

Developing Achievement in Mathematics, Specifically in Elementary Logic, through Brain-Based Learning (BBL) Combined with Skill Practice Exercises for Grade 10 Students

Keerati Kaewkumsai¹ & Songsak Phusee-orn²

¹ Faculty of Education, Mahasarakham University, Mahasarakham, Thailand

Correspondence: Songsak Phusee-orn, Faculty of Education, Mahasarakham University, Mahasarakham, Thailand. Tel: 87-872-7151. E-mail: songsak.p@msu.ac.th

Received: April 12, 2024

Accepted: April 27, 2024

Online Published: April 28, 2024

doi:10.5539/hes.v14n2p130

URL: <https://doi.org/10.5539/hes.v14n2p130>

Abstract

This research aims to: 1) Develop an effective Brain-Based Learning (BBL) plan combined with skill practice exercises for Grade 10 students, achieving a performance criterion of 70/70; 2) Compare the learning outcomes in elementary logic before and after implementing the BBL approach combined with skill practice exercises for Grade 10 students; 3) Study the satisfaction level of students towards the BBL approach combined with skill practice exercises for Grade 10 students. The sample group consisted of 39 students from Grade 10 room 4 in the first semester of the 2023 academic year, selected through purposive sampling. Research tools included a learning management plan, an achievement test, skill practice exercises, and a satisfaction questionnaire. Data were analyzed using percentages, mean, standard deviation, and dependent samples t-test.

The research found that: 1) The BBL-based learning management plan for elementary logic for Grade 10 students was effective, with performance levels of 95.69/81.28, exceeding the set criterion of 70/70; 2) The academic achievement of students who underwent the BBL-based learning in elementary logic for Grade 10 students significantly improved post-learning, at a .05 level of statistical significance; 3) Students were highly satisfied with the BBL-based learning approach combined with skill practice exercises in elementary logic for Grade 10 students, with a mean satisfaction score of 4.86.

Keywords: Brain-based learning, skill practice exercises, academic achievement

1. Introduction

Mathematics plays a crucial role in 21st-century learning success as it enables humans to think creatively, reason logically, systematically, and methodically, and to analyze problems or situations thoroughly. It assists in forecasting, planning, making informed decisions, and effectively applying knowledge in real life. Additionally, the core learning content and indicators for mathematics education (revised 2017), according to the 2008 Basic Education Core Curriculum, emphasize equipping students with essential 21st-century skills such as analytical thinking, critical thinking, problem-solving, creativity, technology usage, communication, and collaboration. These skills prepare learners to adapt to changes in the economy, society, culture, and environment, enabling them to compete and coexist in the global community. Successful mathematics education must prepare students to be ready to learn various subjects, enter the workforce upon graduation, or pursue higher education levels. Therefore, educational institutions should tailor learning experiences to the individual potential of each student (Ministry of Education, 2017). Currently, mathematics represents a national challenge due to its complexity, which leads to low learning efficacy. Furthermore, students in Thailand, particularly those in provincial areas, have relatively low mathematical knowledge and foundational skills, partly because they receive fewer educational opportunities and lack adequate learning resources. These factors contribute to the significantly low mathematics achievement levels among Thai students, as evidenced by national O-NET test scores where Grade 6 students average 36.83, and Grade 9 and Grade 12 students score 24.47 and 21.28, respectively. These scores are lower than those of any other subject at those grade levels. Additionally, students in suburban areas tend to score higher in mathematics than those in provincial areas (IPST, 2021). National testing results indicate that the average basic mathematical skills of Grade 9 and Grade 12 students are below 50%, which is below the minimum international standard. Moreover, the PISA (Programme for International Student Assessment) results

show that Thai students' average scores in 2012 and 2015 were below the OECD average (Institute for the Promotion of Teaching Science and Technology, Ministry of Education, 2017, pp. 5-6). To the effectiveness of mathematics education, it is essential to focus on personalized learning by considering individual differences and brain development. Researchers have explored various teaching techniques to find solutions to improve mathematics teaching and make it more effective. One approach is Brain-Based Learning (BBL), which emphasizes student-centered learning by utilizing processes that develop analytical and synthetic thinking, problem-solving, decision-making, and planning skills to facilitate practical application based on how the brain learns. This learning approach considers brain function principles and emphasizes student-centered learning, increasingly popular for developing learners, especially in basic education. This approach integrates thinking, emotion, and action in learning, using the brain's structure as a tool for learning.

The management of learning through the Brain Based Learning (BBL) method has garnered significant interest among students. Caine & Caine (1989) mentioned that learning based on brain function, a theory grounded in the brain's structure and functional operations, continues as long as the brain performs its normal processes. Therefore, student development should be appropriate for their age and compatible with their brain's growth. Consistent with this, research by Amjad Islam Amjad (2023) found that BBL greatly influences students' internal motivation for learning and their capabilities in mathematics. Additionally, research by Triana, Mailis, and others (2019) discovered that teaching mathematics using BBL methods alongside Autograph enhances students' mathematical communication skills. Furthermore, a study by Yatim, Siti Seri Kartini Mohd, and others (2022) revealed that students taught through BBL in conjunction with the GeoGebra program improved their understanding of derivatives. This aligns with findings from Duman, Bilal (2010), which showed that students learning through BBL methods achieve higher academic outcomes than those taught through traditional methods.

For these reasons, the researcher is interested in developing learners' potential further through experimental activities to improve academic achievements in elementary logic using Brain-Based Learning (BBL) combined with skill practice exercises for Grade 10 students at Wapee Pathum School, aiming to enhance their learning outcomes and establish a solid foundation for advanced education levels.

2. Objectives of the Study

To develop an effective Brain-Based Learning (BBL) plan combined with skill practice exercises for Grade 10 students at Wapee Pathum School, meeting a performance criterion of 70/70, to compare academic achievements in elementary logic before and after the implementation of brain-based learning (BBL) combined with skill practice exercises and to study the satisfaction of students towards brain-based learning (BBL) combined with skill practice exercises.

3. Method

3.1 Population and Sample

The population for this research includes Grade 10 students from Wapee Pathum School, Mahasarakham Province, in the first semester of the 2023 academic year, encompassing 5 classrooms with a total of 180 students. The sample group used in this research consists of students from Grade 10 room 4 of Wapee Pathum School, , in the first semester of the 2023 academic year, totaling 1 classroom of 39 students, selected through purposive sampling.

3.2 Research Instruments

The research tools used include four types:

Eleven Brain-Based Learning (BBL) mathematics lesson plans for Grade 10, focused on elementary logic, with a total duration of 11 hours. These plans integrate BBL with skill practice exercises in elementary logic, Skill practice exercises in elementary logic, utilized to measure and evaluate each learning management plan, comprising 11 skill practice assessments, An achievement test in elementary logic for basic mathematics for Grade 10, consisting of 15 multiple-choice questions and 2 open-ended questions, a student satisfaction questionnaire regarding the Brain-Based Learning (BBL) approach combined with skill practice exercises for Grade 10 students. This is a Likert scale questionnaire with 5 levels, consisting of 10 items, all types of research tools have undergone quality inspections by experts and have been modified and improved to meet academic standards.

3.3 Data Analysis

The data analysis process conducted by the researcher includes verifying the accuracy and completeness of the data, followed by the following analyses: The development of Brain-Based Learning (BBL) lesson plans

combined with skill practice exercises in elementary logic for Grade 10. The effectiveness is analyzed by calculating the efficiency values E1/E2. Comparing the academic achievements before and after the implementation of Brain-Based Learning (BBL) activities combined with skill practice exercises in elementary logic for basic mathematics for Grade 10. This is analyzed using the dependent samples t-test. Analyzing the level of student satisfaction with the Brain-Based Learning (BBL) activities combined with skill practice exercises in elementary logic for basic mathematics for Grade 10. This involves calculating the mean (\bar{x}), standard deviation (S.D.), and interpreting the mean satisfaction scores according to the following criteria: A mean score of 4.50 – 5.00 indicates the highest satisfaction, 3.50 – 4.49 indicates high satisfaction, 2.50 – 3.49 indicates moderate satisfaction, 1.50 – 2.49 indicates low satisfaction, 1.00 – 1.49 indicates the lowest satisfaction.

4. Results

The Results of A Study Present in Tables 1-3

Table 1. Efficiency of Brain-Based Learning (BBL) Combined with skill practice exercises for Grade 10 High School Students to Achieve a Standard of 70/70

Score	Full Score	Mean (\bar{x})	S.D.	Percent
Scores During Learning	110	105.26	2.85	95.69
Scores After Learning	20	16.26	1.33	81.28
Efficiency of the learning program (E1/E2) = 95.69/81.28				

From Table 1, the results of the test show that the Brain-Based Learning (BBL) program combined with skill practice exercises for grade 10 high school students yielded an efficiency of 95.69/81.28, which meets the set criteria.

Table 2. Comparative Analysis of Academic Performance Before and After Learning Basic Logic through Brain-Based Learning (BBL) Integrated with Skill Practice in Grade 10

Score	n	Full Score	Mean (\bar{x})	S.D.	t	Sig-value
Pretest	39	20	9.95	1.746	19.422	.000 *
Posttest	39	20	16.26	16.26		

$p < .05$

From Table 2, it is evident that students demonstrated higher academic performance after learning basic logic through Brain-Based Learning (BBL) integrated with skill practice exercises in Grade 10, compared to before learning. This finding is statistically significant at the .05 level.

Table 3. Mean and Standard Deviation of Students' Satisfaction with Brain-Based Learning (BBL) Integrated with skill practice exercises in Basic Logic in Grade 10

Item	Description	Mean	S.D.	Satisfaction Level
1	Content is easy to understand and not overly difficult	4.64	0.49	Highest
2	Teachers are capable of imparting knowledge effectively	4.97	0.16	Highest
3	Teachers are reliable and punctual	4.97	0.16	Highest
4	Content is appropriate for the learning duration	4.82	0.39	Highest
5	I feel happy and enjoy studying mathematics	4.77	0.43	Highest
6	Use of media and activities are suitable for my knowledge and abilities	4.90	0.31	Highest
7	There are sufficient media and learning materials for students	4.95	0.22	Highest
8	I like the activities/skill exercises provided by the teacher	4.90	0.31	Highest
9	I am always satisfied with the scores I achieve in activities or skill exercises	4.72	0.60	Highest
10	Teachers are fair in grading	4.95	0.22	Highest
Total		4.86	0.12	Highest

From Table 3, it is evident that students are highly satisfied with the Brain-Based Learning (BBL) integrated with skill practice exercises in basic logic in Grade 10 ($\bar{X} = 4.86$). When considering each item, it is found that satisfaction is at the highest level for every item. The top three highest mean scores are as follows: item 2 - Teachers are capable of imparting knowledge effectively, and item 3 - Teachers are reliable and punctual ($\bar{X} =$

4.97), with the highest mean score. The next highest mean scores are for item 7 - There are sufficient media and learning materials for students, and item 10 - Teachers are fair in grading ($\bar{X} = 4.95$). The third highest mean scores are for item 6 - Use of media and activities are suitable for my knowledge and abilities, and item 8 - I like the activities/skill exercises provided by the teacher ($\bar{X} = 4.90$), respectively.

5. Conclusion

1) The Brain-Based Learning (BBL) integrated with skill practice exercises in basic logic for Grade 10 is effective with a performance score of 95.69/81.28, which exceeds the standard of 70/70. 2) The academic performance of students who received instruction using Brain-Based Learning (BBL) combined with skill practice exercises in basic logic for Grade 10 is higher after learning than before learning, with statistically significant results at the .05 level. 3) Student are highly satisfied with the Brain-Based Learning (BBL) integrated with skill practice exercises in basic logic for Grade 10 ($\bar{X} = 4.86$).

6. Discussion

1) The instructional plan utilizing Brain-Based Learning (BBL) along with skill practice exercises in basic logic for Grade 10 students is highly effective, with a score of 95.69/81.28, surpassing the set standard of 70/70. This implies that Grade 10 students have a good understanding of basic logic according to the research objectives of item 1. This is because the instructional plan was systematically implemented using Brain-Based Learning (BBL) along with skill practice. The researchers studied the concepts and theories related to brain-based learning and the use of skill practice in teaching, then applied both concepts together. They analyzed the standards, learning objectives, and content from the Basic Education Core Curriculum, Buddhist Era 2551 (Revised Edition 2560), to create the instructional plan. The plan was presented to advisor teachers for evaluation of its suitability and then to experts for assessment of its quality and suitability. Based on expert feedback, adjustments were made to the plan for data collection from the sample group. As a result, the instructional plan using Brain-Based Learning (BBL) along with skill practice in basic logic for Grade 10 students is more effective than the established standard of 70/70. Brain-Based Learning (BBL) involves applying knowledge about the brain and its natural functions in learning processes. This includes organizing learning activities between teachers and students, creating conducive learning environments, and designing and using learning materials to facilitate optimal student learning. The learning activities are structured into five steps: Readiness, Presentation of Knowledge, Engagement in Learning, Knowledge Summary, and Application of Knowledge. This aligns with the concepts of Akaraphoom Jarupakorn and Phornphai Lerthawichat (2551, p. 234), who define brain-based learning as understanding the brain, which involves understanding or having perspectives on learning processes based on knowledge and understanding of brain functions. Such perspectives enable the organization of learning activities based on interests and considerations of which factors contribute to changes in the brain. This includes changes in cell group circuits and internal cell networks in the brain, or how the brain responds to different teaching methods. Changes in student learning, understanding, and proficiency reflect changes within the brain. The effectiveness of learning should be assessed based on these changes, and appropriate assessment methods should be used. These principles are consistent with the research findings of Laddawan Suwannamajo (2556), who conducted a comparative study on the academic performance in cultural knowledge and emotional intelligence of Grade 2 elementary students between brain-based learning (BBL) and cooperative learning using Jigsaw II. The research found that instructional plans based on brain-based learning and Jigsaw II cooperative learning were equally effective, with scores of 88.69/81.83 and 90.40/80.17, respectively, meeting the established criteria.

2) When comparing the academic performance outcomes in mathematics of Grade 10 students who received instruction using Brain-Based Learning (BBL) along with skill practice in basic logic, it was found that their learning outcomes were significantly higher than before the instruction, with statistical significance at the .05 level. This could be attributed to the instructional approach of using Brain-Based Learning (BBL) along with skill practice in basic logic. The instructional process for Grade 10 students involved several activity stages: Stage 1: Readiness Preparation: This stage involved activities to prepare the brain for learning, including suitable movements such as games or music to awaken the brain and reviewing students' prior knowledge. Stage 2: Knowledge Presentation: New knowledge was presented in a stimulating manner through unconventional and challenging media. The content taught had meaning, relevance to real-life contexts, and was delivered through diverse and engaging learning activities. Stage 3: Learning Engagement: Students actively engaged in learning through various activities to connect old knowledge with new knowledge. They reviewed their knowledge and practiced through skill practice exercises, classroom tasks, or answering teacher questions. Stage 4: Knowledge Summary: Students summarized their learning experiences to consolidate their knowledge, understanding of the lesson, and skills acquired. Stage 5: Application of Knowledge: Students applied their knowledge in new situations, such as completing assigned skill practice exercises or various assignments. These activity stages

contributed to the improved academic performance in mathematics among Grade 10 students who received instruction using Brain-Based Learning (BBL) along with skill practice in basic logic. This finding aligns with the research conducted by Parisar Chaiyakul and colleagues (2563), which investigated the effectiveness of Brain-Based Learning (BBL) combined with the KWDL technique on students' problem-solving abilities and mathematical analytical skills. The research involved Grade 3 elementary students and found that their problem-solving abilities in mathematics significantly improved after the instruction, with statistical significance at the .05 level.

3) Students expressed the highest level of satisfaction with the Brain-Based Learning (BBL) approach combined with skill practice in basic logic, with an average satisfaction level of 4.86. Upon examining each item, it was found that satisfaction was at the highest level for all items, with the top three average scores being: Item 2: Teachers are capable of transferring knowledge effectively to students. Item 3: Teachers are reliable and punctual (average score = 4.97). The next highest average scores were for Item 7: There are adequate learning materials and equipment for students, and Item 10: Teachers are fair in grading (average score = 4.95). The third highest average scores were for Item 6: The use of media and activities is suitable for my knowledge and abilities, and Item 8: I enjoy doing activities/skill exercises assigned by the teacher (average score = 2.92). This may be attributed to the fact that the Brain-Based Learning (BBL) approach combined with skill practice activities is suitable for the students' age group and aligns with the natural processes of brain function. Pre-learning brain management activities help students relax, creating a positive atmosphere. Diverse, interesting, and challenging learning activities make students realize the importance of the content studied and how to apply knowledge for future use. Furthermore, good teacher-student relationships, mutual understanding, and care contribute to a relaxed classroom atmosphere, making students feel safe and enabling them to learn to their full potential. These findings are consistent with the research conducted by Parita Kharaphap (2564), which studied the development of learning activities following the Brain-Based Learning (BBL) approach combined with the use of motion graphic media to enhance the reading and spelling abilities of Grade 2 students. The research found that students' satisfaction levels with content, media design, and benefits received were overall high (average satisfaction score = 2.61, S.D.= 0.03)

7. Research Suggestions

7.1 These are the Suggestions from the Study

1) The study on implementing Brain-Based Learning (BBL) combined with skill practice exercises has significantly improved the quality of teaching and learning, resulting in higher academic achievements for students. Therefore, mathematics teachers can apply and adapt Brain-Based Learning (BBL) combined with skill practice exercises continuously in their teaching practices. 2) Before implementing the Brain-Based Learning (BBL) plan combined with skill practice exercises, it is advisable to study the steps involved, prepare learning materials, and assessment tools adequately for the number of students in each class as specified in the learning management plan. This ensures that instructors are confident and that the learning activities are carried out continuously. 3) In applying the Brain-Based Learning (BBL) plan combined with skill practice exercises for learning activities, some learning plans may require extended time for certain steps. It is advisable not to limit sessions to just one hour; instead, sessions might need to last 2-3 hours to be effective. 4) Instructors should provide reinforcement and stimulate student learning in every lesson plan to ensure that students are prepared and engaged in the learning activities.

7.2 Future Research Recommendation

1) Brain-Based Learning (BBL) combined with skill practice exercises should be applied to other topics within mathematics or other subjects and grade levels to explore suitable learning management methods. 2) There should be a comparison of Brain-Based Learning (BBL) combined with skill practice exercises between different groups of students, such as high-achieving students and those who may need more support. 3) The learning model using Brain-Based Learning (BBL) combined with skill practice exercises should be developed further, possibly integrating with other teaching methods to enhance the effectiveness of teaching and learning.

Acknowledgments

I would like to thank you so much for the research samples and the experts who checked the quality of the tools. I would like to thank the students who helped in collecting the data.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

Open access

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

References

- Amjad Islam Amjad, Musarrat Habib, Umaira Tabassum, Gulshan Fatima Alvi, Naveed Ahmad Taseer & Iqra Noreen. (2023). *International Electronic Journal of Elementary Education*, 16(1), 111-122.
- Boonsong Khantong. (2015). *Brain-Based Learning (BBL)*. Retrieved from <https://www.gotoknow.org>
- Caine, R., & Caine, G. (1989). *12 Principles for brain based learning*. Retrieved from http://www.nea.org/teachexperiance/braik_030925.html
- Duman, Bilal. (2010). The Effects of Brain-Based Learning on the Academic Achievement of Students with Different Learning Styles. *Educational Sciences: Theory and Practice*, 10(4), 2077-2103.
- Institute for Academic Quality Development. (2006). *Learning Principles of the Brain*. Bangkok: Suweeriyasarn.
- Institute for Learning Sciences. (2007). *Brain-Based Learning Teaching*. Bangkok: Educational Administration Development Institute.
- Ketsuda Jaikham. (2009). *Brain-Based Learning*. Article, Far Eastern University.
- Laddawan Suwanmajo. (2013). *A Comparison of Academic Achievements in Cultural Knowledge and Emotional Intelligence Between Second Grade Students Using Brain-Based Learning (BBL) and Jigsaw II Cooperative Learning*. Master's Thesis, Faculty of Arts and Sciences, Nakhon Phanom University.
- Ministry of Education. (2008). *The Core Curriculum for Basic Education, Buddhist Era 2551*. Bangkok: Agricultural Cooperative Printing of Thailand.
- Pharita Karaphap. (2021). *Development of Learning Activities Using Brain-Based Learning (BBL) Combined with Motion Graphics to Enhance the Ability to Read and Spell Words of Second Grade Students*. Master's Thesis in Educational Studies, Silpakorn University.
- Rangsit University Learning Center. (2018). *Brain-Based Learning Part 1*. Retrieved from <https://lc.rsu.ac.th/weblog/11>
- Sirinan Wongchotigul. (2016). *Development of Mathematics Teaching Models Using Brain-Based Learning at the Primary Education Level*. Doctoral Dissertation, Faculty of Education, Burapha University.
- Sunthorn Krotbat. (2005). *Principles of Brain-Based Learning*. Bangkok: Educational Administration Development Institute, Office of the Permanent Secretary, Ministry of Education.
- Theerapong Saengsinh. (2007). *Brain-Based Learning (BBL)*. Retrieved from <https://sobkroo.com/articledetail>.
- Triana, Mailis, Zubainur, Cut Morina and Bahrun (2019). Students' Mathematical Communication Ability through the Brain-Based Learning Approach Using Autograph. *Journal of Research and Advances in Mathematics Education*, 4(1), 1-10. <https://doi.org/10.23917/jramathedu.v4i1.6972>

Yatim, Siti Seri Kartini Mohd, Saleh, Salmiza, Zulnaidi, Hutkemri, Yew, Wun Thiam, & Yatim, Siti Ainor Mohd. (2022). Effects of Brain-Based Teaching Approach Integrated with GeoGebra (B-Geo Module) on Students' Conceptual Understanding. *International Journal of Instruction*, 15(1), 327-346.
<https://doi.org/10.29333/iji.2022.15119a>