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Research Paper

# Integrating Brain-Based Learning Activities into Online TESOL Courses: Exploring Different Learning Styles

**Hossein Isaee [1]*, Hamed Barjesteh [2], Neda Fatehi Rad [3]**

[1] PhD Candidate, Department of English Language and Literature, Ayatollah Amoli Branch, Islamic Azad University, Amol, Iran.
hossein_isaee@yahoo.com

[2] Associate Professor, Department of English Language and Literature, Ayatollah Amoli Branch, Islamic Azad University, Amol, Iran.
ha_bar77@yahoo.com

[3] Associate Professor, Department of English Language and Literature, Kerman Branch, Islamic Azad University, Kerman, Iran.
nedafatehi@yahoo.com

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**ABSTRACT**

Brain-based learning (BBL) theory is based on utilizing research about how the brain functions and how instructors can apply such knowledge to assist second language (L2) learners in acquiring new languages quickly and effectively (Thurber, 1980). In essence, the study aimed to explore how Brain-based learning affects the academic performance of 34 BA university students taking an online course in Teaching English to Speakers of Other Languages (TESOL) course, considering different learning styles. The study follows a pretest-posttest experimental design, with participants selected conveniently from Islamic Azad University (Ayatollah Amoli Branch) and divided into 2 groups, namely experimental and control. Both groups were taught via the *Vadana02* Platform. While the experimental group was exposed to brain-based activities, the control group used traditional-based activities. Data was gathered through Kolb's Learning Style questionnaire educational achievement tests. The study's findings showed that the online brain-based activities used in the experimental group improved students' educational achievement more than the traditional approach used in the control group. Additionally, the results indicated that there were no significant differences in the achievement levels among students with various learning styles in the experimental group. The researchers found that integrating BBL into online instruction significantly improves students' academic achievement. This demonstrates that brain-based learning activities enhance students' proficiency

**Keywords**: *Academic Performance, Brain-Based Learning, Learning Styles, Neuroscience, Online Classes*

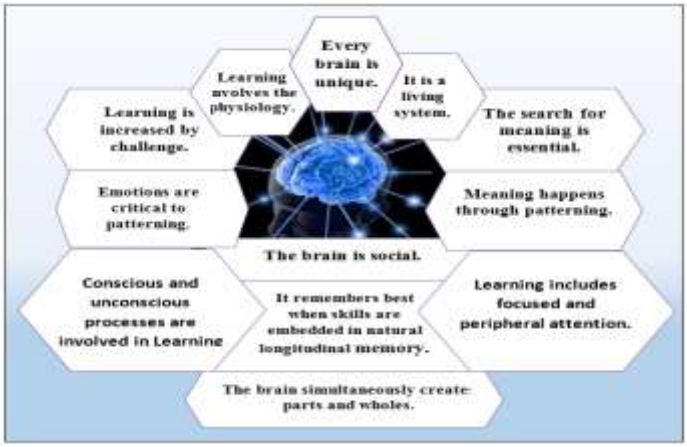
## INTRODUCTION

In the late twentieth century, there was an explosion of information about the human brain and learning, featured in educational journals, popular magazines, and television documentaries (Abdolmaleki & Saeedi, 2024). Numerous books, research projects, and magazine covers presented simple strategies and new information to improve memory and cognitive abilities (Wolfe & Brandt, 1998). As human knowledge of brain sciences has advanced, many scholars have increasingly explored how the principles of neuroscience can influence teaching methods in the classroom (e.g., Jayasankara Reddy et al., 2021; Mujiyanto et al., 2021; Shamim & Sarwar, 2024; Tommerdahl, 2010). Neuroscience is the scientific study of the nervous system, including the spinal cord, peripheral nervous system, and the brain, as well as their functions and disorders (Sylvan and Christodoulou, 2010; Busso and Pollack, 2014). Educational neuroscience is an interdisciplinary effort that combines cognitive science, neuroscience, and education to improve classroom practices (Haddad & Al Hashimi, 2024). Neuroscience is advancing rapidly in areas relevant to language education (Abdolmaleki & Saeedi, 2024). Despite initial skepticism, findings from neuroscience that are still being explored today can provide valuable insights for enhancing teaching and learning (Lackney, 2004).

In his book "Brain-based Learning: The New Paradigm of Teaching," Jensen (2008) defined BBL as learning in line with the way the brain naturally learns. This definition implies that all scientific discoveries about the human brain's functions and structure have influenced the development of learning practices and theories showing that brain-based learning needs an interdisciplinary approach, emphasizing the interconnectedness between education and neuroscience, as well as some disciplines like genetics, psychology, sociology, and neuroanatomy (Shahzadi et al., 2024). The BBL theory, also known as brain-compatible theory, is grounded in investigations about how human brain functions and in what ways educators could employ such knowledge to facilitate efficient and rapid learning, particularly for second-language students learning English (Thurber, 1980). It focuses on understanding how the human brain naturally learns and involves embracing the principles of brain processing to achieve meaningful learning. Twelve principles of brain-based learning introduced by Caine and Caine (1991) are depicted in Figure 1.

**Figure 1**

Twelve principles of brain-based learning



BBL uses scientifically researched strategies to teach students and asserts that combining human experiences, common sense, and brain research yields valuable tools for the classroom context (Caine, 2000). In essence, brain-based learning involves learning while keeping the brain in mind. BBL is a meaningful and motivating way to maximize teaching and learning in a positive manner (Raghavendran & Begum, 2021). An example of this in the traditional classroom is allowing students to move throughout the room, discuss with other students, and remain engaged as they learn a new concept. Some techniques of the BBL with online teaching are beginning with what the learners already know, increasing multi-modal sensory learning, activating students' engagement in the online class, implementing synchronous and asynchronous learning, using online brain breaks, and using metaphors and stories to aid students make brains' connection. Additionally, brain-based teaching could be done by combining ICT tools to ease learning and make it meaningful (Jensen, 2000).

Zull (2002) illustrates that learning occurs through experiences. According to Kolb and Kolb (2005), the most significant shared concept of Experiential Learning Theory (ELT) and Brain-based learning (BBL) is experience. Table 1 summarizes the relationships between BBL and Kolb's ELT model. The ELT and BBL models explain learning based on the brain's lobes. According to Jensen (2008), based on BBL theory, individuals have their circadian rhythm and circulation.

**Table 1**

*The relationships between Kolb's experiential learning theory and brain-based learning*

| ELT | BBL |
|---|---|
| 1. Learning occurs in the form of a circulation. | 1. The brain works in unity |
| 2. Every learning style equips students with special perceptions and processing skills. | 2. Each brain is unique |
| 3. Every individual has his/her particular learning style. Four learning styles exist in the cycle of learning. | 3. The brain is divided into four lobes, each serving different functions and having distinct duties. |
| 4. The information conception is the first and information processing is the second. | 4. The left hemisphere is abstract and analytic while the right hemisphere is concrete and holistic. |
| 5. The learning cycle defines two dimensions of learning. | 5. Having distinct functions, the brain is split up into two hemispheres. |

The level of learning is one of the most crucial elements indicating learning environment success (Sternberg & Grigorenko, 1997; Phillips, 2005). It is necessary to consider the abilities, characteristics, and experiences of learners when planning a learning environment to make sure of the impact of teaching (Kemp et al., 1998).

Ellis (1989, p.31), defined a *learning style* as "the consistent way in which a person perceives, conceptualizes, organizes, and recalls information". Being widely accepted as a pattern of behavior that humans use for new learning and also a way to help progress learning performances, learning styles refer to the fact that individuals differ due to what mode of instruction is most efficacious for them (Kemp et

al., 1998). In this study, Kolb's Learning Style Model is employed as it identifies with the "Generative Theory of Multimedia Learning". Kolb (1984) states that based on experiential learning theory, learning is a mixture of cognition, experience, behavior, and perception (Abdullaeva & Ramazonova, 2024). According to Kolb (1984), learning styles are typically focused on how learners prefer to learn rather than what they learn. They are crucial in students' academic performance and attitudes (Sallata et al., 2024). Students have different learning preferences, some favor concrete information such as experimental data and facts, while others are more inclined towards abstract information like theories and mathematical models. Although there are various literary styles defined by form, genre, and procedure, the term "style" is not commonly associated with the intricate processes involved in individual learning (Sallata et al., 2024). Kolb demonstrated that individuals have varying learning styles, which can be viewed on a continuum ranging from reflective observation, concrete experience, active experimentation, and abstract conceptualization. He proposed different approaches to cater to these styles. For concrete experiencers, he recommended offering labs, fieldwork, observations, or videos. Reflective observers could benefit from using logs, journals, or brainstorming. The abstract conceptualizer may find lectures, papers, and analogies effective, while the active experimenter could benefit from simulations, case studies, and homework (Lin, 2024).

The research on BBL is still limited in L2 education is still limited, despite increasing scholarly discussions. While BBL has been applied in adult education fields, there are significant gaps between L2 learning/teaching and brain science, particularly regarding different learning styles. In effect, this study aims to explore how university students' learning is influenced by their various learning styles. The primary goal of this study is to find out whether brain-based learning has similar effects on the academic achievements of learners with various learning styles; therefore, the research questions are as follows:

*1. Is there a significant difference in the impact of brain-based learning activities compared to the traditional method on the educational achievement of students attending synchronous online TESOL courses?*

*2. Is there a significant difference in the educational achievement levels of online TESOL students in the control group based on their learning styles?*

*3. Are there significant differences in the educational achievement levels of online TESOL students in the experimental group based on their learning styles?*

*4. Is there a significant difference in educational achievement between the control and experimental groups attending synchronous online TESOL courses, taking into account different learning styles?*

## LITERATURE REVIEWS

Tafti and Kadkhodaie (2017) conducted a study on the impacts of BBL on life skills learning. Their research revealed that brain-based training significantly impacts adolescent learning. Mujiyanto et al (2021) surveyed to scrutinize the impact of BBT combined with online instruction. approach on students' reading achievement amid the COVID-19 pandemic. The study revealed distinct differences between the control and experimental groups, showing higher reading achievements for students with high motivation. These findings suggest that integrating BBT with online instruction can enhance students' motivation for reading, encouraging further research in BBT approaches.

In the same fashion, Shamim and Sarwar (2024) surveyed junior high school instructors using quantitative strategies to gather numerical data. They assessed teachers' perspectives on BBL and self-reported proficiency in 21st-century skills through questionnaires. The study emphasized the influence of BBL on contemporary skills and its implications for secondary education. It also assessed the advantages and disadvantages of brain-based learning techniques. Their findings had the potential to influence educators, legislators, stakeholders, and curriculum developers. The results also revealed that understanding the effect of BBL on 21st-century skills is essential for preparing students for success in today's world and guiding evidence-based teaching strategies and educational policies.

Similarly, Haddad and Al Hashimi (2024) researched the efficacy of a BBL approach on tenth-grade students' educational achievement in life sciences. The researchers divided 84 students into 2 groups: one taught using the brain-based strategy and the other using a conventional strategy. Pre-tests and post-tests were used to measure academic achievement, and the data was analyzed using various statistical methods. The results showed a positive relationship between academic achievement and brain-based learning strategy in life sciences. In the same vein, Funa et al (2024) found that BBL significantly improves student conceptual understanding. Their meta-analysis of 14 studies showed an overall effect size (ES) of 3.135. The researchers suggested using BBL strategies to enhance student learning across different educational levels.

Lin (2024) summarized the classification of learning styles and their influence on L2 acquisition. The findings showed a strong correlation between educational achievement and learning styles. His study also highlighted the impact of learners' backgrounds and traits on their learning styles, as well as the correlation between students' learning styles and teachers' techniques and aims. The conclusion emphasized the importance of understanding students' learning patterns for the betterment of the teaching profession.

Considering a brief review of the literature, the primary goal of the study is to find out whether BBL has similar effects on the educational achievements of university students doing an online course in TESOL with different learning styles.

## METHOD

### Design of the Study

A quasi-experimental design was used with both an experimental and a control group to compare the efficacy of 2 teaching approaches on students' achievement (i.e., brain-based learning and traditional approach). The researchers determined all students' learning styles using Kolb's learning style inventory, identified the distribution of the learning styles, and recognized the most and least common learning styles. Before and after the experiment, the researchers tested both classes. The data were analyzed using Statistical Software for Social Sciences (SPSS Version 22). Inferential statistics in addition to descriptive statistics were utilized to compare the pre-test and post-test results for students with different learning styles both between different groups and within the same group.

## Participants

The Department of English Language and Literature at Ayatollah Amoli University, a branch of Islamic Azad University in Iran, offers distance and fully online classes. These courses are conducted virtually with English as a Foreign Language (TEFL) professors who interact with learners in real-time through online platforms. The teacher-researchers at the university, who also train prospective English language teachers, chose to select their sample from their students taking a course in TESOL. In total, 44 students (25 females, 19 males) were invited to take part in the study via WhatsApp messaging and email. All students were aged between 22 and 33, with an average age of 25.5. According to the university's language department records, all the participants had been taking online courses for the past two years (4 academic semesters), so they were very familiar with the online class environment, tools, and platforms such as Vadana and Google Forms. Additionally, the participants had similar socio-economic and cultural backgrounds. To ensure that the learners had similar language proficiency levels, the researchers initially had them complete a simplified intermediate version of the Key English Test, also known as the KET test, using the Google Forms platform. Initially, the researchers had 44 participants for the study, but they excluded 10 based on their scores, in line with the selection criteria provided by Hatch and Farhady (2018). The researchers then divided the remaining participants into two groups of 17 each, using random selection. One group was taught using traditional methods (i.e., the control group), while the other group was instructed using a BBL approach (i.e., the experimental group) over 16 sessions. Both groups had an equal mix of male and female participants.

## Instrument

To conduct this study, two online platforms were used for conducting online virtual classes and administering tests: Vadana and Google Forms, respectively. Additionally, three instruments were utilized: 1) a version of the Key English Test (KET) as a reliable and standard criterion to help the researchers choose a sample, and 2) Kolb's learning styles inventory (KLSI) as a popular criterion to determine the learning styles of the students, and 3) an academic achievement test serving as the pretest and posttest, discussed as follows:

## Online Platforms: Vadana and Google Forms

Iran's Islamic Azad University in line with the ease of carrying out educational and student affairs; launched various electronic systems so that candidates can refer to the specified internet system to use virtual educational services. One of the important infrastructures to advance the quality of education is the *Vadana* system of Azad University, which is available to candidates for holding online classes. It is now a popular Iranian platform among university academia that is used for hosting webinars, online meetings, and virtual classrooms. *Google Forms* is a versatile web-based tool that enables users to create surveys, quizzes, and forms with ease. It seamlessly integrates with other Google Workspace applications, allowing for real-time data collection and analysis. This tool is perfect for gathering information, conducting research, and improving productivity in educational and professional environments.

**Kolb's Learning Styles Inventory (KLSI)**

In a study by Aşkar and Akkoyunlu (1993) in Turkey, Kolb's (1984) learning style scale was adopted. In the original study, its reliability was found to be 0.72. The scale consists of 12 items, with each item having four options representing different learning styles. Each item is scored between 1 and 4, with a maximum score of 48 and a minimum score of 12 for the entire scale. Combined scores need to be calculated to interpret the data from the learning style scale. These scores are determined by subtracting the "Abstract Conceptualization-Abstract Experience (AC-AE) from the Active Experience-Experiential Observation (AE-EO) difference". These calculations can range from -36 to +36. A negative score shows a concrete learning style whereas a positive score for AC-AE indicates that the learner has an abstract learning style. A negative score indicates a reflective learning style while a positive score for AE-EO indicates an active learning style. Finally, by plotting the values derived from these calculations on a diagram based on Kolb's (1984) ELT, the students' learning styles can be determined.

**The Key English Test**

A version of the Key English Test (KET) was used as a reliable and standard criterion to help researchers select a sample. Initially, the KET was sent to 44 participants using the Google Forms platform at the beginning of the project to assess their language proficiency levels and ensure their homogeneity. Based on their scores and following the selection criteria provided by Hatch and Farhady (1982), 10 students were excluded, leaving 34 participants for the study (Table 1). The study tried to scrutinize the efficacy of treatments on L2 learning outcomes within this proficiency range. Therefore, language proficiency level was not a major independent variable but was used solely to ensure comparability among participants. While relying on the internal KET test lacks external validation, it was considered sufficient for this study.

**An Academic Achievement Test**

The researchers made academic achievement test, which consisted of 30 items based on three units of "New Interchange 3" covering topics of friendships, careers, and favors, was validated by three TEFL experts, including supervisors and consultants from the Ayatollah Amoli Branch of Islamic Azad University. To establish the test's reliability, the Cronbach's alpha method was employed. A pilot test was run with a group of 30 learners sharing similar characteristics with the target population, such as age, gender, and level. The pilot test included 30 EFL learners, and the results showed a mean of M=14.68 and a standard deviation of SD=1.821. The test was found to be reliable with an estimated r value of 0.77, as determined by the Kr-21 method. These results indicated that the test was suitable for use.

3.2.5 New Interchange 3 (the 5th Edition)

The study used New Interchange 3 by Professor Jack C. Richards. The book was selected because the Interchange series is popular among EFL learners and language institutes in Iran, and it is also prescribed for TEFL or TESOL students in Iran's universities. These course books cover a variety of topics.

**Data Collection and Analysis Procedure**

To ensure that the learners had similar language proficiency levels, the researchers initially had them complete a simplified intermediate version of the KET test using the Google Forms platform. Initially, the researchers had 44 participants for the study, but they excluded 10 based on their scores, in line with the selection criteria provided by Hatch and Farhady (1982). The researchers then divided the remaining participants into two groups of 17 each, using random selection so that one group would receive traditional methods (i.e., the control group), and the other group would be exposed to a brain-based learning approach (i.e., the experimental group) over 16 online sessions in Vadana Platform by the same teacher.

To determine the participants' learning styles, the teacher-researcher used the Kolb learning style inventory. At the beginning of each synchronous online class on the Vadana Platform, the teacher-researcher gave students detailed instructions on completing a questionnaire. The students were also provided with a video clip showing how to record and submit their answers via the Vadana Platform. Once the responses were received, the student's learning styles were determined. To ensure equal knowledge across both groups, an academic achievement test was administered using Google Forms. Both groups used the course book "New Interchange 3". The topics were taught in the following sequence to both online classes: Unit 1 (Friendship) in sessions 2 to 6, Unit 2 (Career) in sessions 7 to 11, and Unit 3 (Favours) in sessions 12 to 16. During the online classes, both groups had 70-minute sessions twice a week for 8 weeks, based on the university's language department schedule. The control group used traditional teaching methods, including lectures and question-answer activities. The experimental group was exposed to brain-based activities such as showing films and animations about how the brain functions. Moreover, to gain the experimental group's attention the teacher used quotes by famous people related to the content, humorous video clips, and quizzes in the form of word search puzzles and crossword puzzles that contain key content terms and concepts. The teacher tried to incorporate originality into the design of the experimental group's materials trying to stimulate emotions with such techniques as curiosity, excitement, anticipation, fun, or surprise to enhance learning.

Based on the BBL model, the researcher designed a connection between content and methodology. This model represents a learning and teaching design that is based on interconnected conditions, processes, and gains. The design is founded on the principles and conditions outlined by various researchers for BBL (Jensen, 2008). Finally, after the study was completed, the same academic achievement test was sent to both groups as a post-test via Google Forms.

Moreover, a content-time matrix was used when teaching the topics to the experimental group. Content presentations and activities in the teaching/learning environment were organized based on "Primacy-later, Prime Time-1, Prime Time-2, and Downshift Time" (Sousa, 2006). In this regard, during the first 10-15 minutes of the lesson (Prime-time 1), the main topics of the unit were explained using different materials such as PowerPoint slides, video clips, shows, and other activities. When students lost concentration (Downshift-Down-time), an interdisciplinary approach was employed, using music, drawings, cartoons, and group work to teach the topics. During the last 10-15 minutes of the lesson (Prime-time 2), students were encouraged to personally construct and internalize the content of the lesson with the aid of questioning-based coding (Dwyer, 2002) which focused on the principle of questioning and understanding. The lesson concluded by asking some questions to warm up students of the following

lesson topic and to enhance curiosity, motivation, and interest. Finally, the data gathered from the pretest and posttest scores were analyzed using version 22 of SPSS.

## RESULTS

### Results of the first research question

To answer the first research question 'Is there a significant difference in the impact of brain-based learning activities compared to the traditional method on the educational achievement of students attending synchronous online TESOL courses?', the KET test was sent to 44 students through Google Forms and their scores were analyzed. Table 1 shows the descriptive statistics of the selection process of participants.

**Table 1**

*Subject Selection Descriptive Statistics*

| Test | N | Minimum | Maximum |
|---|---|---|---|
| **KET** | 44 | 26.0 | 50.0 |

As presented in Table 1, the average score was M=42.18 with a standard deviation of SD=1.98. Based on this analysis, 34 students with scores within one standard deviation higher and lower than the mean were chosen as the participants.

### Results of the second research question

To answer the second research question '*Is there a significant difference in the educational achievement levels of online TESOL students in the control group based on their learning styles*?', the teacher-researchers created an Academic Achievement Test to be given as both a pre-test and a post-test. This test was initially tried out on a group of 30 students who had similar characteristics such as age, gender, and academic level to those in the main study. The purpose of this trial was to evaluate the test's reliability, and adjustments were made according to the results of the trial. The statistics from the test piloting process can be found in Table 2.

**Table 2**

*Pilot Study of the Academic Achievement Test*

| Test | N | Min | Max | Mean | SD | Variance | Reliability (KR-21) |
|---|---|---|---|---|---|---|---|
| **Academic Achievement Test** | 30 | 14 | 30 | 14.68 | 1.821 | 2.333 | 0.77 |

The average score of the participants is M=14.68 with a standard deviation of SD=1.821, as shown in Table 2. The test reliability, estimated using the Kuder-Richardson Formula 21 (KR-21), indicates an acceptable reliability index (r = 0.77). This test was run as both a pretest and a posttest before and after the treatment.

**Results of the third research question**

In order to answer the third research question '*Are there significant differences in the educational achievement levels of online TESOL students in the experimental group based on their learning styles*?', the learning style distribution of the participants was calculated as follows (Table 3).

**Table 3**

*Learning styles distribution of f both groups*

| Learning Styles | Experimental Group | | Control Group | |
|---|---|---|---|---|
| | frequency | percentage | frequency | percentage |
| **Accommodating** | 2 | 11.8 | 1 | 8.8 |
| **Diverging** | 4 | 23.5 | 4 | 23.5 |
| **Assimilating** | 6 | 36.1 | 8 | 47.2 |
| **Converging** | 5 | 29.4 | 4 | 23.5 |
| **Total** | 17 | 100.0 | 17 | 100.0 |

In Table 3, it is evident that the assimilating style is the most prevalent learning style in the experimental group, accounting for 36.1% (6), while the accommodating style at 11.8% (2) is the least common. Similarly, the assimilating style is most prevalent among the control group students at 47.2% (8), and the accommodating style is least prevalent at 8.8% (1).

The results of the pre-test for learners with various learning styles in the same group showed consistent variance, which was confirmed using Levene statistics. After establishing variance homogeneity, the researchers used Kruskal-Wallis Test statistics to compare the means of the various learning styles, as shown in Table 4.

**Table 4**

*Kruskal-Wallis Test Results of Pre-test for Within-Group Different Learning Styles*

| Group | Learning style | N | Mean rank | DF | Chi-square | Asymp sig |
|---|---|---|---|---|---|---|
| **Experimental group** | Converging | 5 | 16.82 | 3 | 3.24 | 0.31 |
| | Diverging | 4 | 14.55 | | | |
| | Assimilating | 6 | 20.11 | | | |
| | Accommodating | 2 | 24.11 | | | |
| | Total | 17 | | | | |
| **Control group** | Converging | 3 | 19.56 | 3 | 4.395 | 0.25 |
| | Diverging | 4 | 20.23 | | | |
| | Assimilating | 8 | 16.31 | | | |
| | Accommodating | 2 | 8.50 | | | |
| | Total | 17 | | | | |

Upon examining Table 4, based on participants' learning styles (p=0.31>0.05), it is evident that there are no significant differences among the achievement scores of the students of the experimental group. The same holds for the control group as p= 0.25>0.05. Additionally, the chi-square analysis reveals that there is no notable discrepancy between the two groups regarding learning style distribution.

The Mann-Whitney U-Test was used to analyze pretest scores and determine differences between participants with similar learning styles from both groups (Table 5).

**Table 5**

*The Mann-Whitney U-Test Results for Different Learning Styles in both Groups' pre-tests*

| | Learning Style | Comparison | N | Mean Rank | Sum of rank | U | Sig |
|---|---|---|---|---|---|---|---|
| **Within Learning Styles** | Accommodating | Experimental | 3 | 5.70 | 28.50 | | |
| | | Control | 2 | 2.50 | 7.50 | 1.500 | 0.07 |
| | Divergent | Experimental | 4 | 6.64 | 46.50 | | |
| | | Control | 3 | 9.19 | 73.50 | 18.500 | 0.23 |
| | Assimilating | Experimental | 5 | 9.30 | 93.00 | | |
| | | Control | 3 | 8.57 | 60.00 | 32.000 | 0.72 |
| | Converging | Experimental | 6 | 11.17 | 134.00 | | |
| | | Control | 8 | 17.00 | 272.00 | 56.000 | 0.59 |

As to Table 5, to find out whether there were differences among participants with the same learning styles but from various groups, the results of the Mann-Whitney U-Test were utilized which showed that there were no significant discrepancies among the pre-test scores (Diverging, p=0.23 > 0.05; and Accommodating, p=0.07 > 0.05; and Assimilating, p=0.72 > 0.05; and Converging, p=0.059 > 0.05). This means that the pre-test academic achievement scores of participants with various learning styles in both groups are equal.

**Results of the four research question**

In order to answer the third research question '*Is there a significant difference in educational achievement between the control and experimental groups attending synchronous online TESOL courses, taking into account different learning styles?*', the researchers used Levene statistics finding that the experimental group had different variances, while the control group had consistent variances. Since the number of participants with various learning styles prevented a normal distribution, the Mann-Whitney U-test was used to compare the means of different learning styles (as it does not require the assumption of normality). The analysis results can be found in Table 6.

**Table 6**

*The Mann-Whitney U-test results in between groups for post-test scores*

| Groups | N | Mean Rank | Sum of Ranks | U | P |
|---|---|---|---|---|---|
| **Control** | 17 | 21.75 | 688.33 | | |

| | | | | | |
|---|---|---|---|---|---|
| **Experimental** | 17 | 47.25 | 1606.50 | 141.500 | .03 |
| **Total** | 34 | | | | |

Results in Table 6 show significant differences in the experimental group's post-test scores (which used BBL) compared to the post-test scores of the control group who were exposed to a traditional method (U = 141.500, p = 0.03 < 0.05) and this suggests that the BBL approach is more efficacious in enhancing students' educational achievement in online classes. To scrutinize whether there were significant discrepancies among the post-test scores for various learning styles, the Kruksal-Wallis H-test was employed (Table 7).

**Table 7**

*Kruskal-Wallis H-test for posttest concerning the within-group different learning styles*

| Group | Learning style | N | Mean rank | Chi-square | DF | Sig |
|---|---|---|---|---|---|---|
| **Experimental** | Diverging | 4 | 15.57 | | | |
| | Accommodating | 2 | 16.10 | 1.666 | 3 | .659 |
| | Assimilating | 6 | 20.75 | | | |
| | Converging | 5 | 16.50 | | | |
| | Total | 17 | | | | |
| **Control** | Diverging | 4 | 12.56 | | | |
| | Accommodating | 2 | 18.83 | | | |
| | Assimilating | 8 | 20.36 | 2.721 | 3 | .378 |
| | Converging | 3 | 18.84 | | | |
| | Total | 17 | | | | |

In examining Table 7, no significant discrepancy is observed in the experimental group because [x (3) = 1.666, p=.659>.05]. The same applies to the control group [x (3) = 2.721, p=.378>.05]. Therefore, it could be concluded that the different learning styles within each group do not affect learners' educational achievement. Additionally, the Mann-Whitney U-test was utilized to find out if there were eye-catching discrepancies between the post-test scores of learners with the same learning styles but from various groups (Table 8).

**Table 8**

*The Mann-Whitney U-Test results of post-test scores of the students from different groups and with different learning*

| | Comparison | N | Mean Rank | Sum of Rank | U | Sig |
|---|---|---|---|---|---|---|
| **Within Learning Styles** | Control group Accommodating | 2 | 3.11 | 9.10 | 3.000 | .185 |
| | Experimental group Accommodating | 3 | 5.39 | 28.00 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Control group Divergent | 3 | 4.94 | 39.50 | 3.500 | .003 |
| | Experimental group Divergent | 4 | 11.50 | 80.50 | | |
| | Control group Assimilating | 3 | 3.70 | 29.00 | .000 | .002 |
| | Experimental group Assimilating | 5 | 13.10 | 135.00 | | |
| | Control group Converging | 8 | 10.90 | 163.00 | 40.000 | .007 |
| | Experimental group Converging | 6 | 19.35 | 225.00 | | |

As per Table 8, to find out if there were significant discrepancies in the post-test scores of learners from various groups but with similar learning styles, the researchers employed the Mann-Whitney U-test. The results manifested that significant discrepancies concerning the experimental group were seen for the post-test scores of Assimilating learning style ($U = 0.000$, $p = 0.002 < 0.05$), Diverging learning style ($U = 3.500$, $p = 0.003 < 0.05$), and Converging learning style ($U = 40.000$, $p = 0.007 < 0.05$) except for the accommodating style ($U = 3.000$, $p = 0.185 > 0.05$).

## DISCUSSION

Online brain-based activities have a significant impact on the educational achievement of BA students who possess various learning styles based on the study's findings. The post-test scores of the learners in the experimental group were compared with those of the control group to evaluate academic achievement. The study found that BBL had a more significant impact on student's academic achievement compared to traditional teaching methods. Caine (2000) argues that all learning processes are based on the brain, and by emphasizing brain-based learning, we aim to understand how the brain functions best and how humans can boost learning at the highest level (Pool, 1997). BBL is based on understanding how the brain learns and functions. It is also grounded in the belief that everyone can learn. When learning, the brain creates new patterns while also learning from existing ones. Many educators argue that to facilitate meaningful and comprehensive learning, teachers should establish low-threat, high-encouragement environments in which students actively participate and immerse themselves in various experiences (Bruer, 1999). The findings reminisce those of Abdolmaleki and Saeedi (2024), Mujiyanto et al. (2021), Shahzadi et al. (2024), Shamim and Sarwar (2024), and Tommerdahl (2010).

BBL aids learners in understanding their learning styles and the features of their brains so they can recognize how they learn best and engage deeply with the content. When students become aware of their learning styles, they cognitively and emotionally feel more relaxed, which improves their self-concept and boosts motivation (Jang et al., 2022). Lucas (2003) highlights the importance of a positive psychological mood as a catalyst for successful learning. In BBL contexts, instruction and materials should be designed with the learner in mind, and presented in a way that is personally enriching, enjoyable, and meaningful.

Based on the study results, the assimilating learning style was found to be the most prevalent one for both groups. This learning preference focuses on a logical approach, with students requiring clear explanations rather than practical opportunities. Those with an assimilating learning style can comprehend broad-ranging information and present it in a clear, logical format. These students are less concentrated on people and show more interest in abstract ideas/concepts. This piece of finding has also been previously stated by different researchers (e.g., Mujiyanto et al., 2021; Shahzadi et al., 2024). The study revealed that the accommodating learning style is the least common. This style relies on intuition rather than logic, with students preferring to use others' analysis and take a practical, experiential approach in their online sessions. They are drawn to new challenges and experiences. Students with this learning style tend to rely on others for information rather than conduct their analysis.

The study's findings confirm that online instruction using BBT is effective and provides a positive, motivating approach to heighten learning and teaching. This has been previously affirmed by Caine and Caine (1994), Raghavendran and Begum (2021), and Mujiyanto et al. (2021). The expectations of today's learners have heightened due to the advancements in technology. ICT (Information and Communication Technology) and digital technology have had a significant impact on users in general and L2 (second language) learners in particular. L2 instructors need to make sure that the content shared outside and inside the classroom contributes to a productive and meaningful environment. In this regard, Retone and Maricar (2020) suggested that technology can help integrate brain-based teaching principles by providing students with a convenient learning atmosphere and motivating them to use miscellaneous sources of knowledge. Generally, such results are in line with other studies such as Muhammad et al., (2024), Mujiyanto et al., (2021), Shahzadi et al. (2024), Tafti and Kadkhodaie (2017), Yasar (2017). The present study recommended that using brain-based learning principles may help increase the students' educational achievement levels with different learning styles.

The researchers found that including brain-based activities in online instruction significantly improved students' academic achievement. This demonstrates that brain-based learning activities enhance students' skills. The expectations of today's learners have been raised by advances in technology, as digital technology plays a significant effect on learners. To address these challenges, L2 instructors need to make sure that the content shared both in and out of the classroom supports a meaningful, productive learning environment. According to the literature, technology can help incorporate brain-based teaching principles by offering a comfortable learning context and motivating students to explore different sources of knowledge. Brain-based learning theory places great emphasis on maximizing information acquisition and retention. To effectively implement this theory, all participants must have a solid understanding of the brain's structure and take learners' needs into serious consideration to enhance course format and delivery. In BBL environments, the materials should unequivocally be student-centered and highly engaging. Online courses undoubtedly facilitate these objectives compared to traditional in-person instruction. It is imperative to stay updated on the continuous developments in neuroscience research regarding brain-based learning strategies.

## CONCLUSION AND IMPLICATIONS

The researchers found that integrating brain-based activities into online instruction significantly improved students' academic achievement. This demonstrates that brain-based learning activities

enhance students' skills. Expectations of today's learners have risen with the advancements in technology, as digital technology has a significant effect on users; hence; L2 instructors ought to ensure that the content shared in and out of the classroom fosters a productive and meaningful learning context. Brain-based learning strategies continue to develop in the light of Neuroscience research. Educators looking to integrate scientific principles into their online teaching should thoughtfully assess recommendations based on these theories and concepts to determine if they can improve course delivery and content. It's crucial to proceed with caution, but there are compelling reasons to incorporate brain-based learning principles. It is also advised that ELT teachers have a better understanding of how learners' brains work to effectively use online instruction.

As a final statement, the first and last minutes of online sessions are the most memorable (Lucas, 2003). Teachers are advised to grab attention by using quotes from famous people who are related to the content, creating special tests like word search puzzles or crossword puzzles that include key concepts and terms, or sharing humorous video clips. It's important to bring originality into the design of the materials. Instructors could also stimulate emotions such as anticipation, fun, excitement, surprise, and curiosity to boost learning. Interaction is crucial for keeping students engaged in online courses (Isaee & Barjesteh, 2024). According to research studies and distance learning theory, interaction is a key element in successful distance learning courses and increased interaction is linked to higher achievement and student satisfaction. Distance courses should employ more intensive methods than traditional courses to make instruction more meaningful and interactive; however, the effort is worthwhile.

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**Biodata**

**Hossein Isaee (Corresponding Author)** (born in 1981 in Iran) holds a PhD in Teaching English to Speakers of Other Languages. His areas of interest include online/remote teaching, ELT material development and evaluation, and technology-enhanced language instruction. He is an ELT instructor, author, and researcher.
Email: *hossein_isaee@yahoo.com*

**Hamed Barjesteh**, an associate professor of Education and applied linguistics at Islamic Azad University, Ayatollah Amoli branch, has been a teacher educator for two decades. He has authored numerous books and articles on English language teaching for learners of all ages and has shared his expertise at national and international conferences. Barjesteh has also mentored teachers, supervised numerous M.A. theses and Ph.D. dissertations, and currently leads the English Language department. Additionally, he serves as an editor and reviewer for various academic journals and conferences. His research focuses on critical language pedagogy, thinking skills in language learning, Critical Language testing, dynamic assessment, and positive psychology.
Email*: ha_bar77@yahoo.com*

**Neda Fatehi Rad** is an Associate Professor of Applied Linguistics (TEFL) at Islamic Azad University, Kerman Branch, Iran. She mainly teaches language testing, research methodology, and language teaching at the graduate level. Her main areas of interest include teachers' education, cooperative learning, language testing, and research. She has published 107 papers in international and national academic journals and 12 books in translation, language learning, research, and teaching.
Email: *Nedafatehi@yahoo.com*