

ORIGINAL ARTICLE

INITIAL STUDY ON IDENTIFYING COGNITIVE OPERATIONS IN TEACHING AND LEARNING METHODS

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ABSTRACT

Imbalance proportion of examination results between theory and coursework marks in engineering courses among engineering students become central issue among educators in higher learning institutions. This scenario gives indication that possibly the learning and teaching methods used in the class not accounted the students' cognitive background and capability. So that, not every students received the benefits from teaching and learning process. This study investigate and emphasize the significant of understanding the cognitive capability among students as the target audience before educating them using teaching and learning method according to their cognitive capability. Two types of questionnaire were distributed to the two groups of engineering students based on neuro-linguistic programming (NLP) and multiple intelligences (MI) theory and methods. The answers were analysed using data categorizing and data entry technique. The results show that both students group dominated the kinaesthetic and digital auditory according to NLP principles while high percentage in body kinaesthetic and interpersonal category according to MI. However, the other parameters that present 10% feedback should be considered as input in teaching and learning methods because it is considered as high percentage. The contribution of this study not just for teaching and learning process among young students but also significant for ergonomics training that involving people from different groups of age, experience and culture. In future, further investigation will be conducted to examine the effectiveness of NLP and MI method implementation in teaching and learning process among engineering students using the results from this study.

Keywords: Cognitive, NLP, Multiple Intelligences, Engineering students

INTRODUCTION

Currently, teaching and learning methods in higher institutions such as universities, colleges and polytechnic are freely to be implemented according to the lecturers. Creative lecturers will create innovative ways to deliver the courses but normally most of the lecturers conducted the teaching and learning session in traditional way i.e. lecturing (Felder, Silverman and others, 1988). Teaching students from basic sciences background into engineering students is not a simple process. There are several teaching and learning methods that were proposed previously in specific for engineering students such as verbal protocol analysis (Tschimmel, 2011), Schön's reflective practitioner (Adams, Turns and Atman, 2003), basic design (Boucharenc, 2006), design based learning (DBL) (Doppelt, 2009) and pedagogical approach (Pun, 2011). Recently, an issue regarding imbalance proportion of examination results between theory and coursework marks in engineering courses among engineering students had been addressed recently in academic meetings and discussions. It was found that the distribution of theories marks i.e. test and exam more to the fail

grades compare to the practical works' marks i.e. experimental. One of possible factor that driven to this problem is could be the lecturers did not understand their students' cognitive background and capability before conducting the teaching and learning process in the class. According to (Silverman and M.Felder, 1988; Felder and Brent, 2004, 2005), most engineering students are visual, sensing, inductive and active, and some of the most creative students are global but most engineering education is auditory, abstract (intuitive), deductive, passive and sequential. This mismatches teaching method and cognitive ability lead to the poor students' performances, professional frustration and automatically a loss to society of many potentially excellent engineers (Silverman and M.Felder, 1988).

NLP is a psychology framework to understand human cognitive experience and perception in order to redesign that experience according to the application environment (Witkowski, 2010). The goal of NLP is to produce a positive change (Elston and Spohrer, 2009). NLP also mentioned as a credible tool to help teachers building a good and comfortable

relationship with students in teaching and learning process (Witkowski, 2010). NLP is currently practiced world-wide among business people (Yemm, 2006), marketing (Mainwaring and Skinner, 2009), coaches (Tosey and Mathison, 2010), psychologist (Witkowski, 2010) and teachers (Tosey and Mathison, 2003; Carey *et al.*, 2010). Previous research on NLP application in engineering education founded that students learn in many ways i.e. by seeing and hearing, reflecting and acting, reasoning logically and intuitively, memorizing and visualizing and drawing analogies and building mathematical models, steadily and in fits and starts (Danilova and Pudlowski, 2007; Hillmer *et al.*, 2007; Ganiron Jr, 2013).

Basically, NLP methods and tools based on four principles which are behavioural flexibility, sensory acuity, rapport and outcome thinking (Cbe, 2008). Behavioural flexibility is an ability of an individual to adapt his action and reaction in order to influence the other people and get their response as well. Sensory acuity basically the ability of individual uses his senses to assess the efficacy of communication. He could detect the others' small changes in facial expression or eye movement in determining the people reactions. In the other hand, creating rapport is ability to show the other person that he understands what other person trying to communicate. Finally, outcome thinking is an ability to identify the problems and process them into acceptable solutions.

The multiple intelligences (MI) theory was produced by (Gardner, 1943) based on the idea that the previous intelligent test such scores and responses did not help much in predicting the person ability to handle his task. Most psychology tests will result the narrow and almost one specific intelligent which was debated many psychologist at that time. It was believed that there must be more than an intelligent in a person than reflected from the existing simple answers from simple test. As a result from his investigations, Gardner proposed initially six main intelligences which are linguistic, musical, logical-mathematical, spatial, bodily-kinaesthetic and personal intelligences. Later, seventh intelligences were established which is the personal intelligences decompose into intrapersonal and interpersonal intelligence (Gardner, 2011).

MI applications are not something new in the education field. According to (Kementerian Pendidikan Malaysia, 2015), Malaysia had participated in Trends in International Mathematics and Science Study (TIMSS) to assess the mathematics and science learning in Malaysia schools. Result in first year

participation in 1999 showed median score was higher than global median for both mathematics and science. The cycle continues in 2007 and reveals the framework execution had slipped to beneath the global normal median score of mathematics and science with a proportionate drop positioning. 18% to 20% of Malaysia's students neglected to meet basic capability level of science and mathematics as the result. The scenario is a consequence of education system which emphasises educating skills instead of learning. The lack of creative and innovative teaching strategies among the teachers is attributable to consequences upon the knowledge and skills in high achievers (Aziz, 2016).

This paper presents an investigation to identify the cognitive operations in improving the teaching and learning methods for engineering students in higher institutions. This study emphasize the significant of understanding the cognitive operation among students as the target audience before educating them using teaching and learning method according to their cognitive ability.

Next, this paper presents the methods used in this research in order to investigate the cognitive elements, then followed by results and analysis before ended with a conclusion.

METHODS

Participants

108 students involved in this study. The average age of the participants were 20.5 years during this study was conducted. They were students from product design engineering programme (group one) and manufacturing engineering (group two). 81.5% from all participants were registered the programme by using engineering diploma and 18.5% by science matriculation certificate.

Instrumentations

Two sets of questionnaire had been answered by participants. The first set of questionnaire was to measure the NLP parameters (Elston and Spohrer, 2009) and the second set of questionnaire was to investigate the MI parameters (Gardner, 2011).

Based on the four fundamental principles of NLP, four measurement parameters were used to identify the participants' cognitive. The parameters are visual, auditory, kinaesthetic and digital auditory (Elston and Spohrer, 2009) as shown in Table 1.

Table 1 NLP measurement parameters

Parameter	Description		
visual	Describe the world by how it looks. Use picture descriptions a lot in their communication i.e. see, appear, view and look.	Musical	between cause and effect towards a tangible outcome or result. Musical ability, awareness, appreciation and use of sound which is recognition of tones and rhythmic patterns, understands relationship between sound and feeling.
Auditory	Hear is more important compare to visual and feeling, prefer to talk things compare to read something, sensitive to the tone, pace and the quality of sounds which often means they love music and could play them.	Bodily-kinesthetic	Body movement control, manual dexterity, physical agility and balance, eye and body coordination.
Kinaesthetic	This person either very in tune with his feelings or use external touch to understand and guide him or both. Theory method is less effective compare to the physical activity. This learning ability is slower because he needs to feel of what had been said. Also, physical comfort is important to stay focus.	Spatial-visual	Visual and spatial perception, interpretation and creation of visual images and pictorial imagination and expression which is understand relationship between images and meanings and between space and effect.
Auditory digital	Emphasize the logic more than looks, sounds or feels. This person likes facts, science, process and need to understand something before do it.	Interpersonal	Perception of other people's feelings, ability to relate to others, interpretation of behaviour and communications, understands the relationships between people and their situations including other people.
		Intrapersonal	Self-awareness, personal cognisance, personal objectivity, the capability to understand oneself, one's relationship to others and the world, and one's own need for, and reaction to change.

Core operations among the eight criteria of MI were accessed to evaluate one or candidate intelligence as shown in Table 2. According to (Gardner, 2011), a core operation is a fundamental information processing mechanism which is based on a neural network process in the brain that receives a specific type of information and processes it.

Table 2 Core operations of MI

Intelligence	Core operation
Linguistic	Words and language, written and spoken which is retention, interpretation and explanation of ideas and information via language.
Logical-mathematical	Logical thinking, detecting patterns, scientific reasoning and deduction, analyse problems, perform mathematical calculations, understands relationship

Data Analysis

The data from the answer sheets was analysed by using data categorizing and data entry (Gray, 2009).

RESULTS AND DISCUSSION

Neuro-linguistic programing (NLP)

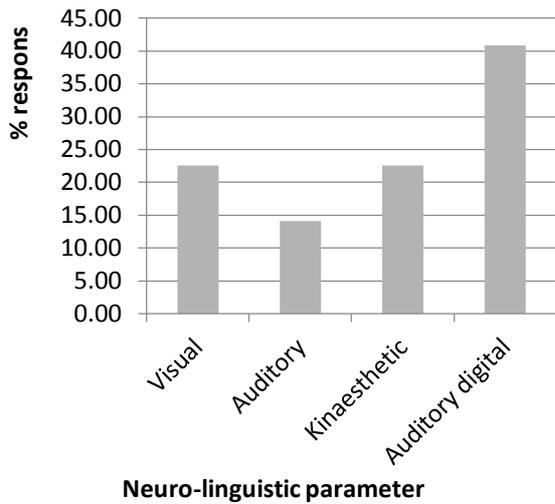


Figure 1 Results for NLP parameters among students in group one

Figure 1 illustrates the results for NLP parameters among engineering students group one. 40.85% of the participants respond to the auditory digital as dominant cognitive ability followed with 22.54% each for visual and kinaesthetic and 14.08% more towards auditory individual. It is important to note that most of the students belong to all four NLP criteria but this result represents the highest marks between four of them and it is accounted as dominant cognitive for every participants.

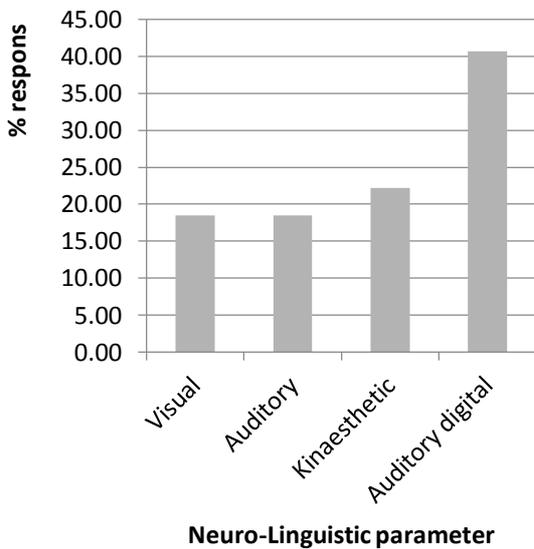


Figure 2 Results for NLP parameters among students in group two

Figure 2 illustrates the results for NLP parameters among students group two. 40.74% of participants demonstrate the auditory digital as dominant cognitive ability, while 22.22% kinaesthetic and 18.52% reflects to visual and auditory each. Also, similar to group one, most

of the students belong to all four NLP criteria but this result represents the highest marks between four of them and it is accounted as dominant cognitive for every participants.

Based on the two results from Figure 1 and 2, students from both groups reflect the auditory digital as first dominant learning cognitive. As described in introduction section, the teaching and learning method that suits to this type of students should include the facts and science and guide them through a logical sequence. In addition, details are very important for them to understand. It is suggested to use non sensory words i.e. understand, know and make sense and avoid feeling words.

The second preference is shared by both groups is kinaesthetic ability. Studies from previous investigations note that this kind of student is very stubborn and blocking if their feelings are hurt, this causes a lot of problems to the lecturers. The best possible approach to communicate with them in class is instructing them through physical things or activities. Use feeling words i.e. get a grasp of, get to grips with and etc. as these are all kinaesthetic words that their neuro-linguistic can process easily. In addition, comfortable environment and patients also important elements in conducting learning and teaching process for kinaesthetic students.

Visual ability also second preference among students in group one while it is become third preference among group two. However, this type of students should not be ignored because they contribute to more than 10% response of feedback, which accounted as high percentage. The suitable technique for visual students is explain them with something to look at such as power point presentation, pictures, graphs, diagrams etc. Also, use visual words in communicating with them like see, picture and look to help them understand better.

Finally, auditory is the least preference for both groups of students but still considered as important group because it belongs to more than 10% of overall responses. The good approach for this group is to invite them explaining their ideas rather interrupting their conversation because their nature is loves to talk. It is important to use phrases such as that sounds like or I hear you in communicating with them to help them understand the topic better.

Multiple intelligences (MI)

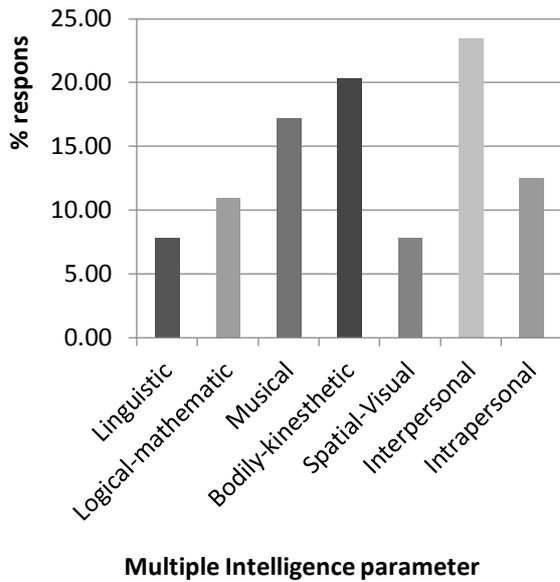


Figure 3 Results for MI parameters among students in group one

Figure 3 shows the results for MI parameters among students in group one. 23.44% of the students are cognitive dominant in interpersonal, followed by 20.31% are bodily-kinaesthetic type, 17.19% belongs to musical preference, 12.50% intrapersonal, 10.94% logical-mathematic and 7.81% have linguistic and spatial-visual cognitive preference each. It is important to note that most of the students response to all seven MI criteria but this result represents the highest marks obtained from each of them and it is accounted as dominant cognitive for every students.

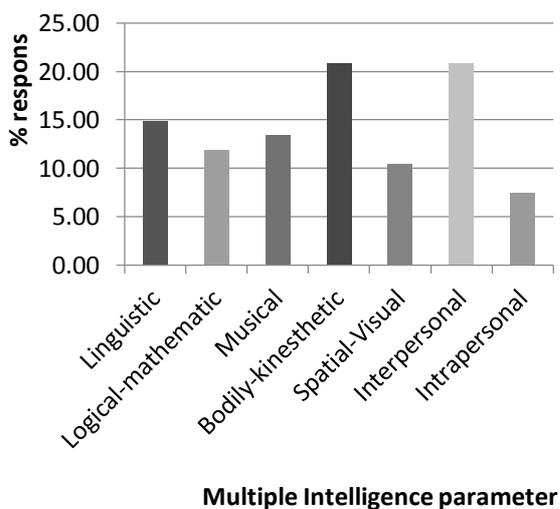


Figure 4 Results for MI parameters among students in group two

Figure 4 presents the results for MI parameters among students in group two. 20.99% of the students are cognitive dominant in interpersonal. Also, the similar percentage

responded the bodily-kinaesthetic as preference. 14.93% belongs to linguistic preference, 13.43% musical, 11.94% logical-mathematic, 10.45 % spatial-visual and 7.46% intrapersonal type. Also, similar to group one, most of the students represent to all MI criteria but this result emphasize the highest marks between seven of them for every students and it is accounted as dominant cognitive.

Results from Figure 3 and 4 indicate the similar outcome that students from both groups dominant in interpersonal and bodily-kinaesthetic. The teaching and learning medium for interpersonal students are through human contact, communications, cooperation and teamwork. The activities that could be suggested in the teaching session including the interpret moods from facial expressions, demonstrate feelings through body language, affect the feelings of others in a planned way, coach or counsel another person. While the teaching method for bodily-kinaesthetic is using physical experience and movement and touch and feel such as create a mime to explain something, coach workplace posture, assess workstation ergonomics, arrange workplace furniture, design a window display and put together a piece of modular furniture.

Besides, the ranking of importance of other preferences are difference between the two groups of students. However, most of the preferences represent high percentage of response which is requiring the suitable teaching methods to handle them.

For linguistic type, the teaching method that suitable is through words and language such as writing activities, oral presentation, list the strengths and weaknesses of a product, write a report and etc.

Differ with others; logical-mathematical students require numbers and logic to understand something. The suitable activities in the class for logical-mathematical students such as create a process to measure something difficult, analyse how a machine works, create a process and devise a strategy to achieve an aim.

For musical type, the approaches that include sounds and rhythm are more effective in their learning process such as specify mood music for telephone systems, compose media jingles, identify music for malls and retail stores, lead a choir, perform a musical piece, review a musical play and whistle a tune music.

The Spatial-visual students require pictures, shapes, images and 3D space to facilitate them in learning session. The related

activities for them are like design an object, interpret a painting and compose photographs.

Finally, for intrapersonal group of students, self-reflection and self-discovery are the best medium to process the new information such as setting own goals, planning, strength and weaknesses.

It is important to highlight from this study that the cognitive operation identification is not only important in teaching and learning process among young students but also can be implemented for future ergonomics training participants. The combination of NLP and MI methods with existing ergonomics training and coaching techniques possibly produce an effective training to the public people that coming from multiple groups of age, experience and cultural. Therefore, it is suggested that identification of cognitive operation using NLP and MI is conducted among participants in ergonomic training to ensure the training contents well delivered to all participants.

CONCLUSION

The continuity problem in teaching the engineering students was reflected by their examination results which had shown the gap in relating the theories and coursework. This scenario gave a sign that possibly the learning and teaching methods used in the class were not accounted the students' cognitive background and capability. An investigation had been conducted in this study to understand the cognitive operation ability among students as the target audience before educating them using appropriate teaching and learning method. Two types of questionnaire were distributed to the two groups of engineering students based on neuro-linguistic programming (NLP) and multiple intelligences (MI) theory and methods. The results show that both students group dominated the kinaesthetic and digital auditory according to NLP principles while high percentage in body kinaesthetic and interpersonal parameter according to MI. However, the other parameters that present more than 10% feedback should be considered in implementation of teaching and learning methods. The contribution of this study not just for teaching and learning process among young students but also important for ergonomics training that involving participants from different groups of age, experience and culture. In future, further investigation will be conducted to examine the effectiveness of NLP and MI method implementation in teaching and learning process among engineering students using the results from this study.

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COMPETING INTERESTS

There is no conflict of interest.

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