

## The Use of Microgenetic Method to Measures the Cognitive Change by Introducing New Education Tool

Saipul Azmi Bin Mohd Hashim  
Kolej Komuniti Kepala Batas  
saipulneural@gmail.com

Saidin Bin Abdul Hamid  
Politeknik Seberang Perai  
saidin@psp.edu.my

Muhammad Zhafran bin Muhyiddin  
Kolej Komuniti Kepala Batas  
zaftfrunc@yahoo.com

**Abstract:** This paper presents students' cognitive change study by introducing new education tool. Student are classed and grouped based on their expose or interaction with the new education tool and question-answer session with lecturer. For comparative purpose, there are groups that are not interact with the new education tool and question-answer session. Based on this interaction differences, student were observed with mini report submission; used to measures students' cognitive. The observation of students' cognitive in done in six times and the cognitive change is determined which follow the Microgenetic Method. The result of  $p = 0.99$  (99%) for the student getting above passing marks stimulated by education tool and question-answer session. And based on the total of 30 marks, on average student that exposed to the matters gained about 29 marks and student those who are not expose gained about 13 marks.

**Keyword:** Microgenetic Method, Education Tool, Hypothesis Test, Cognitive Measurement

### 1.0 Introduction

Most of student at community college are come from average secondary education background. Student in this group are encourage to enter the offered programs so that they are furnished with potential skills for work industry. Thanks to the government for the college community initiative to mould these students in skills with lesser academic requirements. However still for certain programs, there is a need for academic capability to apply in the courses especially in technological based programs. This includes programs such as Manufacturing Technology, Light Transport Servicing and Cooling and Air Conditioning Technology. Thus, these are the challenges for lecturer to educate the students.

There are many cases that student is friendlier with the gadget i.e. mobile phone than learning to lectures in class – students are bored in the class. For instance in Manufacturing Technology program, students are prone to entering Workshop Technology course (WT) rather than Electromechanical course (EM). This is due to in order for them to complete EM task, student needs to complete certain academic need such as electric circuit diagram which required to well-verse with the symbols and system logic. However in WT student need a while before start using tools for their project in the workshop. Hence, for the matter some lecturers initiate project as education tool to attract student attention in the class.

Introducing new education tool may influence the brain strategy of thinking. The change of the thinking strategy can be measured by many methods. Microgenetic Method is one of the many methods. The method superiority is not only it measured the performance of the students i.e. marks, but also how they getting the marks through observation (Granott & Parziale, 2002). The rapid change of student cognitive is observed by repetitive measurements within span of short of duration. By the method, a study delivered three critical feedbacks i.e. observation must span a known period of change; observation density is high in comparison with change rate; and analyzed intensively to establish the process that gave rise to them (Emma Flynn et. al, 2006). In this study, the method will be used to measures the student performance of brain thinking strategy to understand a topic in Electromechanical course that exposed with new education tool and compared with other sample, who are not exposed to the tool.

This paper aims to measure the change of two samples of student that study electromechanical course. The parameters to be measured are student cognitive value, reflection of thought, and lecturer observation. Reflection of the parameter indicates the level of student understanding and metacognitive capability. Students are expected to have at least moderate marks as they are not leave on their own to study the subject. The lecturer's assistance is given during theoretical class since this is the higher priority compare to this experimentation. In addition, by considering these matters three hypotheses to be tested are: (i) Students exposed to the education tool obtain marks higher than 70% ( $H_{a1}$ ); (ii) Students that have question-answer session with lecturer will obtain marks higher than 60% ( $H_{a2}$ ); and (iii) Students have no expose to both the education tool and question-answer session will get marks lower than 40% ( $H_{a3}$ ). The detail about the paper is organized in five sections. Introduction and literature review to justify and set the pattern of the study. Section 3 explains the Methodology used. The following section i.e. results and discussion; and conclusion spell out about the finding of the study.

## 2.0 Literature Review

Though many microgenetic method researches focus on children's strategy of thinking, still the method is applicable to adult. This is due to adult and children learning strategy shows similar pattern and the difference between them is less clear accordance to Siegler (2002), Granott & Parziale (2002) and Kuhn & Franklin (2006). Even monitoring by magnetic resonance imaging (MRI) technology founds that adult and children brain activity are also similar (Casey et al. 2002). This is due to number of reason such as McClelland (2001) suggested that learning strength in adult is subject to change where it weakened in adulthood. By comparative Schauble (1996) urged that adult returned from correct belief to incorrect belief [forget] is less often as compared to children which at certain time the level of incorrect belief is similar. Therefore to the method used to adult sample may gain rational outcome.

Back then before the year of 2000, the trend of method used to measures the brain strategy of thinking for adult sample and the outcome is positive. For example Kuhn et al. (1995) applied the method to the adolescents and college students group, and elderly adults by Siegler & Lemaire (1997) and Granott (1998). But none of these researches applied the method for brain strategy change of thinking based on introducing new education tool. In addition, the versatility of the method is suit to this study. The versatility of the method has proven applicable in wide area of brain functional studies. In higher level academic application the method applied in many studies such as in locomotion (Thelen & Ulrich, 1991), arithmetic computational (Siegler & Jenkins, 1989), mathematical principles (Alibali & Goldin-Meadow, 1993), conceptual understanding (Metz, 1998), scientific reasoning (Kuhn & Phelps, 1982; Kuhn et al., 1995; Schauble, 1996), pictorial representation (Karmiloff-Smith, 1992), and analogical reasoning (Chen & Klahr, 1999).

By the year 2010 and beyond the study related to the cognitive measurement is fused with the other factor which also known as non-cognitive abilities. Researchers (Heckman & Kautz, 2014; Levin, 2013; Tough, 2013) believed that other than cognitive abilities also have significant influence which determined student success. Jackson et al. (2015) clarified that the non-cognitive parameters can be parameterized includes: Goal-directed Effort e.g. grit, self-control; Healthy Social Relationship e.g. social belonging & emotional intelligent; and Judgement and Decision Making e.g. curiosity and open-mindedness.

These three parameters were further clarified by other researchers in each of the parameter. For example in encouraging student to completing their task by Carlson et al. (2014); Best & Miller (2010); Toplak et al. (2013); Diamond et al. (2013); Diamond & Lee (2011). Student cognitive development influence by their emotion in relation and classroom social environment supported by Durlak et al. (2011); Durlak et al. (2015); Weissberg & Cascarino (2013). The additional parameters which studied and proven by Zirkel et al. (2015); Yeager et al. (2014); Hofmann et al. (2012) and Farrington et al. (2012) are through the exposure by experiencing, replicating and self-learning improved students' cognitive change in a classroom.

These facts are enforced with current research trend, regarding to Microgenetic Method. Fogal (2017) study on interaction via authorial voice development for learning other than the first language. Similarly by language learning study but in different context and fused with sociocultural interaction conducted by Marzban et al. (2017). Ranjbar & Ghonsooly (2017) study on learning based on social interaction for writing skills. And the interaction between the emotions with the arts i.e. drawing, studied by Stamatopoulou & Cupchik (2017). They successfully recorded the change of cognitive by Microgenetic Method which fused with non-cognitive parameters. These evidences support and justify of conducting this study. Distinctively this study allows student to interact with new educational tool; and student are also interact with lecturer during the question-answer session for justifying their decision making in solving their task.

### 3.0 Methodology

This section considered the five factors that need to be done before and during the experimentation – the setup of participant, design, education tool, laboratory and procedure. These must be spelled out prior before the experimentation.

#### 3.1 Participant

At Community College Kepala Batas, for the academic session of March 2017, there are only two classes that open for EM course -- Class A and Class B. Thus there is the constrained which not many of option in detailing the selection of the sample. Fortunately the clear cut it is fixed into two classes: involved with 21 students for Class A and 15 students for Class B. However six students in class A is exempted since they are working after school. They cannot participate with the experimentation that is also conducted after school hour. Thus the total of 30 students took part with an average of their age is 19 years old. The class session is different for Class A and Class B. Fortunately this easy the study to set up the control of study environment. All of the student were male and came from three races Malay, Chinese and Indian. The students agreed to participate to the experimentation and willing to involve in extra hour after school.

#### 3.2 Design

The student in this study taking part in six sessions of evaluation set. For normal class session, student-lecturer meeting is twice a week three hours for theoretical session and five hours for lab work session. For this study purpose, student will participate for six alternate days – Monday, Wednesday, and Friday in two weeks. The experimentation designed so that no other courses will be disturbed as the experimentation also conducted after school hour. Based on the experimentation the students will be categorized into four which the detail is in procedure section. The six sessions generate the data for analyzing the performance of each student category and the matter correlates with the performance.

#### 3.3 The Education Tool

The tool is designed for a general purpose but still flexible in application also known as *Rewarded Dumpster* (INOCOPP 2015, 8.12.15) or automatic rubbish bin. Figure 1 shows the tool's electrical circuit. It operates automatically to open the bin cover. Initially, the switch S1 must be normally closed condition. The sensor B1 will be activated by the present of user about 60cm from the sensor position. Then the sensor B1 sends a signal to motor M1 to open bin cover. It is expected that the human will throw the rubbish inside the opened bin. Another sensor B2 inside the bin will detected the present of any rubbish. Then a signal sent to the motor M2 so that it will close back the cover. And at the same time a stamp that used motor M3 will generates stamped ticket to be collected by the user. The use of a relay, contacts, and other components are a part of the syllabus covered in the course.

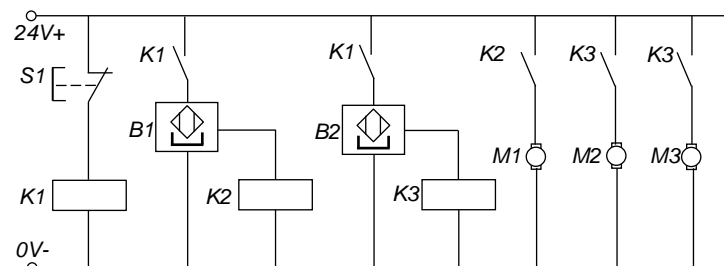


Figure 1. The Primary Electrical Circuit of the Education Tool

**Table 1. The sequence operation of the Education Tool**

Task	Sequence	Task	Sequence
1	S1 > K1 > K2 > M1 S1 > K1 > K3 > M2 & M3	4	S1 > K1 > M3 S1 > K1 > K2 > M1 S1 > K1 > K3 > M2
2	S1 > K1 > K2 > M1 & M3 S1 > K1 > K3 > M2	5	S1 > K1 > M1 S1 > K1 > K2 > M3 S1 > K1 > K3 > M2
3	S1 > K1 > M1 S1 > K1 > K2 > M2 S1 > K1 > K3 > M3	6	S1 > K1 > M1 & M3 S1 > K1 > K2 > M3 S1 > K1 > K3 > M2

As the tool is operationally flexible there are number of ways the operation sequences can be adjusted. The sequences of the operation depend on the combination of part by symbols as shown in table 1. The table shows the sequence from the switch (S1) switched on to the next operation activated the relays and by that other component will be activated. Based on the table the student task will be changed for each experiment of microgenetic session. The student tasks are expected to replicate from the education tool. The repetitive of doing the task has superior advantage which not only enforcing the memory of the concept but it helps an individual exhibits a range of alternative strategies applied to the task and suggested a more frequent usage may develop better, more effective strategies and less frequent usage develop less effective strategies (Kuhn, 1995).

### 3.4 The Laboratory

Electromechanical laboratory use has four active panels that installed with student kit. Thus at each session can only run by four students. They will use the panel to replicate the idea of the circuit and function as the education tool can exhibit. For the lab work session student are given an hour to complete their task which will require four hours. The straight control of no cheating rule is applied during the task is done. Copying other student work for the mini report and asking other to help them complete their task on the student kit shall not be allowed. Lecturer must monitor the matter so that student's follow the rule.

### 3.5 Procedure

The primary concerned in this study is, this microgenetic experiment must not neglect the student's need for the knowledge of this course. Student must be furnished with the course minimal needs in both theoretical and practical. Thus, this is the priority compared to this experiment.

The procedure will set the student category. The student first category is based on report submission. For Class A, students are required to submit their mini report that contains material (i) and (ii). However for Class B, students are required to submit their mini report that contain only material (i). Students are required to prepare a complete set of (i) electrical circuit on the task they have; and (ii) response of the decision they take on the task. Question-answer session in verbal represents the second category. By this mean, the lecturer evaluates them by questioning the idea they are doing. Then in return they need to answer the question. This session is done randomly pick eight persons for each class. The third category is based on student exposure to the education tool. In class A, student will be exposed the education tool application during the theoretical and lab work sessions. But for class B, students have not exposed at all to the Education Tool. The submission of material (ii) is significant if it is reflected the student ability. Thus, the material (ii) submitted will be classified as good or not good material. This is depending to the reason the student explains in the report. Ultimately, if the report taken lightly even the right answer will be classified as not good, since it does not reflects the student ability.

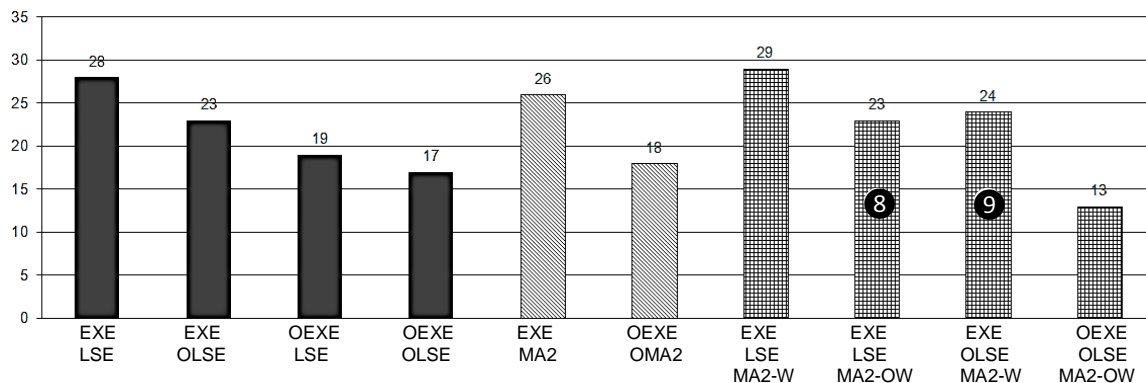
In order to analyses the student cognitive performance, they must be grouped. The group is compulsory since a student may fall into more than one category as mentioned in previous paragraph. Based on the experiment there will be four main groups of student that categorized as follow: (i) Student need to submit (i) and (ii) and involved with question-answer session; and also exposed to the education tool; (ii) Student need to submit (i) and (ii) and exposed to the education tool; (iii) Student need to submit (i) and involved with question-answer session; and (iv) Student need to submit (i) only.

#### 4.0 Result and Discussion

The result and discussion about the result are focusing on the student performance. The performance is evaluated from task completion; circuit installation to the student kit, and student schematic electric circuit. For the point of observation and statistical viewpoint are also discussed to better understand and convince with the result outcome.

##### 4.1 Student Performance

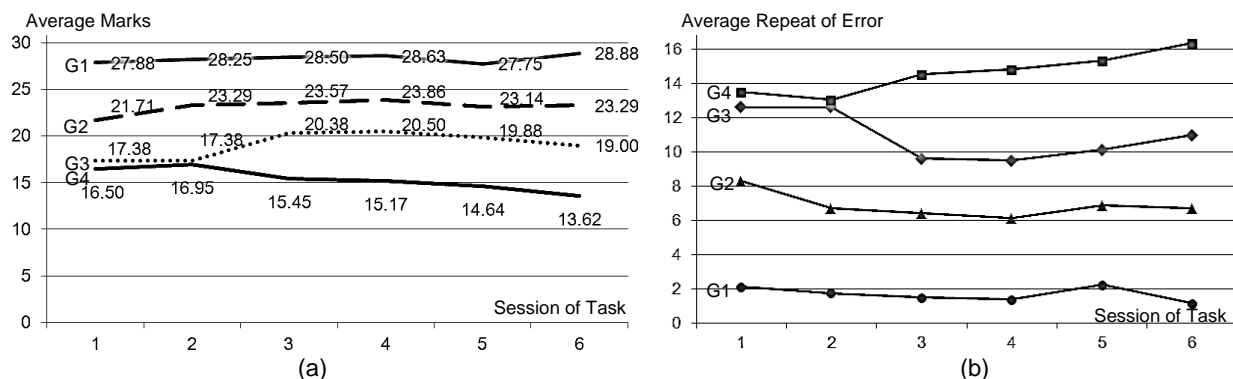
Student performance evaluation is based on three components i.e. (i) Task completion at student kit (COM); (ii) the task is correctly complete (COR); and (iii) the submission of material (i) (MA1). Each component contributes 10 marks and the total is 30 marks. In addition to the evaluation, observation used to monitor the student involvement that has no effect to the marks. They are (i) submission of material (ii) (MA2); (ii) exposure to the education tool (EXP); and (iii) question-answer session (LSE).



Note: EXE – Exposed to Education Tool; OEXE – Not Expose to Education Tool; LSE - Questioning and Answering Session; OLSE – No Questioning and Answering Session; MA2 – Submit Material (ii); OMA2 – Not Submit Material (ii); MA2-W – Answering Material (ii) Well; MA2-OW – Not answering Material (ii) Well

**Figure 2. The Student Performance in Group based on Result of Complete Task, Right Task is Answered and Report Material (ii)**

Based on the evaluation the result is shown in Figure 2 shows the student performance based on marks they obtained from schematic electric circuit, completion and answer correct of task at student kit. Histograms in black color show the effect of exposed to both, education tool and involvement in question-answer session. For histogram in stripe lines show the effect of student submitting material (ii), and the box shade histograms show the effect of all the three matters. All of the histograms sum that the more student participate with the matters in the experiment the better their marks. Clearly the histogram number 9 shows that student participate seriously in submitting material (ii) improve their metacognitive ability and as a result they perform better compare to those who submit material (ii) but answer it with less afford as in histogram 8. Take note that student in group for Histogram 9 is not involve in question-answer session, but still performs better which show the session less impact to the performance.



Note: G1 – Student Group Exposed to Education Tool & Questioning and Answering Session; G2 - Student Group Exposed to Education Tool & But Not to Questioning and Answering Session; G3 - Student Group Not Exposed to Education Tool & But Involved in Questioning and Answering Session; G4 - Student Group Not Exposed to both Education Tool & Questioning and Answering Session

### Figure 3. Performance for Every Session by Each Group of the Student

Figure 3 shows the consistency of student performance based on their nature of exposure. The figure shows the graph (a) student average marks by the six microgenetic sessions they attended. The graphs consistently show that the more student expose to the three matters, the better they perform. This is also parallel result the repetitive error the student has made in graph (b). The student repetitive error also represents consistence parameter with slightly no significant increase and decrease. Student in Group 1 (G1) that exposed to the education tool, question-answer session and submitted response report or material (ii) outperform the rest groups.

#### 4.2 Observation on Student that Replicating the System of Education Tool

Student in Class A early exposed to the tool while in preparatory session. At the time students are start attracted to the tool. It flexibility that can be modified up to user's design is the most attractive feature. This has encouraged student to understand the system well in order for them to do their task later. By this exposure they use analogical reasoning thinking from the tool domain into to student kit domain.

Student are coded with code 1A to 15A for class A and 1B to 15B for class B. Based on the observation and the code, student 2A, 5A, and 8A were actively use the tool to modify their system at student kit. As the result their total marks are among the highest – between 29-30 marks. Comparative to other student exposed to the system, student 14A and 15A which have no interest to the tool are gain among the lowest mark about 21-22 marks. For the student which is not exposed at all to the education tool i.e. Class B, their result shows not as good as Class A. The average of the student for this group is 18. The lowest mark for Group B is 13 and the highest is 23.

#### 4.3 Hypothesis Test

Based on the early mentioned, the hypotheses of this study there are three test results obtained. Since the size of the sample is low i.e. about 30 sample size, hence the t-Distribution is selected for the test. For calculation preparatory the percentage used in the aim statement will be converted into real marks and the standard of deviation (s) and sample average ( $\mu$ ) value must be obtained. As the total value is 30 marks, thus the value for 70% is 21 marks; 60% is 18 marks and 40% is 12 marks.

The probability that represent by chance that the student that exposed to the education tool will gain higher than 21 marks ( $H_{a1}$ :  $s = 3.369$ ,  $\mu = 25.93$ ) and student that has question-answer session with lecturer will has higher than 18 marks ( $H_{a2}$ :  $s = 5.633$ ,  $\mu = 23.56$ ); are above 0.99 (99%). However for the student that has no expose to both the education tool and question-answer session the chance probability that they will get lower than 16 marks ( $H_{a3}$ :  $s = 2.992$ ,  $\mu = 15.43$ ) is less than 0.9 (90%).

#### 5.0 Conclusion

Students having question-answer session score significant high marks. In addition, student that required to submit response in their report i.e. material (ii), also shown better marks than those how are not submitting the response. The lecturer's observation also recorded that student actively replicate the tool for their task among the excellent marks scorer. These multitude evaluations supported that student performance significantly high by the tool assistance. The finding conclude that participating the question-answer session, submitting material (ii), replicating the idea behind the education tool and completing the task repetitively have encourage student to apply rational strategy of thinking. By fusing the participation in four ways this support the metacognitive of student brain function. Plus this study also found that question-answer session and response by material (ii) were not sufficient to aid the student analogical reasoning skill development. It appears that the education tool is essential to enhanced levels of student analogical reasoning performance.

Statistically this tested sample gained probability (p) higher than 0.99 for those who are: only exposed to education tool and only involved with question-answer session will get above common passing marks i.e. 50%. In addition those who are not involve to both, exposes to education tool and question-answer session will get marks lower than 40% at p less than 0.9. This is due to the student has already being guided in theoretical class since student priority given the most in this experimentation.



By microgenetic period, in general the repetitive error number decreased and not shows significant increase to any of the student group. The fact that student who performs well are reasoning the connection from previous error and knowledge enforcement during theoretical class which the only way that the student can consistently deliver the correct answer.

This paper has introduces new learning perspective into students' understanding for a complex course. The interaction that the student fosters in depth of understanding if they appreciate the role of education tool plays. And at end this influences the tool used to deepen understanding and has increasing the process to develop understanding.

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