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THE IMPACT OF BRAIN-BASED LEARNING MODEL ON SCIENCE ACHIEVEMENT OF STUDENTS AT THE MIDDLE SCHOOL LEVEL*

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Abstract

The main purpose of this study is to investigate the impact of brain-based learning model on science achievement of students at the middle school level. The research design adopted was explanatory sequential mixed methods (Quan → qual) design. For the quantitative study, nonequivalent control group design, one of the quasi-experimental designs, was used. To follow up on quantitative results, case study research design was used. The research instruments used in this study were pretest, posttest, attitude questionnaire, observation checklists and interview questions. By using simple random sampling method, four basic education high schools were selected from Mandalay Region. As quantitative research findings, overall science achievement of middle school students who receive instruction with proposed brain-based learning model was significantly higher than that of those who do not. Also, there was a strong positive relationship between students' science achievement and their attitudes towards learning science with proposed brain-based learning model. The best predictor for students' science achievement was teaching-learning process, the second predictor was learning materials, the third predictor was learning environment and the last predictor was assessment of proposed brain-based learning model. As qualitative research findings, the results of observation checklists and interviews revealed that science teachers and students well performed and had positive attitudes towards applying proposed brain-based learning model in teaching and learning science. Therefore, the research findings proved that brain-based learning model contributes a positive impact on science achievement of students at the middle school level.

Keywords: brain, learning, brain-based learning, brain-based learning model, science

Introduction

Education is a deliberate process of transformation in the natural growth and development of the person and the surroundings. The ultimate goal of education or pedagogy is to grow, not just physically, of course, but in greater insight into and control over oneself and over one's environment. The young must be taught how to think when the method to use is not now known and the problem to be solved has not even been formulated (Khin Zaw, 2001). Teaching of science should give emphasis on certain important changes in young pupils, changes in their way of thinking, in their habits of action and in the values they endure.

Teaching should be compatible with students' brain behaviour because learning is a function of the brain. Brain-based learning enhances the brain's natural ability to learn by applying three core elements, namely, relaxed alertness, orchestrated immersion and active processing. Brain-based learning stimulates the whole brain for effective function which results in greater academic progress. Brain-based learning model transforms the students from passive recipients of information to active participants in the learning process. It engages the emotions of the students, provides enriched environment, actively process the information, makes meaning and takes maximum participation of learner with high challenge and low threat.

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Objectives of the Research

The main purpose of this study is to investigate the impact of brain-based learning model on science achievement of students at the middle school level. The specific objectives of this research are described as follows:

1. to develop a brain-based learning model for teaching middle school science,
2. to explore the impact of brain-based learning model on science achievement of students, and
3. to make suggestions and recommendations for the improvement of teaching and learning science at the middle school level based on the results of the study.

Research Questions

The research questions addressed in this study are as follows:

1. Is there any significant difference in science achievement of middle school students who receive instruction with brain-based learning model and those who do not receive it?
2. Is there any significant relationship between middle school students' science achievement and their attitudes towards learning science with brain-based learning model?
3. How can middle school students' attitudes towards learning science with brain-based learning model: learning environment, learning materials, teaching-learning process and assessment predict their science achievement?

Scope of the Research

The scope of this study is as follows:

1. This study is limited to Grade Six students who are learning science and teachers who are teaching Grade Six science from the selected schools in Mandalay Region during 2023-2024 Academic Year.
2. This study is also limited to the content areas of force, living things, cell and cell structure, and reproduction from Grade Six science textbook prescribed by the Basic Education Curriculum, Syllabus and Textbook Committee, 2023.

Definition of Key Terms

The key terms in this study are as follows:

Brain: Brain is the one which is not only the control center of the entire human body, organizing behaviors and biological functions, but it is also the seat of humanity (Slavkin, 2004).

Learning: Learning is defined as a process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010).

Brain-based Learning: Brain-based learning is defined as a comprehensive learning approach that is aligned with how the brain naturally learns best and based on findings derived from research in neuroscience (Jensen, 2008).

Brain-based Learning Model (Operational Definition): Brain-based learning model is one which emphasizes creating learning conditions that increase student motivation, engagement and long-term retention in consideration of students' different learning styles and by tapping into the natural ways the brain receives, processes and stores information.

Science: Science is defined as a way of thinking in the pursuit of understanding nature, a way of investigating, and a body of established knowledge (Collette & Chiappetta, 1989).

Statement of the Problem

Basic education curriculum plays an important role for the children and youths of every country by fulfilling their physical, intellectual, linguistic, emotional and social needs. The new curriculum focuses on 21st century skills, soft skills including personal development and employability skills and higher-order thinking skills. Importantly, the new curriculum reduces the content to a manageable level to ensure that there is sufficient time: (a) for teachers to adequately cover the full curriculum within each academic year; and (b) for students to understand new concepts and to develop higher-order thinking skills appropriate for Myanmar's modern economy and changing society needs (Ministry of Education [MOE], 2016).

One of the challenges in implementing the new curriculum in Myanmar is whether the teachers will actually change or upgrade their teaching methods which will be needed to reach the targets of the new curriculum. Promoting students' critical thinking and reasoning will surely need to give the students the chance to question to the teachers. Most of the students are found being reluctant to ask questions (Wint Zaw Htet, 2020).

Most science teachers are curriculum-driven and are more interested in finishing the contents of the syllabus as stipulated by the curriculum at the expense of the students' brain. Both the teachers and the students seem to forget that there is a connection between the brain and everything that goes on in school (Rehman & Haider, 2013). According to Jensen (2008), any attempt to disconnect this will lead to failure, frustration, and disaster in teaching and learning. For the issues and the various efforts made to confront these challenges and the problems remain unsolved, the need for a practical approach as the brain-based learning model might work out better. Therefore, this study is an attempt to investigate the impact of brain-based learning model on science achievement of students at the middle school level.

Review of Related Literature

Philosophical Considerations: Pragmatism, progressivism, humanism, naturalism and constructivism are taken into consideration in developing brain-based learning model. Pragmatism emphasizes an activity-oriented approach so students would learn not only that they can relate various kinds of knowledge and use them to attack a problem but also that they can act on them (Ozmon & Craver, 1986). Progressivism emphasizes the need for students to learn through their own experiences and be actively involved in their own learning process (Armstrong, Henson, & Savage, 1989). Naturalistic educations advocated the system of developing inherent tendencies by providing conducive experiences and the children imbibing knowledge according to their interests and aptitudes by their own efforts, observations and experimentation (Dhiman, 2007). According to humanism, mastering of the subject matter is a natural by-product of such a relaxed environment characterized by warm, positive and accepting human quality. It emphasizes to provide for rich environment with a view to facilitate total and integrated child development (Siddiqui, 2009). A constructivist approach to teaching and learning does not deny the importance of factual knowledge, but it does emphasize that the best way for learners to retain and apply this knowledge is to put it into a larger, more lifelike context that stimulates learners to reflect, organize, analyze, and solve problem (Borich & Tombari, 1997, as cited in Killen, 2016). Therefore, in implementing brain-based learning model, students are given learning experiences from which they can construct their own meaning and share the ideas with other students, and the learning environment where they are with real-world problems that encourage them to do critical thinking and challenge them to have problem-solving skills.

Learning Theories: As the second part of theoretical considerations, Piaget's stage theory of cognitive development, Vygotsky's theory of cognitive development, Bruner's theory of cognitive growth, Ausubel's meaningful learning theory, information processing theory, brain-based learning theory and Gardner's theory of multiple intelligence are taken into consideration to develop brain-based learning model. Therefore, in implementing brain-based learning model, effective learning procedures are created to tailor instruction to meet the needs of diverse learners and promote better learning outcomes, and appropriate learning activities are prepared to maximize students' experiences. Students are more engaged in learning when they are presented with activities that match their strengths and interests.

Background Teaching Models: To support the proposed brain-based learning model, six teaching models were considered as background concepts. These are Glaser's basic teaching model, Dr. Khin Zaw's multimodal model, Selfridge's sequential (serial) parallel model, Kovalik's integrated thematic instruction model, Hardiman's brain-targeted teaching model and Jensen's brain-based teaching model.

Brain-based Learning Model: The summary of brain-based learning model is described in Table 1 and brain-based learning model for teaching middle school science is presented in Figure 1.

Table 1 Summary of Brain-based Learning Model

Phase	Step		Major Activity
Prepare	Selection of Content		- selecting the content
	Clarification of Learning Objectives		- clarifying specific statements of what the students will be able to do at the end of teaching-learning process
	Preparation of Required Materials		- preparing materials required for instruction to provide students with enriched experiences
	Pre-exposure	to provide relaxed alertness	- providing students with an overview of the new learning
	Preparation of Learning Environment		- preparing learning environment in which students feel physically and emotionally secure (physically secure → pleasant smells, sounds, various sources, samples, working space emotionally secure → strong positive expectations, strong positive rapport)
Implement	Making Connection	to provide orchestrated immersion	- asking questions about the previous lesson or giving an activity to recall the learned concept (brain-based learning principles nine and ten)
	Activation		- engaging the mind and the body (brain-based learning principles six and eleven)

Phase	**Step**		**Major Activity**
	Framing		- explaining students learning outcomes expected from studying the learned concept - overviewing the new information with the help of the poster hung on the wall at the pre-exposure step (brain-based learning principles one, six and twelve)
	Acquisition		- digesting, thinking about, reflecting on and making sense of experience utilizing visualization, auditory, reading/writing and kinesthetic in multiple contexts - providing enriched learning activities for students with different learning styles: uni-modal, bi-modal, tri-modal and multi-modal (brain-based learning principles one, two, four, six, eight and twelve)
	Brain-breaks		- giving break time and providing with reflection and metacognition opportunities to internalize the newly learned material (brain-breaks based on breathing or relaxation, those based on vigorous physical activity and those focused on mental activity)
	Intricacy	to provide active processing	- giving opportunity to the brain to sort, investigate, analyze, test and elaborate lessons
	Incubation and Application		- allowing students to consolidate and internalize information effectively - providing opportunities for students to apply what they have learnt (brain-based learning principles one, ten and twelve)
	Memory Encoding		- enhancing the learning where the brain of the learner will encode what he/she learned
Confirm	Review and Verification		- confirming student learning - stimulating working memory to summarize the lesson (brain-based learning principle eight)
	Functional Integration		- providing opportunities for students to show their understanding of the new concept received from learning period (brain-based learning principles one, nine and twelve)
Assess	Brain-compatible Assessment		- is process-oriented and multi-modal and provides detailed feedback - is an ongoing activity in which teachers gather information about student learning in multiple ways (rubrics, observation, self-evaluation, portfolio, term projects and all in-class activities)

Phase	Step		Major Activity
	Summative Assessment		- evaluating student learning, skill acquisition and academic achievement at the end of an assigned instructional period Yes → Next Concept No → Feedback

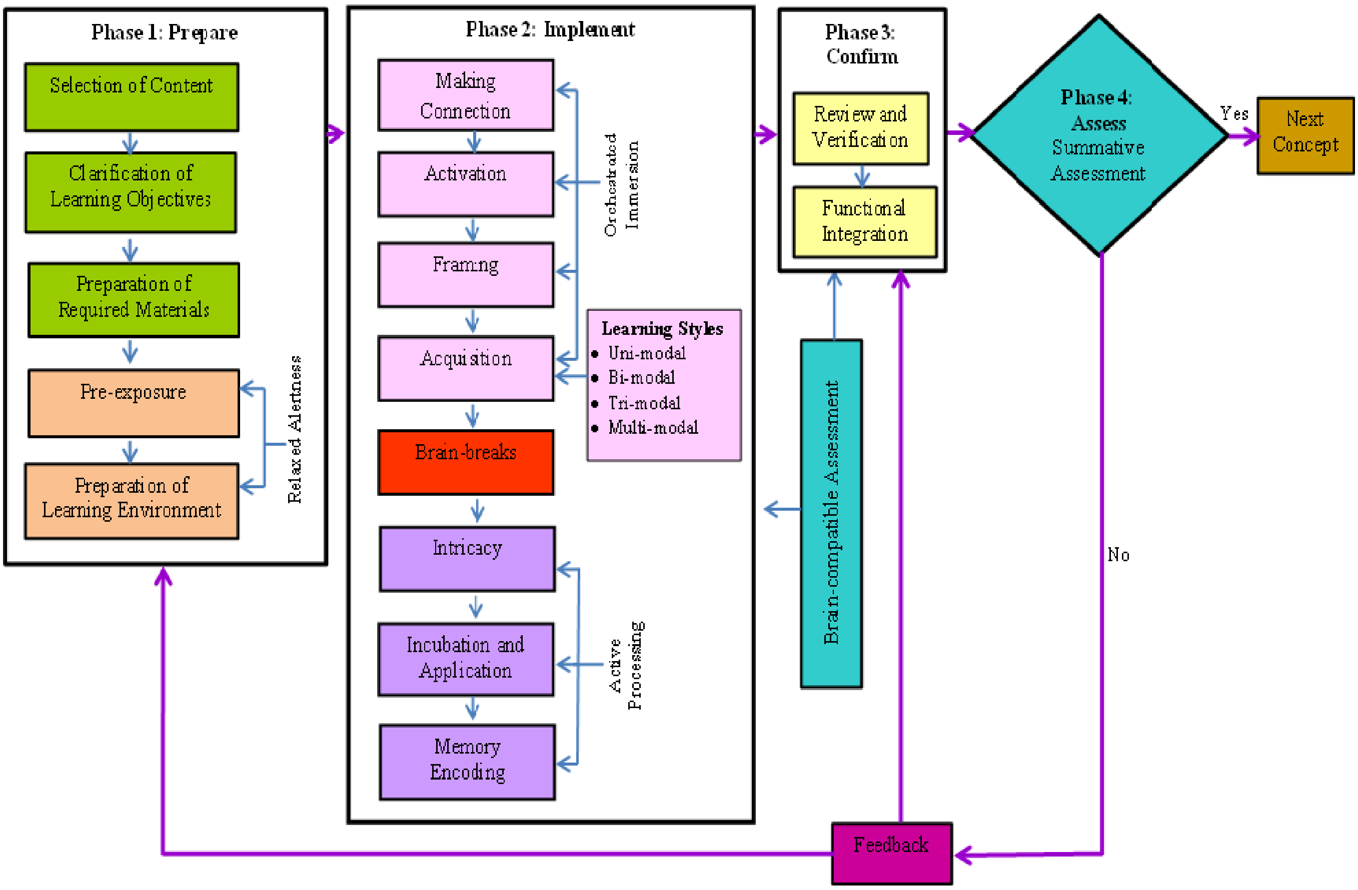

Figure 1 Brain-based Learning Model for Teaching Middle School Science

Methods

Research design, population and sample size, instruments and analysis of data are discussed in this section.

Research Design

To carry out the research, explanatory sequential (QUAN → qual) design, one of the mixed methods research designs, was used. The research design for the current study is illustrated in Figure 2.

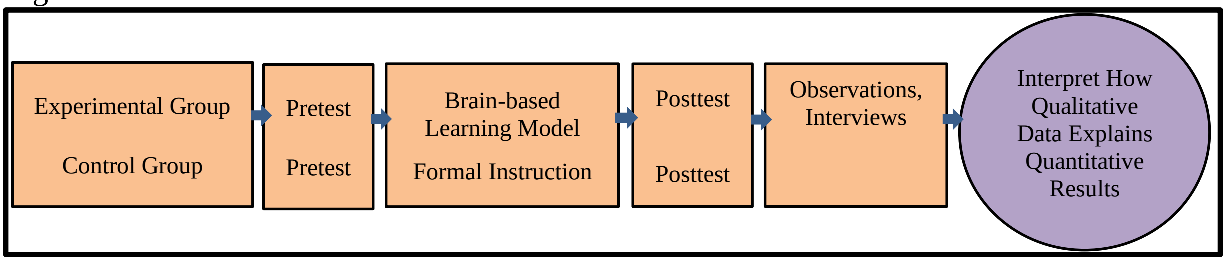

Figure 2 Research Design for the Current Study

Source: Adapted from Mills and Gay, (2016), p. 446.

In the quantitative phase of the study, nonequivalent control group design, one of the quasi-experimental designs, was used. In the qualitative phase, case study research design was used.

Population and Sample Size

Simple random sampling was used in the quantitative study. The population and sample size for the quantitative study are shown in Table 2.

Table 2 Population and Sample Size for Quantitative Study

Region	District	Township	School	No. of Population	No. of Sample
Mandalay	Maharaungmyay	Chanayetharsan	No. (5), BEHS, Chanayetharsan	108	108
	Aungmyaytharsan	Aungmyaytharsan	No. (20), BEHS, Aungmyaytharsan	165	109
	Meikhtila	Meikhtila	No. (1), BEHS, Meikhtila	228	115
	Yamethin	Pyawbwe	No. (1), BEHS, Pyawbwe	220	111
	Total			**721**	**443**

For qualitative study, purposive sampling was used to select participants. The population and sample size for the qualitative study are depicted in Table 3.

Table 3 Population and Sample Size for Qualitative Study

Selected Township	Name of School	No. of Participants for Observation		No. of Participants for Interview	
		Teacher	Students	Teacher	Students
Chanayetharsan	No. (5), BEHS, Chanayetharsan	1	54	1	4
Aungmyaytharsan	No. (20), BEHS, Aungmyaytharsan	1	55	1	4
Meikhtila	No. (1), BEHS, Meikhtila	1	58	1	4
Pyawbwe	No. (1), BEHS, Pyawbwe	1	55	1	4
Total		**4**	**222**	**4**	**16**

Instruments

For quantitative study, pretest, posttest and attitude questionnaire were used. As qualitative research instruments, observation checklists and interview questions were used.

Analysis of Data

Quantitative data were analyzed by using one-way analysis of covariance (ANCOVA), Pearson product-moment correlation and multiple regression. Qualitative data were analyzed by descriptive statistics and thematic analysis.

Findings

The findings of this study are discussed as quantitative research findings and qualitative research findings.

Quantitative Research Findings

In an attempt to answer the first research question, one-way analysis of covariance (ANCOVA) was used to analyze the data from posttest. According to the selected research design, the two intact groups from each school were assigned as the experimental group who receive instruction with brain-based learning model and the control group who receive formal instruction. Analysis of covariance is used to explore differences between groups while statistically controlling for an additionally (continuous) variable. ANCOVA is handy when it is unable to randomly assign the participants to the different groups, but instead have had to use existing groups (Pallant, 2013). The ANCOVA results of pretest scores on science knowledge in four selected schools are presented in Table 4.

Table 4 Analysis of Covariance (ANCOVA) Results for Pretest Scores on Science Knowledge in Four Selected Schools

School	Group	N	M	SD	MD	*F*	*p*
School 1	EG	54	21.74	0.48	0.07	0.55	.459 (ns)
	CG	54	21.67	0.55			
School 2	EG	55	21.53	0.74	0.25	2.90	.091 (ns)
	CG	54	21.28	0.79			
School 3	EG	58	20.66	0.69	-0.04	0.13	.721 (ns)
	CG	57	20.70	0.71			
School 4	EG	55	19.49	0.66	0.08	0.43	.514 (ns)
	CG	56	19.41	0.63			

Note. School 1 = No. (5), Basic Education High School, Chanayetharsan; School 2 = No. (20), Basic Education High School, Aungmyaytharsan; School 3 = No. (1), Basic Education High School, Meikhtila; School 4 = No. (1), Basic Education High School, Pyawbwe.
EG = Experimental Group; CG = Control Group. ns = not significant.

According to Table 4, there was no significant difference in the pretest mean scores between the experimental and control groups in four selected schools. It can be interpreted that the students in the experimental and control groups could be assumed to have similar science knowledge prior to the treatment.

The analysis of covariance results of posttest scores on science achievement in four selected schools are presented in Table 5.

Table 5 Analysis of Covariance (ANCOVA) Results for Posttest Scores on Science Achievement in Four Selected Schools

School	Level	Group	N	Unadjusted M	Adjusted M	MD	*F*	*p*
School 1	Remembering	EG	54	11.91	11.90	0.10	2.14	.147 (ns)
		CG	54	11.80	11.80			
	Understanding	EG	54	11.26	11.25	0.78	65.46	.000***
		CG	54	10.46	10.47			

School	**Level**	**Group**	**N**	**Unadjusted M**	**Adjusted M**	**MD**	***F***	***p***
	Applying	EG	54	10.80	10.78	0.80	97.38	.000***
		CG	54	9.96	9.98			
	Analyzing	EG	54	9.96	9.95	0.38	17.14	.000***
		CG	54	9.56	9.57			
	Total	EG	54	43.93	43.88	2.06	152.31	.000***
		CG	54	41.78	41.82			
School 2	Remembering	EG	55	10.89	10.86	-0.01	0.02	.884 (ns)
		CG	54	10.83	10.87			
	Understanding	EG	55	11.44	11.38	0.97	93.11	.000***
		CG	54	10.35	10.41			
	Applying	EG	55	10.67	10.63	0.71	72.76	.000***
		CG	54	9.87	9.92			
	Analyzing	EG	55	9.82	9.76	0.57	31.25	.000***
		CG	54	9.13	9.19			
	Total	EG	55	42.82	42.62	2.23	265.08	.000***
		CG	54	40.19	40.39			
School 3	Remembering	EG	58	10.14	10.14	0.09	2.06	.154 (ns)
		CG	57	10.05	10.05			
	Understanding	EG	58	10.69	10.70	0.69	97.95	.000***
		CG	57	10.02	10.01			
	Applying	EG	58	9.91	9.93	0.84	91.86	.000***
		CG	57	9.11	9.09			
	Analyzing	EG	58	9.16	9.16	0.85	85.88	.000***
		CG	57	8.32	8.31			
	Total	EG	58	39.90	39.93	2.47	279.03	.000***
		CG	57	37.49	37.46			
School 4	Remembering	EG	55	10.07	10.07	0.03	0.17	.683 (ns)
		CG	56	10.04	10.04			
	Understanding	EG	55	10.69	10.68	0.70	74.40	.000***
		CG	56	9.96	9.98			
	Applying	EG	55	9.80	9.79	0.63	43.14	.000***
		CG	56	9.14	9.16			
	Analyzing	EG	55	9.09	9.07	0.86	47.34	.000***
		CG	56	8.20	8.21			
	Total	EG	55	39.65	39.60	2.21	182.93	.000***
		CG	56	37.34	37.39			

Note. EG = Experimental Group; CG = Control Group. ns = not significant. ***$p < .001$.

The results in Table 5 showed that at the remembering level questions, there was no significant difference between the experimental group and control group on posttest scores of science achievement in four selected schools. Therefore, it can be interpreted that formal instruction could improve students' remembering of science knowledge similarly with brain-based learning model. But at the understanding, applying and analyzing level questions, there was a significant difference between the experimental group and control group on posttest scores of science achievement in four selected schools. Therefore, it can be interpreted that brain-based learning model significantly enhanced students' understanding of science concepts, students' ability to apply learned science concepts in other similar conditions and to dissect science knowledge and see its relationships.

Relationship between Students' Science Achievement and their Attitudes towards Learning with Brain-based Learning Model: In an attempt to answer the second research question, Pearson product-moment correlation coefficient (*r*) was used. The correlation results are shown in Table 6.

Table 6 Correlation between Students' Science Achievement and their Attitudes towards Learning Science with Brain-based Learning Model

Variable	Science Achievement	Learning Environment	Learning Materials	Teaching-Learning Process	Assessment
Science Achievement	1	.649**	.690**	.700**	.587**
Learning Environment		1	.588**	.495**	.452**
Learning Materials			1	.540**	.552**
Teaching-Learning Process				1	.484**
Assessment					1

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

According to the results in Table 6, there was a moderate, positive correlation between students' science achievement and their attitudes towards learning science with brain-based learning model: learning environment (r = .649, n = 222, p < .01), assessment (r = .587, n = 222, p < .01). There was a strong, positive correlation between students' science achievement and their attitudes towards learning science with brain-based learning model: learning materials (r = .690, n = 222, p < .01), teaching-learning process (r = .700, n = 222, p < .01). Therefore, it can be interpreted that the stronger attitudes students have towards learning science with brain-based learning model, the higher their science achievement.

Regression Analysis of Predictions of Students' Attitudes towards Learning with Brain-based Learning Model for their Science Achievement: In an attempt to answer the third research question, multiple regression analysis was used. Table 7 shows the results of the regression for predicting science achievement.

Table 7 Regression Analysis Summary for the Variables Predicting Science Achievement

Variable	*B*	*β*	*t*	*R*	R^2	Adj R^2	*F*
Science Achievement	4.167		2.054*	.828	.686	.680	118.495***
Predictor Variables							
Learning Environment	.340	.244	4.964***				
Learning Materials	.333	.266	5.026***				
Teaching-Learning Process	.299	.360	7.498***				
Assessment	.223	.156	3.264**				

Note. Constant = Dependent variable: Science Achievement

*p < .05. **p < .01. ***p < .001.

The summary table (Table 7) shows that the multiple correlation coefficient (*R*), using all the predictors simultaneously is .828 (R^2 = .686) and the adjusted R^2 is .680. It means that 68% of the variance in science achievement can be predicted from learning environment, learning materials, teaching-learning process and assessment of brain-based learning model. In predicting students' science achievement, the best predictor was teaching-learning process (β = .360***, p < .001), the second predictor was learning materials (β = .266***, p < .001), the third predictor was learning environment (β = .244***, p < .001) and the last predictor was assessment (β = .156**, p < .01) of brain-based learning model.

Based on these regression findings for learning environment, learning materials, teaching-learning process and assessment of brain-based learning predicting science achievement, the regression equation can be defined:

SA = 4.167 + .340 X1 +.333 X2 + .299 X3 +.223 X4

where: SA = Science Achievement

X1 = Learning Environment

X2 = Learning Materials

X3 = Teaching-learning Process

X4 = Assessment

The multiple regression model of predicting students' attitudes towards learning science with brain-based learning model for their science achievement obtained from applying regression analysis is shown in Figure 3.

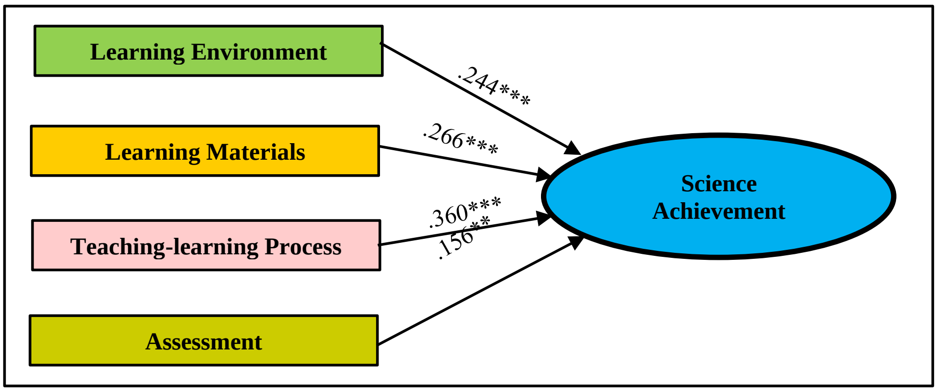

Figure 3 Multiple Regression Model of Predicting Students' Attitudes towards Learning Science with Brain-based Learning Model for Science Achievement

According to the results from this regression findings, there is no multicollinearity problem and the assumptions of linearity, normality and equality of variance are all met. Therefore, it can be interpreted that the multiple regression model predicting students' attitudes towards learning science with brain-based learning model for science achievement is stable, good and quite respectable.

Qualitative Research Findings

The results from observation checklists and interview are as follows.

Findings from Observation Checklist for Teachers: According to the observation results, it can be interpreted that teachers who taught the experimental groups were not familiar with the steps of brain-based learning model at the beginning but they were able to implement all these steps well in later chapters.

Findings from Observation Checklist for Students: From the results of observations, it can be interpreted that students were not much familiar with the steps of brain-based learning model in earlier lessons but they were able to participate well in all steps of the teaching-learning process in later lessons.

Findings from Science Teachers' Interview: Based on the thematic analysis of teachers' interview data, there are three main themes: attitudes towards brain-based learning model, teaching-learning process of brain-based learning model and impact of brain-based learning model. From the results, it can be interpreted that teachers have positive attitudes towards applying brain-based learning model in teaching middle school science.

Findings from Students' Interview: Based on the thematic analysis of students' interview data, there are three main themes: attitudes towards learning with brain-based learning model, teaching-learning process of brain-based learning model and impact of brain-based learning model. From the results, it can be interpreted that students have positive attitudes towards learning middle school science with brain-based learning model.

Discussion

Regarding one-way analysis of covariance (ANCOVA) results of posttest scores, it can be interpreted that the use of brain-based learning model had a significant effect on science achievement in the cognitive level. The research findings are in line with the results of Saleh (2011), Akyurek and Afacan (2013), and Bada and Jita (2023) who found that there was a significant difference between experimental groups and control groups favoring brain-based learning. Students who receive instruction with brain-based learning model gain much science knowledge, have a deep understanding of science concept, apply this concept in similar contexts and real-life experience, divide the learned concepts into different parts, identify the causes and solve problems with evidence. This may be due to the fact that using enriched learning activities can support students' understanding, creating contexts and questions that relate to real-life experiences can give opportunities to apply their learned concepts, and having opportunities to show their understanding at functional integration step can improve their analytical skills.

The results of Pearson product-moment correlation revealed that there was a statistically significant relationship between the four dimensions of students' attitudes towards learning with brain-based learning model with their science achievement. It can be interpreted that students have stronger attitudes towards learning science with brain-based learning model, they achieve higher in learning science. In the study conducted by Bruke and Williams (2008), it was found out that the students who are much better motivated for learning both get more successful and tend towards the thinking skills. According to Kara (2010), positive beliefs of students towards obtaining knowledge support their efforts to learn a subject.

The results of multiple regression analysis indicated that the best predictor for students' science achievement was teaching-learning process, the second predictor was learning materials, the third predictor was learning environment and the last predictor was assessment of brain-based learning model. Therefore, it can be interpreted that students who have high positive attitude towards learning environment, learning materials, teaching-learning process and assessment have high science achievement. According to Cetin (2006), attitude is a tendency which is attributed to individuals and creates ideas, feeling and behaviors about an object in an orderly manner.

Suggestions

Based on the findings of the research, a few suggestions can be made for teachers, students and school administrators to be effective teaching and learning science at the middle school level in using brain-based learning model.

Suggestions for Middle School Science Teachers: The results of posttest scores revealed that students who learn with brain-based learning model performed significantly better in learning science than those who do not. From observations, it was found that teachers implement brain-based learning model productively by providing various learning activities in teaching middle school science. Aljorani (2008) indicates that enrichment of teaching, with the varied activities and techniques, can meet the needs and interests of students. This enrichment can also develop positive attitudes and self-confidence of the learners which in turn helps them involve in the activities of teaching situations. It helps students have more relaxation, active processing and improve achievement. Therefore, it is suggested that teachers should prepare and use varieties of learning activities with multiple experiences to reach preferences of every student in the class.

Suggestions for Middle School Students: The results of posttest scores indicated that students who learn science with brain-based learning model have better achievement in science than those who do not. The observation and interview results also revealed that participating in the brain-based learning process has an advantage of improving science achievement. Therefore, it is suggested that students should participate actively in teaching-learning activities. Active participation in learning activities can help students better understand the material being taught. When students ask questions or share their ideas, they can clarify concepts they may have been confusing before. It can lead to better retention of information and develop critical thinking skills. As class participation requires students to analyze information and form opinions based on evidence, it can help develop lower-order thinking skills as well as higher-order thinking skills which are valuable in many areas of life.

Suggestions for School Administrators: From interviews, it was found that teachers have positive attitudes towards applying brain-based learning model in teaching science. Developing partnerships with other schools to share knowledge and instructional practices could facilitate teachers' and students' efforts in understanding how the brain functions. Providing professional support in helping teachers understand the brain and how students learn, will guide instructional practices that liberate students to seek the power within themselves and the world beyond.

Therefore, school administrators should provide opportunities to hold meeting or workshops for professional development of science teachers.

Recommendations

It is assumed that this study has contributed to the improvement of teaching and learning science at the middle school level. However, this research is not perfect and somewhat limited in scope. Based on the research findings, some recommendations can be provided for further research studies. This study was conducted with the sample schools from Mandalay Region. Therefore, further studies should be conducted in other states and regions in Myanmar with larger samples. As this study was limited to physics and biology concepts of science, further studies should be investigated with other science concepts such as chemistry concepts. In this study, the impact of brain-based learning model was explored by the evidence of students' science achievement. Further studies can be carried out to develop problem-solving ability, critical thinking ability, science processing skills, metacognitive skills, reasoning skills and creativity. This study was conducted by using explanatory sequential mixed methods research design and therefore, further studies can be conducted with different research designs to collect more reliable data.

Conclusion

Nowadays, learner's learning to learn, making effort for learning and high desire towards it are important focal points. In this context, it is one of the important roles of teachers to support the learners for developing positive attitudes towards learning and fulfilling their needs in learning. Brain-based learning model motivates student engagement in learning that leads to achievement in science for each individual student. The results of this study revealed that students learning with brain-based learning model performed significantly better than those who are taught with formally. Teachers and students have positive attitudes towards teaching and learning science with brain-based learning model. As teachers provide a stimulating learning environment that is both challenging and relaxing, students see the connections between the learned concepts and its practical applications, in order to better understand the knowledge and skill.

Brain-based learning model can be used to reduce the amount of rote memorization required since it helps students access and use more effective types of memory storage retrieval. It helps students to recognize patterns and then make connections between prior knowledge and new knowledge to be integrated in the brain's long-term memory storage areas. The significant contribution of brain-based research in education is the synoptic essence of Khin Zaw (1993) who pointed that the human brain seemly possesses at least two unique capabilities: multimoded processing and multi-channel communication. The human brains perform processing functions sometimes uni-modally, sometimes bi-modally, but most of the time, or generally, they do so in a multiple mode. It can be assumed that brain-based learning model based on the theories and assumptions of brain-based research has a significant contribution in teaching science at the middle school level.

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