

Full Length Research paper

The effect of using learning model based on problem solving method on students with different cognitive style and logic ability

¹Ahmad Rizal Madar*, ²Mohd Yusop Ab.Hadi, ³Abdul Rasid Razzaq, ⁴Mohamad Zaid Mustafa

^{1/2/3/4}Faculty of Technical Education University Tun Hussein Onn Malaysia 86400, Parit Raja, Batu Pahat, Johor Malaysia

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This research aims to study the effect of using learning model based on problem solving method on students with different cognitive styles and logic ability. Cognitive styles and the ability to think logically also influence one's ability to program and to solve problems. Therefore, by using a quasi experimental design, this research studies the effect of using learning model based on problem solving methods on students with Field Dependent (FD) and *Field Independent* (FI) cognitive styles as well as high logical thinking ability (LT) and low logical thinking ability (LR). Samples are students that chosen by purposive sampling from third semester Diploma of Electrical and Electronic Engineering from Polytechnic Merlimau Melaka that undergo Computer Programming subject (E3062). Total samples used in this research are 71 students. Instruments used in this research are Group Embedded Figures Test (GEFT), Sequences Test, pre-test, post-test and the learning model based on problem solving method. Data obtained was analyzed using descriptive statistic and statistical inference model. Result showed that the majority of the students were categorized as FI and LT where 51 students were FI and 46 students were LT. Descriptive analysis also showed that mean score of the treatment group's achievement it was overall or according to cognitive style and logic ability, was much higher than the control group. Inference analysis using independent t-test indicated that the difference between the treatment group's achievements with the control group's achievement was statistically significant. Result also showed that the achievements of FI students were higher than FD students and the LT students' achievement were higher than the LR students' achievement. Independent t-test proved some significant differences between those groups of students. In conclusion, the learning model based on problem solving method has potential in enhancing the students' achievement by overall for the Computer Programming subject with students categorized as FI and LT receive more benefit than those categorized as FD and LR.

Keywords: Cognitive style, logic ability, field dependent, field independent, high logic ability, low logic ability.

INTRODUCTION

A survey from Knowledge Worker Exchange (2004) defined job opportunities in Information and Communication Technology (ICT) industry has a total increase of 23%. Besides, the survey also found that demand of programming engineers in industry sectors has increased from 20.1% in year 2003 to 23% in year

2004. However, qualifications that local graduates posed are not reach to industries' requirements. Industries have to employ programming engineers from oversea like India and United Kingdom (Knowledge Worker Exchange, 2004).

Programming language is very important in computer programming activities. However, it is not easy subject to master. Major of Computer Science students answered programming language is a very hard topic for them, and they cannot perform this subject as expected from their

*Corresponding author email: rizalm@uthm.edu.my

teachers (McCracken et al., 2001). There were several researches carried out to define problems that stunt students' learning process for programming language. Hamid and Nordin (2003) and Deraman (2003) have contributed some factors that affected students' learning outcome for computer programming are: Students fail to visually imagine programming processes; Students fail to oversee changes for all elements when they programming their software; Students fail to picture out elaborations for stages in programming software and; Students are too dependent for their mates to receive solutions.

According to White and Sivitanides (2002), when we able to identify students' features and arrange them into courses that adapt to their features, then the students' academic performance will be enhance. It is very important to understand how students learn through educators before educators actually teach their students (Traynor and Gibson, 2004). Problem solving methods play as the key to master software programming, students who weak in software programming will also means they are weak in strategic problem solving (Deek and McHugh, 2003; Hansen, 1997; DeFranco-Tommarello and Deek, 2004). Cognitive factors and Logic abilities being categorized as critical to help students solve their problems develop their software (Engemann, 2000; McIntyre, 2006; Jenkins, 2002; White and Sivitanides, 2002; Mancy and Reid, 2004).

Biggs (1994) pointed out factors that influence students' characteristics, they are: Skills, Knowledge learned before, Motivation, Personalities, Learning Styles, Learning Approach, and others that will affect students learning process. These factors mostly focus on individual's nature that is stable like skills and learning styles. In teaching Context, educators have to prepare and be sensitive for students' feedback. Educators have to frequently back-check and value their teaching methods as well.

Teaching method should be consistent with learning objectives as well. Let's say if learning objective is to improve students' communication skills, then self-learning method will became futile. As Education in Technical and Vocational requires students to involve in actual industries, problem solving learning method are said more effective to expose for students. This trend was highly due to nature of working environment that require technical workers like engineers to solve daily issues encountering (Engineering Subject Centre, 2007). Moreover, industry owners are preferring engineers that poses high problem solving skills (Sobek II and Jain, 2004).

Engemann (2000) and Macintyre (2006) found that students' ability to solve problems is much depends on their competence to make assumptions logically. A research from Jenkins (2002) has pointed out factors that might affect programming abilities are Natural Talents; Cognitive that include learning motives and motivation;

and Difficulties of the programming itself. Jenkins (2002) further proposed possibilities of Cognitive Ability would become the key to easily and efficiently master computer programming. Another research from Mancy and Reid (2004) has proven Jenkins finding, stated *Field Dependent* is the critical ability to master computer programming, while memory power was found unimportant for it.

According to a research contributed by Ronning, McCurdy and Ballinger (1984), students who posed *Field Independent* solved more issues than student who posed *Field Dependent*; however, students with *Field Dependent* obtained more benefit in processes to solve issues by focus on objectives set for each processes. Compiling from literatures above, it is clear to see that suitable teaching methods will effectively improve students' learning processes.

Learning model based on problem solving method was refer to *Dual Common Model* (DCM) to identify Cognitive technique in order to solve every problems or setting up programs (Deek, 1997). DCM was designed by Deek and McHugh (2003) for the purpose of software development. This model was a combination of Cognitive Bloom Theory and Human Information Processing Theory from Sternberg; and Learning Theory from Gagne. The word *Dual* represents two models that were Problem Solving Model and Cognitive Model that combined into one in DCM.

Cognitive ability

Cognitive is a mental process for seeing, memorizing, organizing, processing, thinking and solving for particular issues. Therefore, Cognitive Abilities were elaborated as factors that decided ways a person seeing, memorizing, organizing, processing, thinking and solving issues they encountered (Liu and Ginther, 1999). One of the Cognitive Abilities widely use for purposes of analyzing human activities is *Field Dependent* (FD) and *Field Independent* (FI) introduced by Witkin and Fellows at year 1977. A person who posed Field Dependent are external motivated, they are holistic thinking, interpersonal oriented and easier to influenced by others. On the other hand, a person who posed Field Independent are more analytical, intrapersonal oriented, prefer to work independent and internal motivated (Liu and Ginther, 1999).

Hansen (1997) defined Cognitive Ability as ways how information being receive and process, and Cognitive Ability not appear any difference among learning skills and memory. This definition was found similar with Messick (1984) proposed for Cognitive Ability as a tool to differentiate individual in organizing and processing information and experience. Tennant (1988) also elaborated a similar definition where Cognitive Ability as a individual consistence features in organizing and pro-

cessing information. As summary, these three definitions carried out a common ground that Cognitive Ability is an individual feature in processing information they receive.

Liu and Ginther (1999) propounded Cognitive Ability or Learning Ability as consistent and it serve as early factors that will influence individual in seeing, memorizing, organizing, processing thinking and solving problems. This definition is concurrent with another definition proposed by Witkins (1977) that stated Cognitive Ability vary from how individual seeing, memorizing, thinking, solving problems, learn from the solving experience gained and relate the experience with other issues. These two definition also share a same point of view that Cognitive Ability define how individual obtain, process and apply information,

Understanding students Cognitive Abilities will help educators in choosing the most effective teaching method for their students. As examples, students with *Field Independent* may prefer self-learning method as they posed a learning behavior of analytical thinking and interpersonal oriented, where students with *Field Dependent* may require collaborative or corporative learning method as they are intrapersonal oriented and need much team influences in their learning process (Hashim *et al.*, 2003). As it, besides of students Cognitive Abilities, teaching method also plays an important role in promoting their motivation.

Logic ability

Logic is interpreted as science of principles that enable thinking and behaving activities orderly arranged. Ability to think logically always relate to field of science and problem solving abilities. It was supported by Engemann (2000) that ability to solve problems is much depend on individual logic ability and mental capability.

Problems solving ability

Problems here were defined as a particular situation and objective where that situation occurred was due to an exact situation or just an imagination, and that imagination also can be treated as an exact situation or just an abstraction, intellection, or case study (Engineering Subject Centre, 2007). Creative problem solving skills, Logic Ability and Analytical Skills were then concluded as very important requirement. Logic Ability and Analytical Skills are used in understanding problems, analysis situation and checking decisions for every step of solution, where creativity are required for designing their solutions for the problems. There are several problem solving methods in dividing processes of problem solving into several levels and hence assist students to analytically and systematically ravel out their problems. Among the steps in problem solving, there are

sequences of solving method that will ease up the process named: Problem Definition, Drafting Solutions, Solving Problems and Review Results to reach targeted objective.

Deek and McHugh (2003) stated that problem solving ability is very important to understand calculations and this ability should be trained when students undergoing their computer programming subjects. DeFranco – Tommarello and Deek (2004) further elaborated that problem solving activities is part of programming process. A research from Hung (2006) revealed that learning model based on problem solving method has improved students' academic performance in programming subjects.

According to Engineering Subject Centre (2007), *"Problems solving is what engineers do. It is what they are, or should be, good at.....problem-solving skills may be the most important thing we can teach our students and, if students don't come to university with the necessary skills, we do have to teach them. To progress onto other engineering course content without ensuring that students can apply a systematic problem-solving process is pointless."* The statement above has clearly transmitted the importance of problem solving skills in engineering courses and educators are responsible to guide students to master these skills.

METHODS

Research objective

The objective of this research is to prove the effect of using learning model based on problem solving method on students with different Cognitive Style and Logic Ability. Besides, outcome of this research will at its best to benefit student, educators and Ministry of Higher Education (KPT). Students will able to understand the significations of Cognitive Style and Logic Ability, thus indirectly they may design their learning strategies that will adapt to their own strong suits. Moreover, students will also employ a suitable problem solving method in untie difficulties for their programming and other subjects. Educators will be benefited by preparing propitious activities for students depend on their Cognitive Style and Logic Ability. Better problem solving methods will be more effectively introduce to students base on their styles and ability as well. Lastly, polytechnic may refer to this outcome to develop suitable programs to improve students' learning process. This research will be appropriate to serve as reference for KPT in developing their modules that contain compatible problem solving methods.

Procedure

Populations for this research were third semester stu-

Table 1: Mean Score for FD Students

Group		Pre-Test	Post-test	Improvement
Control	Mean	3.11	25.33	22.22
	N	9	9	9
	Standard Deviation	0.928	4.583	4.116
Treatment	Mean	4	32.73	28.73
	N	11	11	11
	Standard Deviation	1.095	4.756	4.052
Total	Mean	3.60	29.40	25.80
	N	20	20	20
	Standard Deviation	1.095	5.915	5.177

Table 2: Mean Score for FI Students

Group		Pre-Test	Post-test	Improvement
Control	Mean	6.15	34.15	28.00
	N	27	27	27
	Standard Deviation	1.895	4.383	3.464
Treatment	Mean	6.13	38.83	32.71
	N	24	24	24
	Standard Deviation	1.849	4.896	4.298
Total	Mean	6.14	36.35	30.22
	N	51	51	51
	Standard Deviation	1.855	5.157	4.514

dents in Diploma in Electric and Electronic Engineering from Polytechnic Merlimau, Melaka that undertaking subject E3062 Computer Programming. Samples were divided into two groups that were Control Group and Treatment Group where students belong to class DET3 classified as Control Group and students from DKE3 classified as Treatment Group. There were 19 males and 17 female students in Control Group, and 17 males and 18 female students in Treatment Group. From academic point of view, both DET3 and DKE3 classes have shared same conditions as they took same subjects at previous and current semester. To further break off any factors that may influence research results, both classes were conducted at same time that was from 2:15pm to 5:15pm but at different days that were Monday for Control Group and Thursday for Treatment Group. This experiment took a full semester (3months) to complete.

Test instruments

Samples were given a *Group Embedded Figures Test* (GEFT) to classified them into two groups of Cognitive Style (*Field Independent* or *Field Dependent*) and *Sequence Test* to classified them into two groups of

Logic Ability (*High Logic Ability* or *Low Logic Ability*). After that, students were required to sit in a pre-test to confirm their knowledge about their subject title chosen. One week after pre-test, Treatment Group delivered teaching and learning model base on problem solving methods while Control Group received conventional teaching and learning method. Finally, both groups were given a post-test to compare their improvements.

RESULTS

A comparison in table 1 above has clearly shown a higher mean score for Field Dependent students in treatment group (28.73) is higher than Field Dependent students in control group (22.22).

Another comparison in table 2 above has indicated a higher mean score for Field Independent students in treatment group (32.71) are higher than Field Independent students in control group (28.00).

Next, comparison in table 3 below has shown a higher mean score from Field Independent students (30.22) than Field Dependent students (25.80).

Table 4 below indicated a t-test result for significant difference in students' academic performance. Significant

Table 3: Comparison of Mean Score for FD and FI Students

Group		Pre-Test	Post-test	Improvement
Field Independent (FI)	Mean	6.14	36.35	30.22
	N	51	51	51
	Standard Deviation	1.855	5.157	4.514
Field Dependent (FD)	Mean	3.60	29.40	25.80
	N	20	20	20
	Standard Deviation	1.095	5.915	5.177
Total	Mean	5.42	34.39	28.97
	N	71	71	71
	Standard Deviation	2.026	6.198	5.082

Table 4: Analysis for FD and FI Students' Academic Performance

Group	N	Mean	Standard Deviation	t	df	Significant (2 tailed)
FD	20	25.80	5.177	3.557	69	0.001
FI	51	30.22	4.514			

Table 5: Mean Score for LT Students

Group		Pre-Test	Post-test	Improvement
Control	Mean	6.38	34.75	28.38
	N	24	24	24
	Standard Deviation	1.861	4.214	3.398
Treatment	Mean	6.41	39.64	33.23
	N	22	22	22
	Standard Deviation	1.709	4.716	4.353
Total	Mean	6.39	37.09	30.70
	N	46	46	46
	Standard Deviation	1.770	5.054	4.555

value of 0.001 was smaller than 0.05, hence, there was really difference beyond FD students and FI students in terms of their academic performance.

For Logic Ability, comparison in table 5 above shown a higher mean score for High Logic Ability students in treatment group (33.23) is higher than High Logic Ability students in control group (28.38).

Comparison for Logic Ability in table 6 below also shown a higher mean score for Low Logic Ability students in treatment group (28.46) is higher than Low Logic Ability students in control group (22.92).

Table 7 below displayed a higher mean score for High Logic Ability students (28.46) than Low Logic Ability students (22.92).

Lastly, table 8 below indicated a t-test result for significant difference in students' academic performance. Significant value of 0.000 was smaller than 0.05, hence,

there was really difference beyond LR students and LT students in terms of their academic performance.

DISCUSSION

Research result showed a majority of students were categorized as *Field Independent* (72%) and *High Logic Ability* (65%). Results also showed a higher academic achievement from treatment group that used learning model based on problem solving method than control group that used conventional learning model. It clearly defined learning model based on problem solving method is effective in improving students academic performance for Computer Programming subject.

Descriptive analysis on students' achievements has shown achievements on Treatment Group that underwent

Table 6: Mean Score for LR Students

Group		Pre-Test	Post-test	Improvement
Control	Mean	3.42	26.33	22.92
	N	12	12	12
	Standard Deviation	1.084	4.438	3.919
Treatment	Mean	3.85	32.31	28.46
	N	13	13	13
	Standard Deviation	0.899	3.568	3.230
Total	Mean	3.64	29.44	25.80
	N	25	25	25
	Standard Deviation	0.995	4.967	4.500

Table 7: Comparison of Mean Score for LT and LR Students

Group		Pre-Test	Post-test	Improvement
High Logic Ability (LT)	Mean	6.39	37.09	30.70
	N	46	46	46
	Standard Deviation	1.770	5.054	4.555
Low Logic Ability (LR)	Mean	3.64	29.44	25.80
	N	25	25	25
	Standard Deviation	0.995	4.967	4.500
Total	Mean	5.42	34.39	28.97
	N	71	71	71
	Standard Deviation	2.026	6.198	5.082

Table 8: Analysis for LR and LT Students' Academic Performance

Group	N	Mean	Standard Deviation	t	df	Significant (2 tailed)
LR	25	25.80	4.5	4.344	69	0.000
LT	46	30.7	4.555			

teaching and learning model with problem solving method has improved much more than Control Group that underwent conventional learning method. *Field Dependent* students in Treatment Group have higher achievement than Control Group has proofed the sound of problem solving method. According to Canolos et. al (1980), individuals that posed *Field Dependent* Ability always puzzled down when trying to draw out relevant information from tough instructions. Problem solving method will effectively help students to overcome their weakness as this method lay out solution steps that will pinpoint relevant information like input and output information required by computer programming. Akdemir (2005) also summarized *Field Dependent* students as groups of individual who need close monitoring from their educators due to their similarity as always come out

irrelevant facts from what they received. Since that problem solving method provide steps of solutions, hence it will reduce educators' uneasy about their *Field Dependent* students in absorbing false information.

Research results also mirrored out effectiveness of problem solving method in improve *Field Independent* students' academic performance. According to Town (2003), this group of individuals prefers methods that are more focus, systematic, in sequence and cumulative. Since problem solving method provide a focus, systematic and sequence solution steps to develop programs according to questions' requirements, *Field Independent* students should relish this method. It further supported by Brown (1998) that students will motivated when they use problem solving method to come out their solutions. *Field Independent* students have obtained

higher performance achievement than *Field Dependent* students since they are able to think creatively, analytically and reflectively. Town (2003) also claimed that *Field Independent* individuals are group of people that will always analytically, reflectively and carefully ponder for their tasks. This group of students has acquitted these specialties as they done fewer errors than *Field Dependent* students.

Logic Ability is very important to solve problems. According to Engemann (2000), effectiveness in solving problems is highly depends on ability to develop logical reasons. Steps in developing solutions introduced in learning method have provided students well organized and arranged strategies in solving problems. At this point, students with *High Logic Ability* will also be benefited as well. On the other hand, problem solving method also serves as guidance for *Low Logic Ability* students by presenting well developed problem solving steps. From a research by Yaman (2005), a good problem solving method will assist individual to think logically. As it, problem solving method will *improve Low Logic Ability* student to improve their logic thinking and thus boost up their academic performance for computer programming subject. *High Logic Ability* has being concluded to be critical point to success in computer programming subject. According to Macintyre (2006), individuals' ability to solve problems depends on their logic thinking ability, therefore, students with

High Logic Ability has submitted better performance results than *Low Logic Ability students* in problem solving activities.

Research results showed a significant relation between Cognitive Ability and students' academic performance. It is alias with results from Dwyer and Moore (1995) stated Cognitive Ability indeed has an effect on students' academic performance. However, a survey from Gibbs (1999) that used Constructive Approach in computer programming turned out a non relation between Cognitive Ability and students' performance. Another research from Altun and Cakan (2006) also indicated a non significant relation between Cognitive Ability and students' performance as well. These results vary might due to subjects and delivering methods used in researches that unconsciously affected impacts of Cognitive Ability on academic results. Next, another research result detected Logic Ability has stronger effect than Cognitive Ability in students' academic performance. Vodounon (2004) contributed that Logic Ability has a higher correlation that is 87.7% in ability to solve problems for C++ computer programming. This has clearly proofed that Logic Ability will influence students' performance on computer programming.

CONCLUSION

This research has fully fulfilled objective that is to study

the effect of using learning model based on problemsolving method on students with different Cognitive Style and Logic Ability. Results indicated learning model based on problem solving method has a positive effect on all groups of students that posed different Cognitive Style (*Field Dependent* or *Field Independent*) and Logic Ability (*High Logic Ability* or *Low Logic Ability*) for their Computer programming subject (E3062). This research also revealed that students with *Field Independent* and *High Logic Ability* have better academic results from students with *Field Dependent* and *Low Logic Ability*. Results also found a significant relation between academic performance for Computer Programming subject and Cognitive Style and Logic Ability. In summarize, learning model based on problem solving method will improve students' academic performance for Computer programming subject no matter their Cognitive Ability and Logic Ability.

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