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The Significance of Neuroscience for Teaching English as Second Language (TESL) in the Digital Era

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Abstract

In formal TESL courses, Phonetics, Linguistics, Grammar as well as Psychology are taught. However, Neuroscience, the study of the brain, is necessary for ESL teachers for future professional development to meet the rapidly changing needs of the students at all levels in the digital era. Designing educational practices without knowledge of the brain is like "an automobile designer without a full understanding of engines" (Hart, 1999). Based on the neurological evidence of processing of English and Chinese words in the bilinguals' brain, Sham (2002) found a new Dual Coding (Paivio, 1986) model for designing CSL teaching materials that best fits young learners' limited capacity of the brain by reducing their cognitive load (Sweller *et al.*, 1998). Although little research linking neuroscience and learning, Guy and Byrn (2013) emphasis on the understanding of neuroscience of working memory has positive effects on motivating students learning. Direct implication of neuroscience by language teachers has been found difficult, but interdisciplinary study of neuroscience, psychology and education is fruitful (Coch *et al.*, 2007) and there has a great impact of neuroscience on teaching and learning including its implication for ESL college classroom (Sousa, 2010). This paper reviews current research of neuroscience, psychology integrating with ESL teaching and learning, and provides the adult students' feedback of learning IELTS through the design related to neuropsychological findings in order to demonstrate how significant neuroscience is on TESL. In other words, understanding of neuroscience facilitates ESL teaching and benefits ESL teachers' professional development in future (247 words).

Keywords: Neuroscience; TESL; Brain; Interdisciplinary study; Dual Coding model; Cognitive load; MBE Science; Psychology; ESL teacher development.

1. Introduction

In formal TESL courses, Phonetics, Linguistics, Grammar as well as Psychology are taught. However, Neuroscience, the study of the brain and nervous system, is necessary for ESL teachers for future professional development to meet the rapidly changing needs of the students at all levels in the digital era. Designing educational practices without knowledge of the brain is like "an automobile designer without a full understanding of engines" (Hart, 1999). Based on the neurological evidence of processing of English and Chinese words in the bilinguals' brain, Sham (2002) found a new Dual Coding (Paivio, 1986) model for designing CSL teaching materials that best fits young learners' limited capacity of the brain by reducing their cognitive load (Sweller *et al.*, 1998).

This paper reviews current research of neuroscience, psychology integrating with ESL teaching and learning, and provides the adult students' feedback of learning IELTS through the design related to neuropsychological findings in order to demonstrate how significant neuroscience is on TESL. In other words, understanding of neuroscience facilitates ESL teaching and benefits ESL teachers' professional development in future.

2.1. Neuroscience and Adult L2 Acquisition

Although little research linking neuroscience and learning, Guy and Byrn (2013) emphasis on the understanding of neuroscience of working memory (Baddeley, 1986) has positive effects on motivating students learning. Miirtensson *et al.* (2012) investigated the L2 acquisition in adulthood hypothesizing there was an increase of gray matter density and hippocampus density in the brain due to L2 acquisition. While 14 interpreters from the Swedish Armed Forces Intelligence and Security Centre participated, 17 monolinguals from Sweden's Umea University formed the control group. All participants were 18-20 years old. The results demonstrated the large increases of cortical thickness in left middle frontal gyrus, inferior frontal gyrus, and superior temporal gyrus of the left hemisphere of the experimental individuals due to L2 exposure after three months, whereas slight decrease in the control group in the left hemisphere. Meanwhile, the hippocampus volume also increased in the interpreters' right hemisphere. It confirmed that L2 acquisition in young adults resulted in increased thickness of cortical matter and volume of the hippocampus in the brain.

In the investigation of innate differences in resting-state connectivity relating to L2 performance, Chai and Klein (2016) scanned 16 adult English (L1) learners' brain by functional magnetic resonance imaging (fMRI) prior to an intensive 12-week French (L2) course, as well as provided tests for their language ability before and after the course. The result showed that L2 learners having greater connectivity between left superior gyrus, which is a significant region for language network in the brain, and the left AI/FO improved greater in spoken word fluency. Meanwhile, L2 adult participants having stronger connections between VWFA and a different area in left superior gyrus

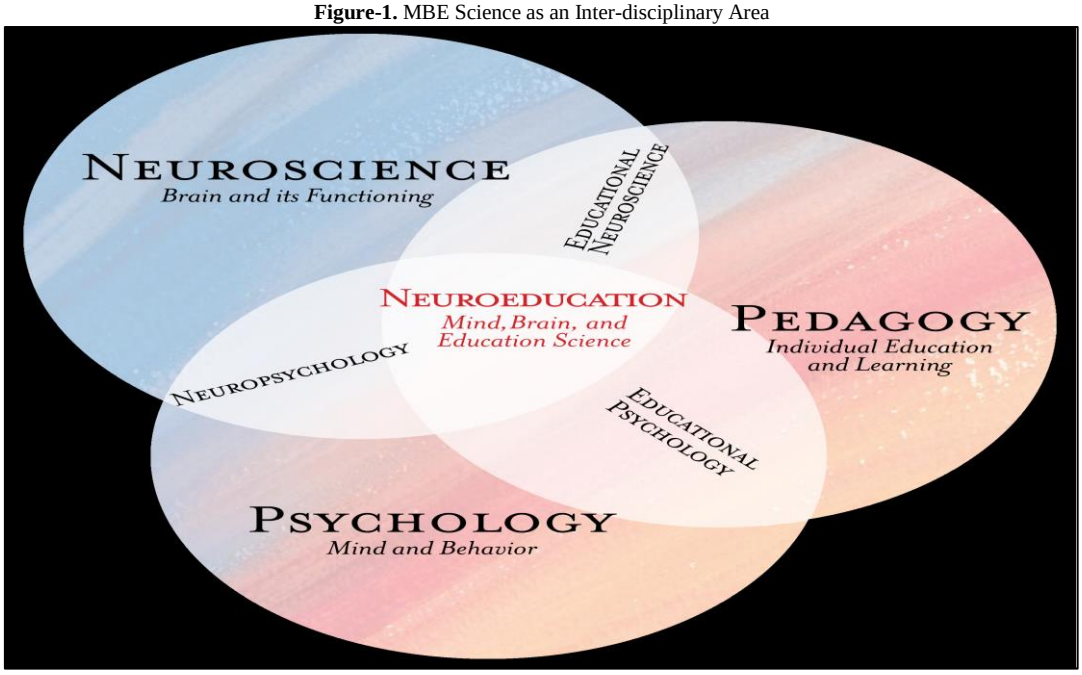
demonstrated greater improvement in reading speed by the end of the course. By using brain functionally connectivity to predict learning success and failure of L2 language, this study could help teachers to establish better methods for second language teaching.

Another study sheds light on L2 learning in adulthood in neuroscience exploring the neural mechanism underlying adults' learning of L2 sound was conducted by Grimaldi *et al.* (2014). Two groups including one group in first year and another fifth year undergraduates of Foreign Languages and Literature Faculty in Italy participated in the behavioral and electroencephalography (EEG) lab. The result indicated that adult L2 learning is assimilating the sound of L2 vowels to L1 phonemes of native language L1. The researchers concluded that students benefited from a foreign language classroom unless they received a certain degree of high-quality input from L2 native teachers, and used L2 for function and communication. Moreover, the adult learners also benefitted if their perception and production of L2 sounds for reactivation of neuroplasticity of auditory cortex were trained intensively. Therefore, they suggested that the perception of phonetics improved with stable development of phonetic representation of L2 adult learners through targeted training for further implication.

2.2. The New Inter-Disciplinary Area: Mind, Brain and Education (MBE) Science

Direct implication of neuroscience by language teachers has been found difficult, but interdisciplinary study of neuroscience, psychology and education is fruitful (Coch *et al.*, 2007) and there has a great impact of neuroscience on teaching and learning including its implication for ESL college classroom (Sousa, 2010). Therefore, international cooperation concerning the interdisciplinary research of applying neuroscience in education formed by neurologists, psychologists and educators has been increasing since 1990s. Researchers have been focusing on how to link the knowledge, theories and findings of Neuroscience (Science of brain and its functioning) , Psychology (Science of mind and behavior), and Education (Science of individual education and learning) together, which means they collaborate for exploring the new inter-disciplinary area called "Mind, Brain and Education (MBE) Science" (See Figure 1). The intersection of these three disciplines are also named "Brain-based Learning", "Educational Neuroscience" (Sousa, 2010) or "Neuro-Education".

Figure-1. MBE Science as an Inter-disciplinary Area



Source: (Tokuhama-Espinosa, 2011). Why Mind, Bain, and Education Science is the "New" Brain-based Education. (Interpretation of Tokuhama---Espinosa's transdisciplinary field by Nakagawa, (2008), redrawn by Bramwell 2010.)

Due to a lot of complex problems that we could not solve by pedagogical approach only, teachers with the understanding of the brain and also how it operates in learning best, as well as neurologists and psychologists, who can tell us how to implement their research findings in classroom settings, are needed. The innovative MBE science has brought new evident-based solutions for solving the old educational problems by selecting the best information across the three disciplines. In order to teach effectively based on MBE science, teachers are well equipped with the ability of synthesis – understand the basic concepts and theories within different disciplines from various information sources, and then assess and judge their applicability in the classroom by critical thinking.

2.3. Practical Applications of Mind, Brain and Education (MBE) Science

Tokuhama-Espinosa (2010), is an expert in MBE science in applying the knowledge, research findings and theories of Neuroscience and Psychology in educational settings. Relating to the multilingual classroom, nine examples quoted from *Making Classroom Better: 50 Best Classroom Practices from Mind, Brain, and Education Science* (Tokuhama-Espinosa, 2014a) are listed below:

First, Hatti (2012) demonstrated that the self-confidence of students is the most important factor for the best outcome in learning second languages. Thus, foreign language teachers should support and assist the low achievers to build their confidence in learning other languages. Second, good teachers should have self- confidence to teach with contagion and enthusiasm (Campbell-Meiklejohn *et al.*, 2010) as "Social contagion" is developed from the complex mirror neuron system in the brain. Third, teachers could help the students to establish the right attitude towards the intervention of teacher towards their errors. Fourth, teachers with expertise teach the new knowledge based upon the students' prior concepts, and use different methods catering for various needs and levels of the language learners. Fifth, skillful language teachers favor informative assessment and activities every day to enhance the students' learning in certain areas. Sixth, L2 language expert teachers are able to master "gap analysis" by choosing appropriate activities and methods for the students to fill in the gap of knowledge. Seventh, good teachers present in a clear manner and explain sentences, grammar and core knowledge in various ways in order to make the students of different levels fully understand. Eighth, teachers allow students to work in groups based on the belief that human brain is social while most people prefer learning in group activities rather than in isolated situation (Paulus, 2000). Ninth, great teachers know how to handle the disturbance caused by a student's distracting other students from the real learning goal (Nelson *et al.*, 1999), and then lead them back to the right track.

3. Questionnaire and Participants

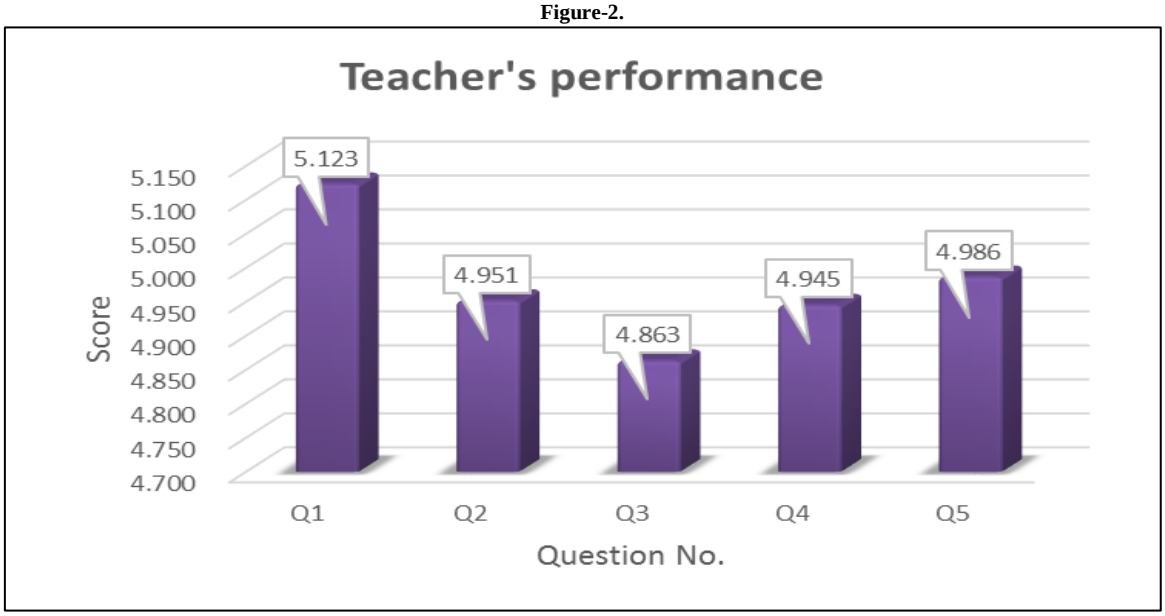
Based upon the nine best applications of Mind, Brain, and Education (MBE) science (Tokuhama-Espinosa, 2014b) in ESL classroom, IELTS Preparation Course was designed and a questionnaire for investigation of the efficacy of these practical applications was used. The course includes Reading, Speaking, Listening and Writing for IELTS. After introducing each type of questions in Reading, the adult learners had to finish a reading test of the relevant type, which means they had several informative assessments each lesson. For Speaking, the students practiced in pairs and presented orally, and then the instructor gave each student marks and comments for their improvement. In each lesson of Speaking, the learners participated in two 30-minute listening tests besides the lecturing of the teacher. Writing is the longest section as adult students had to finished two writing assignments after brainstorming and discussion in groups (Paulus, 2000) every time. Marks and comments including the spelling mistakes, grammatical and punctuation errors were given for upgrading their ESL standard and returned to the students after marking.

In total, there were 146 adult students in 20 classes participated in the evaluation of teaching and learning after they had finished 8 lessons of 24 hours IELTS Preparation course in CUHK,SCS. Each of them answered 14 questions, which are divided into four categories:

1. Teacher's performance: Q1 - Q5
2. The Corse design: Q6 – Q9
3. Learning outcome and assessment: Q10 – Q12
4. Overall comment: Q13 & Q14

3.1. Results and Discussion

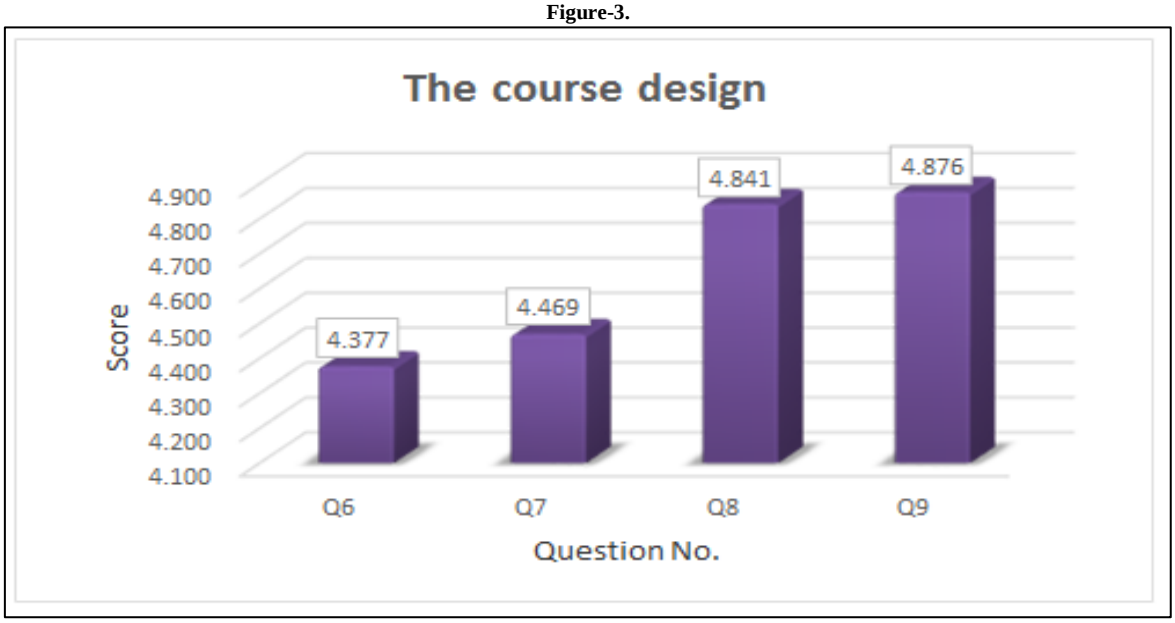
Figure-2.



According to Figure 2 for evaluating the teacher's performance in IELTS Preparation Course, all average marks were very high varying from 5.123 to 4.863 out of 6. Most participants strongly agreed that the teacher presented in a clear manner that made learners of various levels fully understand (Tokuhama-Espinosa, 2014a) as the score was 5.123. The average 4.951 indicates that the majority attested that the teacher used relevant examples to assist their learning by using appropriate teaching methods to master the gap of knowledge (Tokuhama-Espinosa, 2014b). Meanwhile, the mark 4.863 means that they agreed the teacher was enthusiastic, contagious and full of confidence

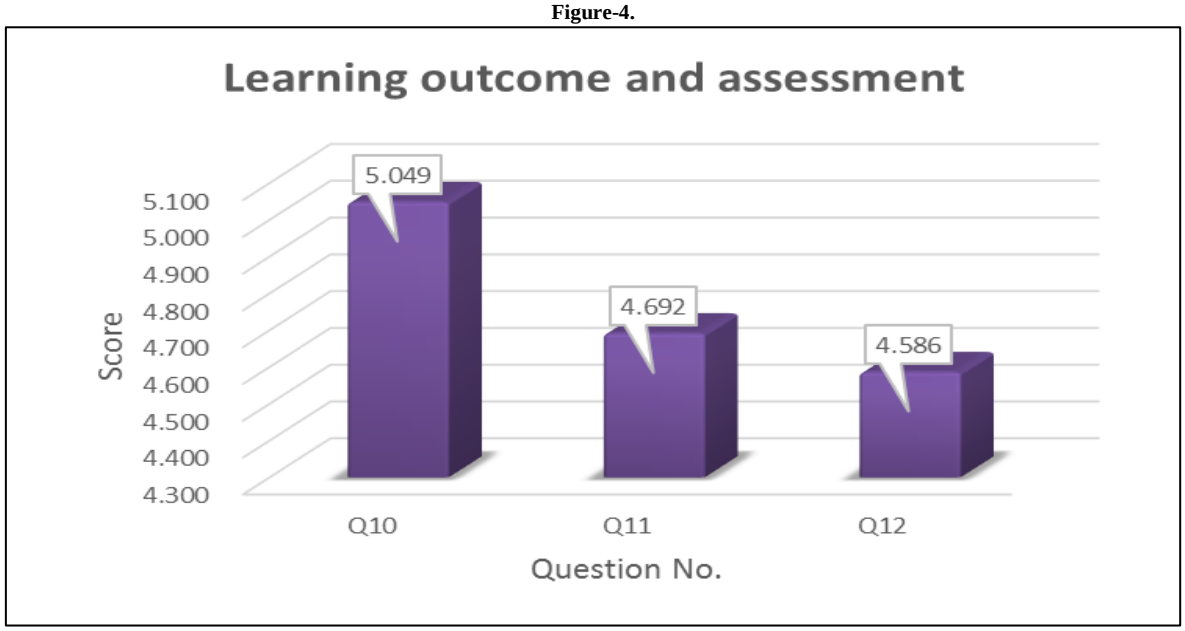
(Campbell-Meiklejohn *et al.*, 2010) in teaching IELTS as she had a variety of knowledge and expertise in various disciplines, such as Linguistics, second language acquisition, psychology, and neuroscience. Having average score of 4.945 in Q4 represented that she also assisted the students to foster their self-confidence (Hatti, 2012) by building their right attitude towards the instructor's corrections of the mistakes (Tokuhama-Espinosa, 2014b) as well as encouraging their active participation in the ESL class. The adults gave 4.986 in Q5 which means that they attested there was effective communication between the teacher and the students as her teaching met the needs and levels of different language learners (Tokuhama-Espinosa, 2014a) and led them back to real learning goals even facing distraction (Nelson *et al.*, 1999).

Figure-3.



In Figure 3, there were four questions concerning the course design of IELTS Preparation Course. The average scores were between 4.377 and 4.876 out of 6. The adult learners attested that the course, which was divided into four sections: Reading, Speaking, Listening and Writing for IELTS providing not only individual tasks, but also group activities based upon the social brain that learners preferred group work rather than work alone (Paulus, 2000), was found interesting with average mark 4.377 and stimulating with a score of 4.469. And also, 4.841 in Q8 reflected that they agreed that the course enhanced their knowledge in this subject as the expert instructor taught the new knowledge based on their prerequisite concepts and apply different pedagogical means meeting the L2 learners' needs and levels (Tokuhama-Espinosa, 2014a). By giving 4.876, the participants attested that the course was well-organized consisting a variety of activities and methods, individual or in groups, lectures, written and speaking tests, and writing assignments. Therefore, the course activated their brain and build their brain's network to learn better.

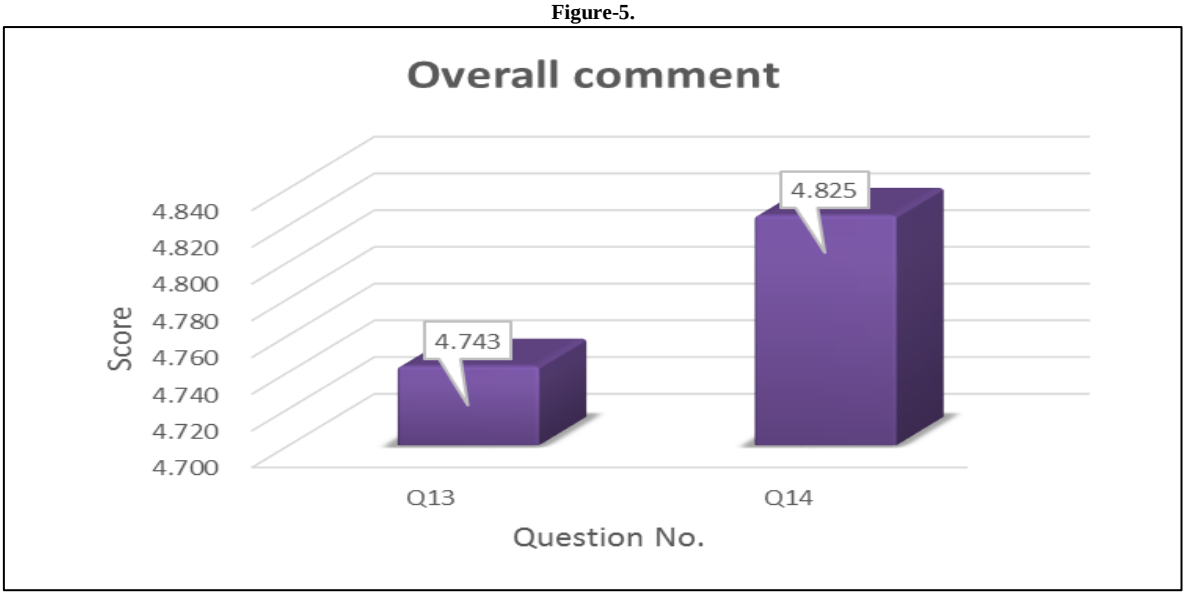
Figure-4.



Furthermore, the average scores of the learning outcome and assessment of IELTS Preparation Course from Q10 to Q12 were reported in Figure 4. In the course, different sections consisted of different assessments: Reading

includes 10-minute, 20-minute, and 60-minute reading tests; Speaking is separated into pair works and individual presentation; Listening only requires 30-minute listening tests; Writing is divided into Task 1 for writing a report in groups within 20 minutes while Task 2 for writing an essay in 40 minutes through brainstorming and group discussion. The participants had several informative assessments each lesson which facilitated their ESL learning (Tokuhama-Espinosa, 2014b). Written or oral comments with marks were given after each assessment, so the adults had their learning outcomes for each test, evaluation and presentation. The average mark 5.049 shows that they strongly agreed the learning outcomes of the course were clear as they benefitted from it. The learners attested that the assessment methods were appropriate as the mark was 4.692, and the amount of workload was appropriate as well by scoring 4.586.

Figure-5.



The last section dealing with the overall comment of IELTS Preparation Course was reflected in Figure 5. The average mark 4.743 indicates that the participants were satisfied with the course overall and the score 4.825 shows that they were satisfied with the teacher's performance overall. Overall, they were satisfied with IELTS Preparation Course which was designed by L2 experienced instructor applying findings of neuroscience and psychology in classroom.

Lastly, the average marks varied from 4.377 (Q6) to 5.123 (Q1) out of 6 for 14 questions indicate that the adult learners are satisfied or strongly satisfied with the IELTS Preparation Course including Teacher's Performance, Course Design, Learning outcomes and Assessment and Overall Comments. This means that the ESL course for adults based upon MBE science is fruitful and successful.

4. Conclusion

Supporting by the evidence of practical applications of MBE science in IELTS classroom, it is clear that teachers have the widespread knowledge of various disciplines including psychology and neuroscience and are able to implement the findings of neuroscience in teacher performance, course design, learning outcomes and overall comments made adult L2 learners very satisfied or satisfied, and learned better. In other words, understanding the brain and how to works benefits Teaching English as a Second Language (TESL).

In the digital era, solving the educational problems by only pedagogical approach is not enough, basic concepts, findings and models from Neuroscience, understanding of the brain and its function; Psychology, understanding of mind and behavior, plus Education, understanding of education and learning, that is Mind, Brain and Education (MBE) science is significant, effective and powerful. We can conclude that ESL teachers with the expertise in Neuroscience and Psychology and the ability to synthesis the findings for the application in classroom will cater the L2 language learners for the best learning outcomes. In the coming decades, selecting the best information from understanding of neuroscience linking with psychology and education will assist and support ESL teachers to meet the rapidly changing needs of the students at all levels, to handle the complicated classroom problems and to enhance their professional growth.

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