International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 05, 2020
ISSN: 1475-7192

Choosing Appropriate Retrieval based Learning Elements among Students in Java Programming Course

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Abstract--- *Effective learning needs consistent and relevant strategies to help students process and maintain new information. This importance is influenced by researchers' objectives to help students who are able to retain memory in learning, and manage to master learning well. Encoding, learning condition and learning practice are the important elements in Retrieval Based Learning (RBL) strategies. This research aims to decide suitable RBL strategies for students who join Java Programming course at vocational institutions. Research sample consists of 72 DVM students in their first semester for the Data and Web Application Database Management course in four different vocational institutions. Research data were obtained using questionnaire and analysed using the Statistical Package of the Social Sciences (SPSS) software version 22.0. The questionnaire was divided into four sections, encoding, learning condition, retrieval practice and suitable materials to be used in learning. Results from the descriptive analysis showed that the use of encoding through acoustic, visual semantic and elaborative methods has become students' choices in program learning, while the appropriate learning condition by students with the highest mean value of 4.0694 is through repetitive practices or individual tests to improve memory in learning. The three retrieval practices which are free recall, serial recall and cue recall, receive the highest interpretation other than using hardcopy materials and computer application in learning. Students' learning approaches were different depending on suitability and comfort. Thus, educators should realize this and the effort of adapting learning between students' choices and Java Programming course which could create an effective learning environment for all students. The results of the study are hoped to provide important knowledge in improving program learning, generally, and at vocational institutions, specifically, for computer programming courses.*

Keywords--- *Retrieval Based Learning, Encoding, Retrieval, Learning Condition.*

I. INTRODUCTION

21st century learning skills are important and very much needed by students to be competent (Rahmah et al., 2017) in addition to the country's education transformation that aims to complement each student with various new skills to grab job opportunities and to overcome challenges in the 21st century [2]. It is wrong to assume that students will receive knowledge through the same teaching and learning methods from years ago and expect the same impact today [3]. Thus, the implementation of new methods is encouraged in teaching to attract students' attention and easily understood as a need in education. Based on past studies [4], studies related to RBL are

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DOI: 10.37200/IJPR/V24I5/PR2020251
Received: 14 Mar 2020 | Revised: 30 Mar 2020 | Accepted: 06 Apr 2020

expanded in various fields and levels of education. RBL is a student-centred learning strategy that is not costly, does not change the curriculum, and is not time-consuming.

Although other studies found RBL to be effective in enhancing memory and students' comprehension for students in foreign countries, however the researchers are interested to study the effectiveness of RBL in the context of national education system in Malaysia [5]–[10]. This is because, if RBL strategies are implemented at vocational institution level, more challenges need to be focused on. The results of this study are expected to give positive impacts in improving students' potential, and able to enhance conventional learning methods towards more meaningful methods. According to the education system in Malaysia, RBL still needs to be explored in depth to become educators' choice in the future.

Most RBL strategies are studied using materials like word list, foreign language learning, textual paragraphs and video learning recordings [11]. The fields of study are language learning, Mathematics and Science, as these three fields need high metacognitive level. The researcher has tried to relate the fields with computer programming which needs improvement in metacognitive and memory retention while developing computer programming. According to Karpicke and Grimaldi (2012a), most students lack realization in metacognitive skills and they are not exposed with the benefits that they receive when using TBL in learning. This realization needs to be instilled through teaching using RBL strategies at earlier stages, and students can continue on without teachers' help. The use of RBL in technical and vocational education is not available in previous studies as RBL is only focusing on academic subjects like Science [6], Mathematics [12] and academic language use [13] . Respondents from previous studies [14] are primary school students, secondary school students and students of higher education [7]. There is none involving technical and vocational students as hoped, although the subjects offered for them need high metacognitive level and comprehension prior to any skills implemented in students' competency evaluation.

In computer programming, metacognitive skills are needed by students [15]. This is due to the need of the subject that involves pseudocode, algorithm, flow charts and syntax. According to Rahmat et al.(2012), the language of computer programming is a process of translating algorithms to become program codes. Metacognitive skills are needed when translating algorithms into program codes to create the correct and suitable program that fits the need of the question. This process needs program writing skill using the correct syntax, and RBL strategies are expected to be able to help by translating algorithms into program codes. This research is supported by Oroma et al. (2012), as problems arise by writing pseudocodes followed by flow charts, and finally producing program codes. Students face problems in writing the important steps in program writing.

According to Sentance and Csizmadia (2017), problems faced by students when learning programming language include lack of knowledge, lack of comprehension, lack of problem solving skill, no endurance, no involvement in the programming field, no ability in Mathematics, not fluent in reading programs, difficulty in remembering and cannot solve problems independently. Emmanuel (2015) states that students found programming as a new thing, and they need to master the basic programming syntax and structures. This requires strategies to refine teaching and learning methods in order to improve students' academic achievement. RBL strategies are expected to help solve problems of programming structure comprehension and the right syntax writing.

DOI: 10.37200/IJPR/V24I5/PR2020251
Received: 14 Mar 2020 | Revised: 30 Mar 2020 | Accepted: 06 Apr 2020

According to Emmanuel et al. (2015), the percentage of students with academic achievement that show a decline every semester are of students who face difficulty and those who thought of programming as hard [20]–[22]. This is due to students' absence from classes, lack of interest in programming and less effective programming learning strategies. Bruce and McMahon (2002) state that high level of failure in programming could be due to students who are not even able to write easy programming. This is supported by Moström (2011) who states that students not only are unable to write easy programming, but also not able to create programming using algorithms. This shows that learning programming is not something frivolous. Based on a study by Azizah et al. (2017), the topic on Array Data Structure is the most difficult, and students have a hard time coming up with arithmetic expressions. A few topics need to be emphasized and need extra time to be understood. A study by Khaleel et al. (2017) states that students face difficulty to visually present the process that happens in computer memory while writing programming. Thus, programming students receive low grades in examination. If RBL strategies are introduced, students could be able to complete assignments given in a short period of time.

In order to overcome students' weaknesses in programming, students' learning methods or strategies need to be improved to ensure that students are able to enhance their academic achievement aside producing useful programming. RBL strategies are recommended as students are hoped to be able to solve formula and arrange programming well. Sakibayeva (2016) emphasizes that the current research on programming is still insufficient, and requires suitability in the current technological advances. The recent technologies are still used based on traditional approaches, and have lack of interesting factors which cause negative attitudes towards programming among students.

II. METHODOLOGY

This research employs quantitative approach with observational review design. This design is chosen because the researchers want to decide on suitable RBL strategies with students who take the Java Programming course at vocational institutions. The observational method is commonly used in education field as a data collection method. Data in this research were collected through questionnaires administered by the researchers at the research venue. The research population was DVM students who were in their first semester in 2019 with a total of 115 students, thus the suitable number of sample was 92 respondents (Krejcie & Morgan, 1970).

The researcher has utilized a set of questionnaires consisting of 4 parts; the first part is on encoding, the second part is on learning condition, the third part is on retrieval practice and the fourth part is on material. The questionnaires were built based on the memory theory which emphasizes on the stages of memory. The stages consist of three main processes which are encoding, storage and retrieval [27]. The questionnaires were adapted from Karpicke, Butler and Roediger (2009) and Pampori and Malla (2016). Not only that, the instrument was also reviewed by 4 experts; a language expert, an ICT expert and two field experts in order to verify the content and tested items in accordance to suitability of venue and sample. The researchers used 5-point Likert scale [30] of 1 to 5 where 1 = Totally Disagree, 2 = Disagree, 3 = Somewhat Agree, 4 = Agree and 5 = Totally Agree. Cronbach's alpha test was administered to test the items' reliability. The reliability values of item/person were 0.74 and 0.99, and both exceeded the value of 0.6. Bond, Eds and Lawrence (2001) and Bond and Fox (2007) state that values above 0.8

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show that the items have strong reliability and can be used for the real research. Next, the questionnaires were collected to be analysed using the Statistical Package for Social Sciences (SPSS) software. Data were analyzed using descriptive statistics based on the mean score interpretation as in Table 1.

Table 1: Mean Core Analysis

Mean Score	High
3.67 to 5.00	Interpretation
2.34 to 3.66	Moderate
1.00 to 2.33	Low

III. RESEARCH RESULT ANALYSIS

Encoding Activities that Suit Programming Learning

Results obtained were analysed descriptively by acquiring the mean and standard deviation of each item. The results obtained based on the acoustic (listening) constructs are as in Table 2, the analysis based on visual constructs is as shown in Table 3, the analysis based on tactile (touch) constructs is as in Table 4, the analysis based on semantic constructs is as in Table 5 and the analysis based on elaborative construct is as shown in Table 6. According to the mean value, the most suitable encoding method for Java Programming was by acoustic method, which is listening to lectures (mean =4.222) and semantic method which is increasing memory by understanding the meaning of every programming syntax (mean =4.0417).

Table 2: Analysis based on Acoustic (Listening) Construct

No	Acoustic items that suit Java Programming	Mean	SD	Interpretation
1	I listen to lectures given by the lecturers in classes.	4.2222	0.509	High
2	I use music or rhythm to remember any fact to improve my memory.	3.0000	1.210	High
3	I listen again to the recorded audio of the learning process to improve my memory.	2.7083	0.984	Low

Table 3: Analysis based on Visual Constructs

No	Visual items that suit Java Programming	Mean	SD	Interpretation
4	I visualize output that will be produced after writing the programming.	3.9861	0.66062	High
5	I visualize how data are stored in computer memory.	3.6250	.73996	Moderate
6	I visualize how the compiler reads the programming one by one.	3.5417	.78610	Moderate

Table 4: Analysis based on Tactile (Touch) Constructs

No	Tactile items that suit Java Programming	Mean	SD	Interpretation
7	I am able to improve my memory by touching the keyboard to type the programming.	3.4444	.82032	Moderate
8	I am able to improve my memory by writing the programming using pen/pencil.	3.5694	.90112	Moderate

Table 5: Analysis based on Semantic (Giving Specific Meanings) Constructs

No	Semantic items that suit Java Programming	Mean	SD	Interpretation
9	I am able to improve my memory by understanding the meaning of each syntax in programming.	4.041	0.60	High
10	I am able to improve my memory by using mnemonics/ flash cards in remembering programming syntax.	3.388	0.62	Moderate
11	I am able to improve my memory by understanding the concepts in programming.	3.972	0.627	High

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Table 6: Analysis based on Elaborative (Combination of Prior and Current Knowledge) Constructs

No	Elaborative items that suit Java Programming	Mean	SD	Interpretation
12	I am able to improve my memory by combining prior programming knowledge and the current knowledge.	3.814	.6786	High
13	I am able to improve my memory by organizing learning in mnemonic forms to help with the remembering process.	3.444	.6897	Moderate
14	I am able to improve my memory by gaining main ideas in writing programming and new ideas will grow.	3.680	.6884	High

Suitable Programming Learning Activities

There are 11 items for learning condition as recommended in RBL and listed as in Table 7. The results obtained showed that suitable learning condition with Java Programming course was through repetitive practices or independent repetitive tests to improve memory in learning (mean=4.069), followed by group discussion (mean=4.027) and highlighting important points in notes (mean=4.000).

Table 7: Analysis based on Learning Activities

No	Learning activity items that are suitable with Java Programming	Mean	SD	Interpretation
15	Read the programming repetitively until important information is obtained from the programming and learning notes.	3.9861	.68161	High
16	Solve questions in the form of problem solving.	3.7778	.63295	High
17	Use flash cards.	3.2083	.76798	Moderate
18	Rewrite the notes and programming repetitively using own language.	3.6806	.76594	High
19	Discuss in groups.	4.0278	.76861	High
20	Memorise the programming.	3.6111	.84845	Moderate
21	Produce mnemonics (acronyms, rhymes etc.).	3.3611	.71809	Moderate
22	Conclude learning outcomes after learning takes place.	3.4861	.62783	Moderate
23	Do exercises or independent tests repetitively to improve memory in learning.	4.0694	.58926	High
24	Highlight important points in notes.	4.0000	.65003	High
25	Think about the real example.	3.8472	.74417	High

Retrieval Activities that are Suitable with Programming Learning

Table 8: Analysis based on Free Recall Construct– Freely Recalling

No	Free recall items that are suitable with Java Programming	Mean	SD	Interpretation
26	Try recalling by rewriting learnt programming in the form of text.	3.8750	.62658	High
27	Try recalling by sketching concept maps or flow charts of the learnt programming in the form of text.	3.6250	.72067	High
28	Try recalling by memorising verbally the learnt information through speaking.	3.7778	.82602	High

Table 9: Analysis based on Cue Recall Constructs – Recalling via Signals or Hints

No	Cue recall items that are suitable with Java Programming	Mean	SD	Interpretation
29	Try recalling by using signals obtained from notes.	3.7639	.61651	High
30	Try recalling using signals or hints from the exercises given.	3.7083	.68046	High
31	Try recalling by using signals or hints obtained from self-visualization without referring to the signals provided.	3.6528	.75358	Moderate

There are 3 types of constructs for retrieval activities which are free recall, serial recall and cue recall, based on

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Table 8, Table 9 and Table 10, respectively. All constructs are deemed suitable with the Java Programming course as the mean values are almost similar for all recommended items.

Table 10: Analysis based on Serial Recall Constructs – Recalling through Sequence

No	Serial recall items that are suitable with Java Programming	Mean	SD	Interpretation
32	Try recalling step by step top-down in programming writing.	3.8333	.80491	High
33	Try recalling step by step bottom-up in programming writing.	3.4861	.85569	Moderate
34	Try recalling step by step in programming writing in the form of compiler reading.	3.7778	.75475	High

Suitable Materials with Programming Learning

All five items for material utilization in RBL are stated in Table 11. The mean values showed that the use of hardcopy and computer application were both suitable in learning Java Programming course. Both materials were needed by students to enhance memory in programming learning.

Table 11: Analysis based on Materials Used

No	Acoustic items that are suitable with Java Programming	Mean	SD	Interpretation
35	Use video recording.	3.486	.8556	Moderate
36	Use texts/wordlist on paper (hardcopy).	3.847	.7250	High
37	Use diagrams like concept paper (hardcopy).	3.777	.7911	High
38	Use repeated quiz questions (hardcopy).	3.861	.8102	High
39	Use quiz questions based on computer application.	3.819	.8278	High

IV. DISCUSSION

Based on the results analyzed, the acoustic method that was found to be relevant and practical by students in the learning process of Java Programming was listening to lectures in classes compared to listening to music and listening to recorded audio which were seen as irrelevant in the process of comprehension and memory. The mean values for visual learning that were seen quite similar among items showed the output produced and how the compiler read the programming. This was evident that computer programming learning using visual method was suitable through the research done [33], [34] as the use of visual method was relevant and gave positive effects towards learning in addition to 21st century learning which needs exclusivity in education.

Suitable learning condition of computer programming showed the highest mean values by repetitive practices or independent repetitive tests to improve memory in learning (mean=4.069). The relevance of this learning method fits the study done by Hawi and Ph (2014) by giving extra program writing exercises in class which could benefit students to improve their skill at program writing. The suitability of free recall, serial recall and cue recall in computer programming was parallel to each other. This method is almost similar to the methods used in research theory by Xie et al. (2019) where programming learning must start by isolating programming at certain parts, restructure programming and rearrange programming sequentially.

The use of technology in computer programming [36] in teaching and learning is encouraged in realizing the era of industrial revolution 4.0 [38]. The mean values were almost similar in the use of computer application and using hardcopy. This showed that both methods were relevant in computer programming and are still needed in learning

DOI: 10.37200/IJPR/V24I5/PR2020251
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process. According to Jancheski (2017), the use of computer software in learning programming language is able to improve students' academic achievement as the software is able to give immediate feedback, and is able to attract students' interest while revising. Programming learning without using the computer but using paper and pen can also improve students' achievement as in the studies done by Bell, Alexander, Freeman and Grimley (2015) and Faber, Wierdsma, Doornbos and Ven (2017). They suggest interesting activities without using computer software and it positively affects students' achievement.

V. CONCLUSION

Based on the discussion done, it can be concluded that students are encouraged to identify suitable student-centered learning strategies as recommended in the 21st century learning. Students should also realize that learning strategies can be combined to fulfil their priorities. This not only creates an effective environment, but also encouragement to students to achieve success in computer programming.

Conflict of Interest: The authors declare no conflict of interest.

Source of Funding: None

Ethical Clearance: Done research committee

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DOI: 10.37200/IJPR/V24I5/PR2020251
Received: 14 Mar 2020 | Revised: 30 Mar 2020 | Accepted: 06 Apr 2020