball causes it to bounce.

Analysis shows that for the group that followed the BBTA, 16 students were found to have a scientific conception of the tested idea, by providing the correct answer as required; 14 students have a combination conception, giving incomplete answer, stating that the object acts based on Newton's Third Law only, without explaining the situation; 12 students have alternative conception, stating that either the force or energy from the hand / ping pong ball had caused the bounce as well as the collision or reaction with the floor. Whereas the remaining eight other students are considered of not having the idea of this concept as they could not give any justification for the situation. In the same context, for the group that received the CTM, the findings show that only 10 students were found to have a scientific conception, 14 students have a combination conception, 16 students have alternative conceptions and the remaining 10 students are still considered as having no idea of the tested concept. Compared to the CTM group, more students from the BBTA group possess a scientific understanding of *Newton's Third Law* concept.

Summary of the findings

In general, it is found that, after the intervention, the pattern of conceptual understanding of Newtonian Physics among students have been changed to be more scientific than before. Results showed that there are four types of students' conceptual understanding patterns formed after the intervention of the BBTA; namely (i) scientific conception, (ii) combination conception (scientific and alternative), (iii) alternative conceptions and (iv) no idea of the concept. The same result applies to the group that received the CTM. There is no difference in students' conceptual understanding patterns formed after the intervention for both the BBTA and CTM. However, compared to the group that received the CTM, it is found that more students from the group that followed the BBTA have a scientific conception of the tested concept. Therefore, it can be concluded that the Brain Besed Teaching Approach effective in enhancing students' conceptual understanding in learning Newtonian Physics.

Discussion

With regards to this study, students' conceptual understanding of Newtonian Physics has been established due to the implementation of the Brain Based Teaching Approach. Unlike the conventional method, which is said to pay more attention towards the left-brained students, the Brain Based Teaching Approach provides opportunities to all students to affirm for themselves their personal performance target by considering a strategy which caters to both left dan right brained students. The phase of c*larification of the outcome and painting the big picture of the* *lesson* aims to alleviate students' anxieties over the accessibility and relevance of the material enable students to become more focused and be prepared to their lesson as well as to create relaxed alertness among students. This assures a greater amount of attention devoted to the learning situation that helps the learner to build the appropriate scientific understanding.

The concept of teaching which places a great emphasis on the relationship between the idea about to be completed with what the learners already know and understand has been proven to trigger personal connections between the learners and what is being learnt. As *familiarity* enhances *learning*, it helps students to assimilate and integrate new information to the desired meaning.

The situation of orchestrated immersion is promoted when every student in the Brain Based Teaching Approach group are encouraged to experience on their own the learned Newtonian Physics concepts in the real situations. Variety of learning experiences with the integration of various inputs (particularly visualization, auditory and kinesthetic), based on the learners' context and daily event provided, is seen to be able to stimulate students' sensory engagement during the learning process. This leads to the optimum learning climate that allows students to actively process the information obtained and eventually grasp the concepts learned. Since learners learn best when they are actively involved in interesting and challenging situations (Sousa, 1998), this phase provides a boost to students' conceptual understanding.

The creation of these optimal conditions is then further strengthened by strategies of focusing on students active processing techniques performed inductively through the activities of discussion, evaluation and problems solving (Caine & Caine, 2003) to retain the information obtained in their long term storage system. The continuity of this process is found to stimulate the smooth transfer of information and generate effective learning among students.

The results obtained support the findings of several studies that have investigated the effectiveness of brain-oriented teaching methods (She, 2005; Wagner-Heaston, 2006; Salmiza, 2011; Bawaneh, Ahmad Nurulazam & Salmiza, 2010; 2011). It confirms that the Brain Based Teaching Approach is effective in yielding a remarkable learning achievement among students, and has been proven by a school in New Jersey which adopted this method as their main instructional strategy several years ago (Della Neve, 1985), as well as the implementation of Quantum Teaching that orchestrates students' successes (De Porter, Reardon & Singer-Nourie, 1999). In the Malaysian context, the results consolidate the findings of a study conducted by Goh (1997) who found that the 4MAT system (developed with a consideration of the development of the learner's brain) is effective in enhancing form four students' mathematics achievement. It is also consistent with the Shamsun Nisa's research finding (2005) which found that a brain compatible hypermedia had a significant impact in increasing and accelerating form four students' understanding of Biology concepts.

The approach developed with the consideration of the human brain is found effective in improving students' cognitive performance. Brain compatible elements are believed to be able to facilitate the learning of concepts and stimulate motivation among students.

Limitation

This study was only designed to investigate briefly into the development of form four students' (who are just introduced to the subject of Physics) scientific understanding of the basic concepts of Newtonian Physics, namely Newton's Laws, due to the fact that it is a very important basic knowledge in Physics that they should grasp. Due to this limitation, the detailed answers expected (a description of their understanding of the tested concepts in a more detailed manner) could not be obtained in this research, as the respondents are only able to manage to provide simple answers.

Although the results indicate that the Brain Based Teaching Approach is effective in enhancing scientific understanding of Newtonian Physic among the research samples, admittedly, students' achievement in general is found to have not reached the desired level of excellence. This situation is probably due to several contributing factors:

- Students' active involvement in the learning process: Those who are passive and not participate in the brain based teaching activities will be left behind. The complete assimilation of information is not applicable to these kinds of students. Therefore, their active processing is limited and leads to ineffective learning process.
- Teachers' skill and experience: Since the teachers involved are less skilled and less experienced on the approach implemented, it is likely that the lessons conducted is less able to achieve the desired level of excellence. This is due to the fact that for a teaching method to be truly effective, besides having total commitment, the time factor plays an important role to determine the performance of the teacher in exploiting the approach effectively.
- Basic knowledge of the Brain Based Learning Strategy: Unlike other teaching strategies, this approach requires the students to understand the brain-based learning strategy. Understanding of the effective techniques of learning, the need for adequate nutrients, oxygen and water as well as body posture can help the brain to function more effectively. Therefore, early exposure of the relevant knowledge is important for students to prepare themselves to this kind of learning process.

Recommendation for future work

It is recommended for this strategy to be developed with more focus on the control over students' behavior, particularly those with negative behavior. It is expected that, through this approach, troubled students are not fringed or neglected during the process of teaching and learning. This attempt is to attract more students to get involved in the classroom activities that guide their active processing in contructing the desired scientific understanding.

Conclusion

Although there was no significant difference in the pattern of scientific understanding among students enrolled in the BBTA and CTM, it is found that more students from the BBTA group possess a scientific understanding of Newtonian Physics, as expected. Therefore, it can be concluded that, based on this study, the implementation of BBTA is effective in enhancing scientific understanding of Newtonian Physics among students.

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Beyin temelli öğretim yaklaşımının Dört Fizik Modeli öğrencilerinin Newton fiziğini bilimsel bir bakışla anlamalarını zenginleştirmedeki etkililiği

Bu çalışmanın amacı, Dört Fizik Modeli Öğretim bağlamında Newton fiziğinin bilimsel bir bakışla öğrencilerin anlamalarını zenginleştirmede Beyin Temelli Öğretim Yaklaşımının etkililiğini değerlendirmektir. Caine & Caine (1991, 2003) tarafından geliştirilen Beyin Temelli Öğretim Prensiplerine dayanan bir teknik uygulanmıştır. Beyin uyumlu strateji yedi temel aşamayı ve her birine özel dikkati gerektirmektedir: (i) Etkinleştirme, (ii) dersle ilgili büyük resmi çizme ve çıktıyı netleştirme, (iii) ilişki kurma, (iv) öğrenme etkinliği yapma, (v) öğrenci anlayışlarını gösterme, (vi) öğrencilerin hatırlamalarını ve akılda tutmalarını sağlamak için özetleme ve (vii) yeni konuyu özetleme. Hedeflenen bağlamda kullanılan öğretim yaklaşımının etkililiği, Malezyanın kuzey yarım adasındaki iki liseye devam eden 100 öğrenciyle quasi-deneysel yaklaşım kullanılarak değerlendirilmiştir. Newton Fiziği Öznel Sorular Anketi kullanılarak toplanan veriler, oluşan örüntüleri incelemek üzere niteliksel olarak analiz edilmiştir. Araştırmanın bulguları, öğrencilerin Newton fiziğini bilimsel bir bakışla anlamalarını zenginleştirmede kullanılan öğretim yaklaşımının etkili olduğunu göstermiştir. BeyinTemelli Öğretim Yaklaşımını takip eden gruptaki öğrencilerin büyük bir çoğunluğunun geleneksel öğretim yöntemindeki öğrencilerle karşılaştırıldığında Newton fiziğine yönelik daha iyi bir bilimsel anlayışa sahip oldukları sonucuna ulaşılmıştır.

Anahtar kavaramlar: Beyin temelli öğretim yaklaşımı, fizik eğitim, bilimsel anlayış.