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The Use of Biofeedback Training Techniques for Improving Heart Rate Variability Scores and Achievements in Science Subjects among Primary School Students

Hasmiza Yaakob[1], Muhammad Nubli Abdul Wahab[2], Abdul Rashid Abdul Aziz[3], Is'haq Ibrahim[4], Mohd Ropizam Mohamad Zainun[5]

[1,2,5]Centre for Human Sciences, Universiti Malaysia Pahang (UMP), Malaysia

[3,4]Faculty of Leadership & Management, Universiti Sains Islam Malaysia (USIM), Malaysia

Corresponding Author: rashid@usim.edu.my

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Abstract

Biofeedback training techniques can help to improve students' achievement levels in a subject. Accordingly, this study investigates differences in HRV scores between high- and low-performing students. This quasi-experimental quantitative study involved conducting pre- and post-tests on students who received biofeedback training during their science-learning integration process. The results show that students with good performance had better coherence scores compared to the poor performers. This is due to the regulation of the sympathetic and parasympathetic nervous systems among them. However, following biofeedback training, it was found that the higher HRV scores of the poor performing students exceeded that of the good performing students. This shows that they can compete with good performing students provided they receive more specific guidance. The findings of the study show that the HRV biofeedback training technique is suitable for use in helping rural primary school students improve their achievement in science and other subjects which require more effective alignment of learning techniques.

Keywords: Science Learning, Academic Performance, Biofeedback Training, Heart Rate Variability scores, primary school

Introduction

In achieving a progressive and scientific society in line with the New Economic Policy that sets science and technology as a prerequisite in stimulating the national economy, Malaysia will require many professionals, especially engineers and scientists. The government has allocated a large portion of the national budget to implement various programmes to attract the interest of youths in science. However, the current scenario shows that even though students acknowledge the importance of science in their lives and careers, interest in learning science, especially pure science is declining (Balilshah et al., 2016).

Education in Malaysia has been subject to gradual transformation from time to time. The government has set several aspects especially in the field of education through the National Education Plan, and the latest being the Malaysia Education Blueprint 2013-2025. The Ministry of Education has identified eleven shifts required to produce the changes desired by all Malaysians. Each shift must impact at least one of the five outcomes of the system, namely access, quality, equity, unity, and efficiency. The first shift in this Plan is to provide equal access to international-quality education and where the government places greater priority on improving the quality of Science, Technology, Engineering, and Mathematics (STEM) education.

When Malaysia participated in the Trends in International Mathematics and Science Study (TIMSS) for the first time in 1999, the scores of the students in those subjects surpassed the international averages. However, the TIMSS reports for 1999, 2003, 2007 and 2011 show a deterioration in the science and mathematics scores of 14-year-old students. In addition to rankings and scores, TIMSS also classifies students into Advanced, High, Intermediate, and Low benchmark groups. In the TIMSS Science area, only 1% of Malaysian students attained the highest group in 2011 (IEA, 2012) compared to 6% in 1999. In comparison, neighbouring Singapore had 40% of its students in the highest group in 2011 compared to 32% in 1999. Despite the various initiatives implemented by the government, this score has remained within the same band where, in 2019, only 5% of Malaysian students were in the highest group.

Phang et al. (2012) stated that the factors contributing to the decline in student achievement include lack of concentration in class, poor time management and lack of exposure to question-answering techniques. Pupils are also not competitive, less motivated to study due to having to work, live far from their schools and lack study facilities at home. They were also found to be less exposed to the concepts and benefits of taking the science stream, did not have access to practical facilities and lacked complete laboratory equipment as well as reference materials.

Learning motivation relates to the drive to achieve success, as measured based on a person's inner values (Sardiman, 2001). Meanwhile, Pace and Faules (1998) noted that individuals will be motivated when they believe that every action taken will surely yield positive values for them and that all good results are due to their own efforts. This will in turn generate positive emotions in the individual that will subsequently affect their Heart Rate Variability (HRV) scores. This value can be measured through the use of the HRV Biofeedback (HRVB) which directly stimulates various homeostatic “negative feedback loops” (Lehrer & Eddie, 2013) which then lead to subsequently positive effects on the regulation of individual emotions (Mather & Thayer, 2018; Thayer et al., 2012).

A study by Norizan and Nubli (2015) states that individuals with good HRV scores also have good achievement performance not only in academics but also in sports, the military and business. This is due to individual changes that take place as measured through HRV scores that show more positive thoughts and emotions, which in turn develop individuals possessing better self-control. As such, research is needed to explore the use of biofeedback training techniques to help control students' emotions and concentration and indirectly improve achievement performance in the learning of science, as well as its effect on HRV scores, especially for primary school students. This study thus sought to investigate the differences in HRV scores for good and poor performance students in science subjects as well as the effects of biofeedback training on the HRV scores of the latter in improving their academic achievements in science.

Literature Review

According to a study by Manisah and Norizza (2016), the effectiveness of a teaching and learning process hinges on the favourable reaction or response from the students. This proves that the students have focused well in following teaching and learning process. Weaknesses in mastering learning skills are due to short attention spans and difficulty in understanding what is being conveyed by teachers. The attitude and response of students to the teaching and learning process are among factors contributing to students' level of understanding, mastery and improvement in their academic performance in science subjects (Nordin & Ling, 2011).

According to Wan Hanim (2017), interest is one of the driving forces or tendencies of a person in focusing on a matter or event. It also leads to an increase in the desire to master a subject as well as inject a sense of wanting to exert extra effort in studying or in acquiring something. Pupils who have an interest in learning enjoy the activity and tend to focus on learning as well as gain satisfaction from the learning process itself.

In their study, Erma and Leong (2014) mention that students who have a high level of interest in a subject tend to study hard in order to constantly improve themselves. In other words, satisfaction can only be achieved when they learn a subject and understand it. This indirectly affects interest in a subject or activity and encourages students to explore the knowledge gained in greater depth.

In general, the majority of students believe that science and mathematics subjects are difficult to learn (Fatin et al., 2014). Many students experience learning difficulties and have low achievement in those subjects. Common problems faced include conceptual errors and misconceptions, a limited understanding of concepts in science and mathematics, weak mastery of science and mathematics knowledge, and difficulty in formulating and mastering science concepts (Teng, 2002; Rojahan, 2004; Hanafi, 2005).

Research shows that the HRV performance of individuals tends to improve following biofeedback training. Such training enables them to understand how this method can contribute towards their self-control. A study by Nazrolnizah (2014) noted that the HRV Biofeedback training technique introduced by Paul Lehrer can improve individual performance. Through the use of biofeedback instruments, individuals can improve their health, enhance their performance as well as measure physiological changes such as their thoughts, emotions and behaviour. The HRV Biofeedback training technique can also provide information on the activities in the body's system, namely heart rate variability (HRV). The information obtained can be applied as feedback for the human body system (Lehrer & Gevirtz, 2014). HRV Biofeedback training techniques are also used to stimulate and measure individual emotional and thought changes. In this regard, to date, the focus on the science learning process has been limited to cognitive learning exercises. Research is still lacking in regard to incorporating biofeedback training in the learning process for science subjects.

In his study, Mohd (2015) stated that biofeedback training can measure an individual's ability to self-regulate, especially when given a task. This is achieved through analysing the HRV spectrum, which is also an indication of the balance in the autonomic nervous system comprising the sympathetic and parasympathetic nervous systems. Biofeedback technique is also a means to gauge physiological responses and provide feedback and information that ultimately aids individuals in making psychological changes such as in their emotions and thoughts and then stimulate behavioural changes for improving self-performance.

According to Nubli and Salam (2013) the practice of remembrance or *zikr* is a predominant aspect in human life and an excellent means for the purification of the heart. It removes all ailments from the heart, makes it devouted to Allah and enhances awareness of His Greatness. This creates a sense of calmness in individuals. Therefore, the recitation of *zikr* as a component of psychophysiological training is important through the use of its protocols and those of biofeedback to realize changes in an individual's emotional responses. Studies show that *zikr* training can help in erasing emotional stress among students and at the same time enhance their academic performance.

Research Methodology

This research was based on a quasi-experimental quantitative design that examined the effectiveness of integrating science learning and biofeedback training in elevating student performance in science subjects. It employed the EmWave technology, which is a unique training system based on research on stress, emotions and performance developed by Doc Childre. It objectively monitors heart rhythms and determines the level of physiological coherence.

The study sample comprised 12 Year-6 primary school students. Their selection was based on their initial academic score values in their current year of study, and the purposive sampling method was used in this quasi-experimental study. The study used examination achievement data in the process of assessing mastery of science subjects. Student's answer scripts and examination scores were analyzed to determine whether the students' achievements were excellent or not.

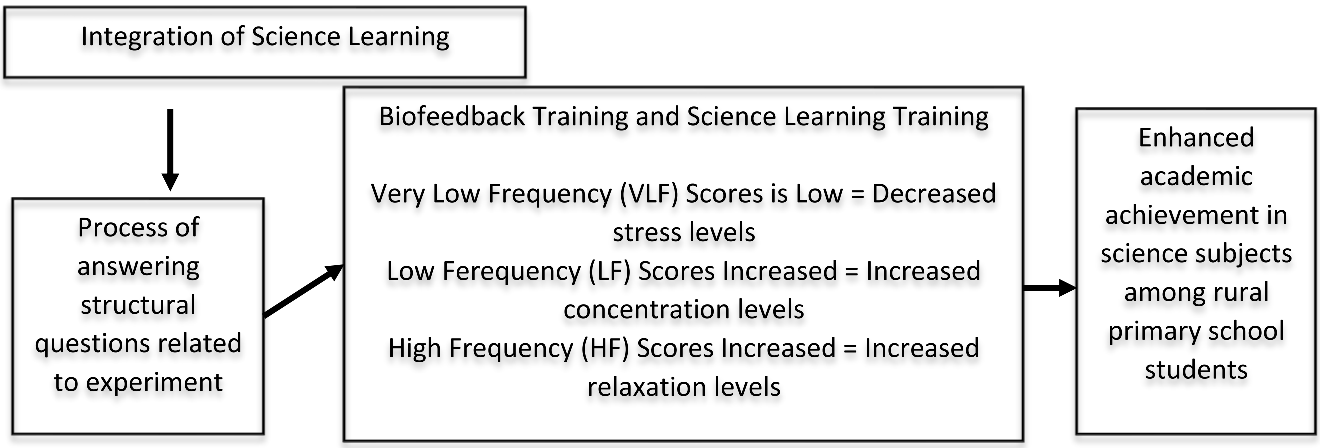

Figure 1: Study Design

Figure 1 shows the design of the study conducted by combining the integration of science learning and biofeedback training to identify the level of regulation in coherence scores among high- and low-performing students.

Formulation of Biofeedback Training Scripts

This study identified several appropriate scripts to increase learning concentration levels among students based on previous studies. The researcher first analyzed and tested the suitability of the modified script according to the needs of the study. The second phase was design where the researcher developed a complete and appropriate script for use in the study to elevate emotional calmness using the *zikr* approach. In the third Development phase, the script was designed by the researcher based on that developed by Nubli and Zulkifly (2012) and is used as a script that was compatible with the study aimed at improving self-performance and to calm the students. Under the Implementation phase, a pilot study was conducted to test the suitability of the script that was developed and improvements made wherever the findings did not meet the objectives of the study. Finally, the adapted script was used for the research data collection process. The following figure illustrates the procedures involved in the implementation protocol of the biofeedback training script.

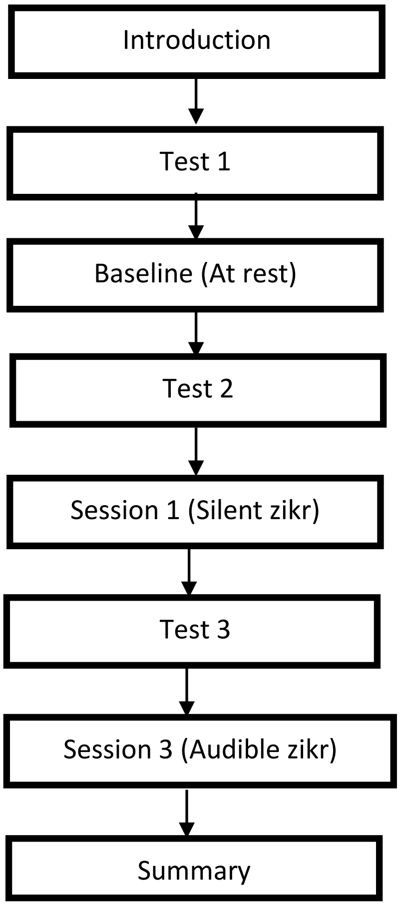

Figure 2: Biofeedback Training Study Protocol

As seen in Figure 2, the module script execution protocol procedure begins with an introduction session between the researcher and the student. The researcher started this session with self-introduction as well as explaination pertaining to biofeedback training, and the purpose of the biofeedback training. The student was instructed to sit comfortably with little movement allowed in order to get an accurate reading of the coherence score. After that, the students underwent for the first test which was on the subject of buoyancy. Students make observations on the experiment that was just conducted and will then be given structured questions. This first testing process was the baseline session where they will need to answer questions related to the experiment.

In this session, EmWave sensors were applied to the students to record and measure the readings for coherence score. At the same time, the researcher guided the students to sit comfortably while answering the questions. Following the baseline session and the recording of the coherence scores, the students were expected to perform the second test. During this session, the researcher guided the students to recite the *zikr* silently and repeated it at 30-second intervals. HRV score reading were also recorded at this session. Next, the students performed the third test where they were required to slowly repeat the *zikr* at 30-second intervals. Coherence score readings were measured. Finally, the researcher established the findings based on the HRV coherence scores and the science subject test scores that had been completed by the students.

Table 1: Sample Biofeedback Study Script

Time (Minutes)	Activity	Researcher's Script for Respondents
5 minutes	Introduction	
	Complete student demographic form.	Assalamualaikum. How are you?
	Student completes parental approval form.	Have a seat and please complete the form.
	Complete student particulars.	Had your breakfast?
	Teacher creates a conducive setting with student.	Anxious?
	Guides student to relax in mind and body.	Please sit in a relaxed manner.
	Instill a sense of enthusiasm in the student.	Do you want to excel/pass in your science subjects?
	Ensure student is not tense.	If you agree, I have a way to help you.
	Ensure student is relaxed and not moves unnecessarily.	Are you ready?
2 minutes	Baseline (At rest)	
	Test 1	Objective
	Ability to float on the water surface. Instructions Section 1: a) There are two containers filled with water. b) Container A has an unpeeled orange floating on the water. c) Container B has a peeled orange at the bottom. Section 2:	Ability of student to identify the reasons for the different situations of the oranges in the two containers.

	a) Please complete the solutions based on this test.	

Table 1 shows the training script used in this study. It begins with a 5-minute introduction process where students provide their personal background information, creating a friendly atmosphere with them, and ensuring they are at ease. The study also uses a uniform training script for each sample in order to provide similar conditions for each of them. After that, biofeedback data is taken with the sample in a state of rest. A biofeedback device will be attached to the students to measure their HRV score readings at rest.

Integration of Science Learning with Biofeedback Training

The topics in the integration of science learning used in this study comprise short-term modules built based on the systematic teaching ones developed by Dick, W. (2013). Guided by the Standard Learning Curriculum Document (Ministry of Education, 2013), the selection and organisation of topics is to allow for simple tests with quick results and appropriate to the duration of the biofeedback training module. Among the selected tests are "standard and non-standard measurements", "soils", "acids and alkalis", "material buoyancy" and "absorption". The biofeedback training module is employed to determine the extent of students' concentration and their confidence levels in reading questions and providing answers. This biofeedback exercise is tested prior to examining the students to identify the initial reading of the HRV scores and also when they answer questions related to the test.

Study Findings

Students undergo three science test sessions as well as biofeedback training and their HRV scores are recorded when they answer the structured questions related to the test. Analysing these findings is important as previous studies have shown that students who perform well produce better coherence scores than their poor-performing counterparts. Therefore, data analysis through Microsoft Excel (percentage), T-test (p value) and Tab data (medium and graphic) was conducted to evaluate the differences in HRV scores between the two groups of students.

Differences in HRV scores between good- and poor-performing students

Differences in HRV scores of the good- and poor-performing students were analyzed using the T-test and based on the raw data. Table 2 shows the differences in HRV scores for the two groups of students based on the paired sample T-test table.

Table 2: HRV Score Differences between Good- and Poor-performing Students (t-test)

Student Group		N	Sig.	t	df	Mean	Std. Deviation
Average Heart Rate (AHR)	Good Performers	6	0.175	1.461	10.00	93.00	15.10
	Poor Performers	6	0.188	1.461	6.85	83.17	6.62

Accumulated Coherence Score (ACS)	Good Performers	6	0.306	-1.079	10.00	19.33	9.29
	Poor Performers	6	0.311	-1.079	8.42	24.17	5.85
Very Low Frequency (VLF)	Good Performers	6	0.225	1.294	10.00	42.83	16.56
	Poor Performers	6	0.225	1.294	9.95	30.00	17.79
Low Frequency (LF)	Good Performers	6	0.554	-0.612	10.00	18.83	7.14
	Poor Performers	6	0.555	-0.612	9.89	21.50	7.94
High Frequency (HF)	Good Performers	6	0.340	-1.003	10.00	38.33	20.61
	Poor Performers	6	0.342	-1.003	9.00	48.67	14.58
MS (Mean score)	Good Performers	6	0.010	3.173	10.00	62.00	8.76
	Poor Performers	6	0.016	3.173	6.75	49.67	3.72

As seen in Table 2, the data analysis shows the difference in HRV scores among the good- and poor-performing students. It can be observed that the AHR score of the good performers is 0.175 ($p<0.5$) compared to the poor performing students where the significance value is 0.188 ($p< 0.5$). The significance value for the ACS score of the good-performing students is 0.306 (($p<0.5$) while that of the poor performers is 0.311 ($p<0.5$). For the VLF score, the significance value is the same for both groups of students at 0.225 ($p<0.5$). However, the LF score does not show much difference with good- and poor-performance students obtaining significance values of 0.554 ($p>0.5$) and 0.555 ($p>0.5$), respectively. For the HF score, the significance value for high-performing students is 0.340 ($p<0.5$) and 0.342 ($p<0.5$) for the poor-performers. Finally, the significance value for science test scores among high-performing students is 0.010 ($p< 0.5$) and 0.016 ($p<0.5$) for the poor performers. Therefore, it can be observed that there is a difference in coherence scores between the two groups of students.

The analysis of the difference in HRV scores of good (n=6) and poor (n=6) performing students based on percentages is shown in Table 3.

Table 3: Differences in HRV Scores between Good- and Poor-performing Students (%)

Item		Baseline		Session 1		Session 2		Notes
		Good Students	**Poor Students**	**Good Students**	**Poor Students**	**Good Students**	**Poor Students**	
Average	AHR	90	83	92	84	97	87	AHR Good Students > AHR Poor Students
	ACS	5	6	19	16	34	34	ACS Good Students = ACS Poor Students
	VLF	81	70	34	27	14	14	VLF Good Students = VLF Poor Students
	LF	**14**	**16**	**24**	**26**	**18**	**16**	**LF Good Students > LF Poor Students**
	HF	4	9	42	45	68	69	HF Good Students < HF Poor Students

The differences in students' HRV scores were analyzed based on the average raw data in percentage form over three sessions, namely Baseline for Trial 1, Session 1 for Trial 2 and Session 2 for Trial 3. The average percentage HRV scores were recorded beginning from the Average Heart Rate (AHR), Accumulated Coherent Score (ACS), Very Low Frequency (VLF), Low Frequency (LF) and High Frequency (HF).

Table 3 shows that the AHR score for good students increased from 90 beats per minute (bpm) for the baseline session to 92 bpm in Session 1 and 97 bpm in Session 2. This also applies to the data of poor performing students which increased from 83 bpm in the Baseline session to 84 bpm in Session 1 and 87 bpm in Session 2. The ACS scores of both good and poor performing students also showed improvements. The scores for good performers at Baseline was 5, and increased to 19 and 34 in Sessions 1 and 2, respectively while for low-performers it was 6 for the Baseline session, 16 in Session 1 and 34 in Session 2. In contrast, the VLF scores of good- and poor-performing students recorded declines. The Baseline session VLF score for the former was 81 but decreased to 34 in Session 1 and 14 in Session 2. Low-performing students' VLF score at the Baseline session was 70 but declined to 27 in Session 1 and 14 in Session 2. The LF score for good-performing students showed an increase from 14 at Baseline to 24 for the first session but declined slightly to 18 in the second session. Likewise, the LF score for poor-performing students which was 16 at Baseline and 26 in the first session, decreased to 16 in the second session. Finally, the HF score for good-performing students was

4% for the Baseline session, 42% in Session 1 and 68% in Session 2. The score for low-performing students was 9% at Baseline, and 45% and 69% in Sessions 1 and 2, respectively.

The findings in Table 3 show that after the second session, the AHR scores of the good-performing students exceeded that of the poor performers, while the ACS and VLF scores for both groups of students were the same. The LF scores of the good-performing students were higher than those of the poor-performers. However, the poor-performing students' HF scores were higher than for the good-performers. This reinforces the evidence that there is a difference in the HRV scores of good- versus poor-performing students.

The boxplot method was used to observe the data analysis of the differences in VLF and LF scores between good- and poor-performing students. This method is used to graphically view the distribution of the data. The following boxplot shows the differences in the VLF scores between the two groups of students.

Boxplot Perbezaan Skor VLF Murid Berprestasi Baik Dengan Murid Berprestasi

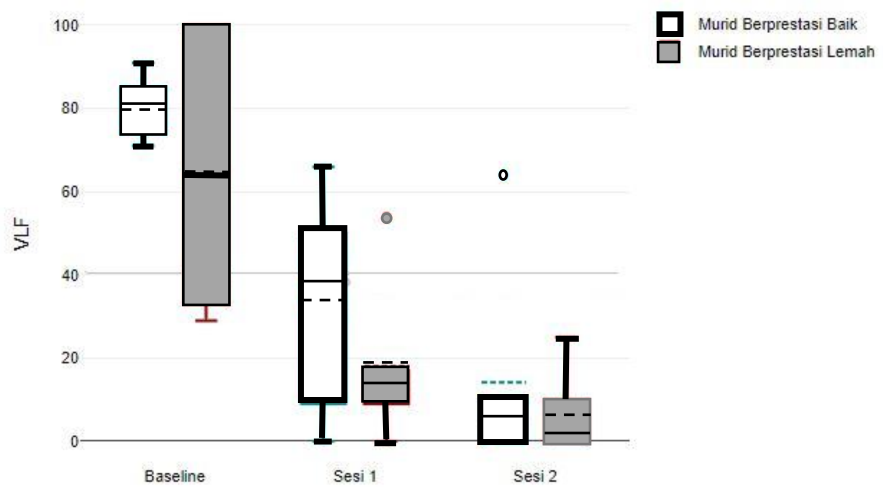

Figure 3 Differences in VLF Scores between Good- and Poor-performing Students

As Figure 3 shows, the maximum average VLF score of good-performing students is 91 while that of the poor performers is 100 in the Baseline session. In Session 1, the average maximum VLF scores of good- and poor-performing students declined to 66 and 54, respectively. For Session 2, the maximum average VLF scores of good-performing students was 64 while that of the poor performers was 25. This shows that although the scores declined for both groups of students, it is more significant for the poor-performing students. This can also be seen in Table 4 which shows the median values of Q1 (the median value between Q2 and the minimum value), Q2 (the median value of the data), and Q3 (the middle value between the median and the maximum value).

Table 4: Median VLF Score Values between Good- and Poor-performing Students

Median	Student Group	Baseline	Session 1	Session 2
Q3	Good Performers	85	50	18
	Poor Performers	100	17	10
Q2	Good Performers	81	33	5.5
	Poor Performers	65	14	6.5
Q1	Good Performers	74	9	0
	Poor Performers	33	9	0

The findings in Table 4 for the Baseline session show a Q3 value of 85 for the high-performing student group and 100 for the poor-performers. For Q2 the values are 81 and 65 while for Q1 they are 74 and 33 respectively.

For Session 1, the average Q3 median value for good-performing students dropped to 50 and 17 for the poor-performing students. The Q2 value also shows a decline at 33 and 14 for the respective groups. The Q1 value shows the same average median value for both groups which is 9.

The second session also showed a decrease, i.e., the Q3 value of the HRV score of the group of good-performing students was 18 while it was 10 for the poor performers. The Q2 value for the good-performing students was 5.5 and for the poor-performing students it was 6.5. The Q1 values for both groups were the same at 0.

From the data analysis it can be concluded that there is a significant difference in the decrease in VLF scores between good- and poor-performing students. This is apparent from the clear decrease in the median values of low-performing students, from 65 in the Baseline session to 14 and 6.5 in Sessions 1 and 2. Meanwhile, the median value of good-performing students began to show a drastic decrease in the second session with a median average of 33 in Session 1 to 5.5 in Session 2. This further strengthens the finding which states that the integration of science learning together with biofeedback training can help reduce stress in students, especially during the process of teaching and learning science.

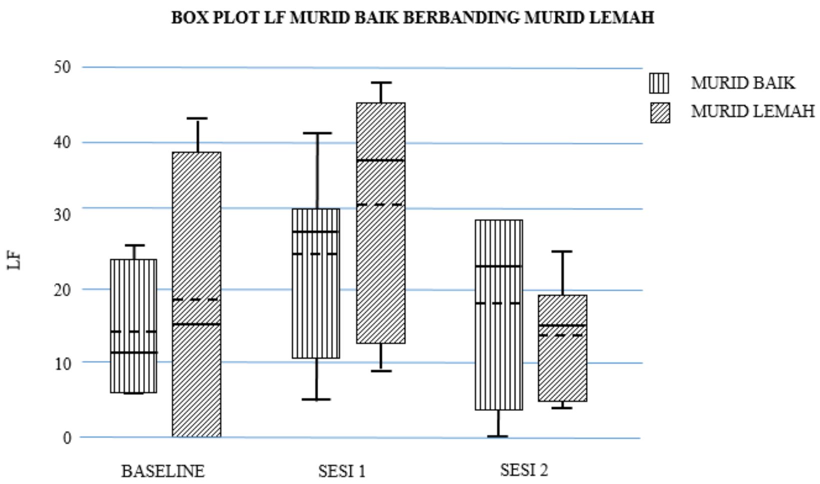

Figure 4: Differences in LF Scores between Good- and Poor-performing Students

The boxplot in Figure 4 shows the median value differences in the LF scores of the good-performing (vertical lines) and poor-performing (slanted lines) students. As seen in the figure, the average maximum median value for the LF scores of good- performers at Baseline is 26 while that for the poor-performers is 43. The average median value of the LF score for Session 1 showed an increase at 45 and 40 for the two groups, respectively. The second session also showed an increase to 75 for the group of good-performing students and 48 for the poor-performers. It can be seen that the maximum average of the median value of the LF scores of good performing students increased from the Baseline session to the second session. For the group of poor-performing students, there was a decline in the average maximum median value between the Baseline and Session 1 but an increase in the second session. This shows that the concentration of poor-performing students can be helped by applying biofeedback training techniques in learning sessions. Figure 4 is further reinforced with Table 5 which shows the median LF score values of Q1, Q2 and Q3 in each of the sessions conducted by both groups of students.

Table 5: Median LF Score Values between Good- and Poor-performing Students

Median	Student Group	Baseline	Session 1	Session 2
Q3	Good Performers	24	31	37.25
	Poor Performers	38	45	40.25
Q2	Good Performers	11.5	28	25
	Poor Performers	15.5	37.5	26
Q1	Good Performers	6	11	14.25
	Poor Performers	0	13	14

Table 5 shows the median values for both categories of students for each session. The Q3 value at Baseline for good-performing students is 24 while it is 38 for the poor performers. Meanwhile, the Q2 values are 11.5 and 15.5 for the two respective groups. The Q1 values for the good- and poor-performing students are 6 and 0, respectively.

For Session 1, the Q3 value for the good-performing students is 31 while it is 45 for the poor performers. Meanwhile, the Q2 values were 28 and 37.5 for the two respective groups. The Q1 values for the good- and poor-performers are 11 and 13, respectively.The second session shows that the Q3 value of good-performing students is 37.25 and that of the poor performers is 40.25. The Q2 values are 25 and 26 for the two respective groups. Finally, the Q1 value of the good-performing students is 14.25 while it is 14 for the poor-performing students.

It can be seen that the median value for the poor-performing students is higher than that for the good-performing ones at Baseline and in Session 1. However, in Session 2, the median value of poor performing students decreased and was lower than that of the good performers. This is because in this session, the students have to recite the *zikir* slowly while answering the comprehension questions in the test. As such, it was found that this method somewhat interferes with the concentration of low-performing students compared to when they recited the *zikir* silently.

Therefore, from the boxplot analysis of the differences in VLF and LF scores of both groups of students it can be concluded that biofeedback training with the help of *zikir* can help in improving the concentration of students, especially the poor-performing ones.

Integrating learning with biofeedback training can also improve student concentration and emotional control in order to excel especially in science subjects.

Discussion

The findings show that students who are good-performers have better HRV scores than their poor-performing counterparts. Nubli et al. (2012) and Vistasari et al. (2011) found that the HRV scores of students who have excellent academic achievements is better than those who are weak academically. This is also apparent in the higher LF and ACS scores among poorly-performing students and those having problems in subjects compared to the good-performance students. Therefore, this HRV measurement coupled with biofeedback training can aid educators measure and guide students who are weak in managing emotional changes in becoming calmer and more focused, especially during teaching and learning sessions in science subjects.

In his study, Mohd (2015) also found that students with low academic achievements recorded higher VLF coherence scores than those who did well academically. A high VLF score indicates that those performing poorly academically are unable to apply methods to obtain higher LF scores. Thus, indicates their inability to control themselves and laziness in attaining goals that have been set. Whereas, those doing well academically can be categorized as having self-control and being successful at achieving their goals in every aspect.

Although the study found an increase in HRV scores after the testing session, the increase in the scores of poor-performing students was relatively high compared to that among the good performers. This is because the increase in the HRV score is able to help improve the achievement of poor performing students compared to their high-performing counterparts (Norizan, 2015).

The difference in HRV scores among poor-performing students shows that it also occurs among good-performing students, proving that children need guidance, instruction and deeper focus to shape them into outstanding individuals especially in the field of academia. The results of the study found that biofeedback training can help improve student performance in self-regulation and this will help them focus on learning, especially in science subjects (Nazrolnizah, 2014).

The study by Maziah (2013) noted that biofeedback training has a positive effect on the development of children's performance in terms of academic achievement. More detailed innovations are required to broaden the use of biofeedback training in the field of education. Its impact on the achievement of students' performance is seen being able to motivate them to better understand and show interest in teaching and learning. Similarly, Norsuhaila (2014) also stated that the biofeedback training technique is able to help 12-year-old children improve the level of reverence when performing prayers. The impact of biofeedback training and its measurement tools can help parents and educators in guiding such children in improving their concentration whether during worship or in teaching and learning sessions.

Vistasari et al. (2011) also stated that students with good levels of academic achievement have better HRV scores than those who perform poorly. The LF and ACS scores of high-performing students reflect better concentration levels than the poor performers. As such, biofeedback training can be included as a new technique in the teaching and learning process to measure student concentration, especially in the classroom.

Accordingly, it can be concluded that biofeedback training can be extended to teachers as a method and approach to enhance the concentration levels and interest among poor-performing students in learning science. Such students can be guided to improve their level of mastery of science subjects (Nordin & Ling, 2011). Teachers play a key role in providing appropriate training to stimulate student concentration and improve performance levels in science subjects. The HRV scores of good-performing students also need to be further improved to ensure that they can achieve greater excellence in science subjects (Nubli & Salam, 2013).

Conclusion

The findings of the study show that the main weakness of students in rural areas is their lack of interest and understanding in science subjects. Both these factors affect their self-confidence in learning science. This addresses the study's research question on identifying the main issues faced by students, particularly those in rural schools. Integrating science learning with HRV biofeedback training is viewed as an early means for helping teachers guide students with learning problems. The HRV results obtained show that students performing poorly in science subjects did not have low VLF and high LF spectrum scores compared to the Baseline score. Similarly, the findings show that students who performed well in science subjects did not obtain high ASC scores compared to the poor performers after the biofeedback training session. This shows that such training can assist teachers in helping students with poor performance and lacking an interest in science subjects to be more positive and develop better concentration levels during the learning process. This will enable weak students to also improve their mastery and achievement levels in science subjects.

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Corresponding Author
Abdul Rashid Abdul Aziz
Faculty of Leadership and Management, Universiti Sains Islam Malaysia (USIM)
Bandar Baru Nilai, 71800 Nilai, Negeri Sembilan, Malaysia.
Email: rashid@usim.edu.my

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