

RETRIEVAL-BASED LEARNING IN JAVA PROGRAMMING AND ONLINE APPLICATION

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Abstract

The production of a computer program requires learners to be skilled in basic concepts of programming, to master mathematical formulas, appropriate syntax usage, and in-depth knowledge of programming languages. Typically, in forming a program, students should be able to identify problems, generate algorithms, and convert algorithms into program code according to the syntax. Therefore, a Java programming course requires a student to master cognitive thinking in which, students can recover knowledge by using 'retrieval-based learning' as a basic recollection strategy in learning programming languages. The retrieval-based learning method refers to the following five waves: mnemonic, semantic, episodic context account, map concept, and quiz. Through these five waves, students should be able to implement retrieval method such as producing their own practice questions, quizzes, scan cards, to rewrite learning, repainting of learning, and concept maps. Instructional materials should include formative (topical) assessment, emphasis on text and content requirements, use of open-ended questions (subjective), answers or feedback, repeating exercises, and student achievement estimation. The main contribution is to create a descriptive Java programming lesson, which includes the choice of difficult topics, learning activities, teaching and learning modules, and online learning. However, the initial purpose of this study is to determine the most difficult topics in Java programming, the retrieval based learning used by students, as well as online student learning modules among students in Diploma of Computer Science (Programming) in vocational colleges. The instrument used to collect the data is through an online questionnaire and the findings were analysed using SPSS software by giving the percentage value for each element studied. The sample of the study was 110 students in Diploma of Computer Science (Programming) from four vocational colleges in Malaysia. The findings from the preliminary study conducted by the researcher are presented in detail in this paper.

Keywords: Java programming, Retrieval- based learning.

1. Introduction

Learning Computer programming is a difficult and challenging thing in addition to the lack of strategy in learning it [1, 2]. According to Shinde [3], it is indeed a challenge for programmers to learn the syntax of programming languages that changes often to the current technology. Sentance and Csizmadia [4] stated that teachers and students are facing new knowledge in accordance with the latest technology circulation and also suggest that the appropriate action in facilitating learning is through the phases of identifying problems, writing algorithms, entering comments on programs, generating program codes, as well as running and examining the syntax code of the program. However, students need a strategy to ensure that the creation of the program code is easier to be remembered, understood, and learned. Retrieval-based learning strategy has been identified as an effective strategy but has been forgotten by current researchers [5]. According to Bayes [6], in addition to this is the statement, which explains that retrieval strategy is less used by teachers and students is due to lack of encouragement and motivation in its use. According to Dewan Bahasa dan Pustaka [7], in the field of education, "retrieval" is targeted as a process of recovery and described as the process of retrieving information in long-term memory.

2. Literature Review

In general, retrieval is a person's ability to regain knowledge learned within a period of time. According to Karpicke and Grimaldi [8], in understanding learning, the process of understanding is very necessary especially when involving the process of regaining knowledge and restructuring the knowledge. Students always think that when they know something they should think of ways to evaluate such knowledge by regaining it. When a person is able to regain knowledge in his memory, there is a difference in the ability of a person to use certain signals in retrieving knowledge. Learning using the Retrieval-Based Learning strategy is the learning process to recover the information previously obtained [9]. They also classify Retrieval-based Learning into five waves namely concept map, repeated quiz (frequent quiz), episodic context account, which is the student's existing knowledge, semantic signal and frequent mnemonic.

The first wave element is a concept map produced in a mind map form through texts given without seeing the text. The concept map can be used as one of the most effective techniques in retrieval-based learning [10-12]. The second wave is a repeated quiz. Retrieval quiz activities conducted once a week or every time the learning takes place is to keep students to learn more often. Based on Roediger and Butler [13], students who regularly respond to the quiz will perform better than those who do not [13]. In computer programming, students are also encouraged to do the quiz in the classroom to practice the use of pseudo-code [14]. Karpicke [15] stated that using quizzes as a form of practice, can often improve students memory provided that teachers give feedback for each quiz generated. The third wave of retrieval is the "episodic context account", which is the existing knowledge in students [16], which explains four assumptions; first, students try to get the encoded information; second, retrieval process occurs when students connect the use of the newly learned cue signals to the previously learned cue signals, third, the current and the past signals studied were updated into a new knowledge, and the fourth, the retrieval process that occurs during the test. Basically, the "episodic context

account" describes the process of acquiring and updating the old and new knowledge to recover the new knowledge. The fourth retrieval wave is a semantic signal, which is the clue. The instructions in this section are languages to help understand the text, signs, symbols, images, and visual media, and so on to improve memory. This is supported by van Eersel et al. [17], who stated that most people use semantic cues to improve memory. The last retrieval wave is mnemonic. Mnemonic helps students to retrieve learning outcomes using their imagination. Mostafa and El Midany [18] stated that their research conducted using mnemonic showed that it could improve memory and students' achievement scores. This is supported by Marzban and Amoli [19] who stated that mnemonic strategies using visuals and pictures help students to memorize information within a short period of time. However, the mnemonic method needs to be done repeatedly to improve students' memory. Agarwal et al. [11] stated that the implementation of Retrieval-Based Learning in the classroom is based on the students' own learning activities as they need to produce their own practice questions, quiz questions, flashcards, to rewrite their learning, to redraw their learning and their own concept map. This shows that the activities that students need to do should be mandatory learning activities to practice the Retrieval-Based Learning method in learning. There are six methods used by Agarwal et al. [20] in implementing this retrieval strategy.

The best method to implement retrieval practice is by using the best form of a questionnaire, and teachers should often provide retrieval training to improve learning [21]. Additionally, it is necessary to provide feedback or correct answers to improve metacognitively as well as to add a method in measuring the level of students' knowledge enhancement. This shows that the current retrieval strategy is supposed to provide a form of a question that is appropriate to the actual assessment and provides a method for measuring students' knowledge before and after the retrieval practice is implemented to prove that this strategy has the best impact on learning. Littrel-Baez et al. [21] used the six recommendations to maximize the effectiveness of retrieval practice in content classrooms.

Karpicke and Grimaldi [8] and Karpicke and Smith [22] explained that retrieval-based learning can be done in many ways and he has tested the traditional concept map and retrieval concept map strategy in the study. Among the methods used in his study is to differentiate students' achievement using retrieval concept map strategies and the use of traditional concept maps. He expects the use of traditional concept maps to be more helpful in learning, but a study has shown that the retrieval strategy improves learning. Blunt and Karpicke [10] also explained that students usually create concept maps while they are looking at the material they are trying to learn. In this situation, the use of concept maps serves as learning activities. This study compares the effectiveness of using concept maps with the use of the format of the paragraph. The result shows that the use of concept maps during retrieval learning activities is more effective. According to the study by Roediger and Karpicke [23], in order to study the learning by retrieval, a test should be conducted without assessment. The study involved "Learning-Learning" (BB) and "Learning-Test" (BU). The "Learning-Learning" shows that students only learn repeatedly while "Learning-Test" further demonstrates that the students learn then tests the learning level with self-test. This study looks at the retrieval level of students' memory using two types of learning styles. The results show that "Learning-Learning" (BB) ensures that memory retention is only five minutes when reviewing the learning but after a

week the memory retention will be less. However, if “Learning-Test “(BU) is used, the retention process on memory can remain longer; within one week.

3. Java Programming Course

Java is an object-oriented program that helps programmers in supporting the construction of internet-based platforms and web services [24]. Java is also one of the most popular programming languages today [24, 25]. As Java programming language is one of the most widely used and supports internet-based platforms, it has become the main essential programming language to be learned. Mow [2] studied that there are various mistakes made by students in learning Java programming language but Java is still a choice for a programming language that should be learned by computer science students.

Therefore, through the Diploma Program of Computer Science (Programming), students are exposed to several courses provided by BPTV, from the Malaysian Vocational Certificate (SVM) until the Malaysian Vocational Diploma (DVM). The Java Programming Course consists of Programming I, Programming II, and Programming III, offered to DVM students in the first, second, and third semesters. This study focuses more on the Programming Course I, which consists of several important topics, including basic programming language, data type, variable and operator, control statement, method, array base, 'string manipulation', as well as 'class and object'. The curriculum production is based on the Vocational College Standard Curriculum (KSKV), which is a vocational education and curriculum in KV that complies with the National Occupational Skill Standards (NOSS) and the Malaysian Qualifications Agency (MQA). The Diploma in KV has been awarded a temporary accreditation (MQA-01) from the Malaysian Qualifications Agency (MQA) and other internationally accredited ministries and agencies [26].

4. Computer Science Program (Programming) at Vocational College

The establishment of Vocational College starts from the upgrading of technical secondary schools under the Technical and Vocational Education Division (BPTV) of the Ministry of Education (MOE). A total of 80 vocational colleges offer 36 programs to meet the country's skilled manpower needs [27]. One such program includes the Database Management System and Web Application Program that started in 2013. Initially, only four KV were pioneers to run this program, which are KV Shah Alam, KV Kulim, KV Sungai Petani, and KV Trade. In 2015, another five vocational colleges offer the program namely KV Jasin, KV Sepang, KV Kuala Selangor, KV Seberang Perai, and KV Gerik. This makes the total number of vocational colleges offering this program is nine throughout Malaysia. However, in 2018, the program name was changed from the Database Management System and Web Application Program to the Diploma Program of Computer Science (Programming) (Unit Perancang Ekonomi, J. P. M.).

5. Research Objectives

The purpose of this initial study is to determine the extent of Java programming mastery among students of the Diploma Program in Computer Science (Programming) at Vocational Colleges (KV). The study focuses on topics considered to be difficult as basic in arrays, one-dimensional arrays, and two-dimensional arrays; the 'string' declaration, the 'string' function, generating classes

and objects and class calls and class 'overloading'. The study was designed and developed to answer the following questions:

- What is the most difficult topic in Java programming?
- Does retrieval-based learning used by students improve the difficulty of learning Java programming language?
- Is the retrieval-based learning element implemented in the student learning activity module online?

6. Research Methodology

A total of 110 students of the Diploma Program in Computer Science (Programming) from three vocational colleges were involved in this initial study covering 50% of the first-year Diploma and 50% of second-year Diploma students. Four samples were selected from nine KV in Malaysia that offer this course namely KV Trade, KV Jasin, KV Sepang, and KV Sg Petani. The participants were one of the groups in the actual population of the study and were selected through random sampling. The research instrument is a questionnaire using a four-point scale, which consisted of five parts, i.e., respondents' demographics, Java programming topics, which were considered to be difficult, 'retrieval-based learning' technique is used by students, 'retrieval-based learning' elements applied in modules, as well as the use of online learning activities.

7. Findings

7.1. Difficulty level of Java programming module at vocational colleges

Based on the scores for the questionnaire in Table 1, it shows that more than 30% of students state that the "Basic of the array", "Manipulation string" and "Classes and object" topics are difficult to understand. This is because the number of hours of learning for the topic is only 5 hours a week compared to other topics that take 10 hours for 2 weeks. This refers to the "course outline" provided by the KPM (Ministry of Education), BPTV (Technical and Vocational Education Division).

7.2. Use of retrieval-based learning method at vocational college

The analysis conducted on student learning methods using the "Retrieval-based Learning" strategy found that more than 40% of students did not use the "Retrieval-based Learning" strategy when reviewing the lesson. Detailed information on the elements evaluated on student learning methods is shown in Table 2.

7.3. Use of retrieval-based learning elements to the Java programming module at vocational colleges

The analysis conducted on the use of "Retrieval-based Learning" strategy in the Java Programming module found that more than 40% of students disagreed using the "Retrieval-based Learning" strategy when reviewing the lesson. Detailed information on the elements assessed in the use of "Retrieval-based Learning" in Java Programming modules is shown in Table 3.

7.4. Use of online learning on the Java programming module at vocational colleges

The analysis conducted on the use of online learning in the Java Programming module found that more than 40% of students disagreed using the "Retrieval-based Learning" strategy when reviewing the lesson. Refer to Table 4.

Table 1. Percentage of students on student learning methods using retrieval-based learning element on Java programming.

Difficulty level of Java programming by topic	Strongly disagree		Disagree		Agree		Strongly agree	
	N	(%)	N	(%)	N	(%)	N	(%)
I find it difficult to understand the topic "Basic of the latest programming language" in programming.	47	42.7	47	42.7	15	3.6	1	0.9
I find it difficult to understand "data types, variables and operators" in programming.	55	50	41	37.3	13	11.8	1	0.9
I find it difficult to understand the "control statement" in programming.	33	30	46	41.8	30	27.3	1	0.9
I find it difficult to understand the "method" in programming.	17	15.6	43	39.4	39	35.8	10	9.2
I find it difficult to understand the "basic of array" in programming.	3	2.7	41	37.3	25	22.7	41	37.3
I find it very difficult to understand "string manipulation" in programming.	8	7.3	30	27.3	34	30.9	38	34.5
I find it difficult to understand "classes and objects" in programming.	11	10	36	32.7	22	20	41	37.3

*Total N=110

Table 2. Percentage of students on student learning methods using retrieval-based learning element on Java programming.

Student learning method using retrieval-based learning element	Strongly disagree		Disagree		Agree		Strongly agree	
	N	(%)	N	(%)	N	(%)	N	(%)
I use the method of answering my self-generated training questions.	39	35.5	40	36.4	29	26.4	2	1.8
I used the method of answering my self-generated quiz questions.	36	32.7	49	44.5	21	19.1	4	3.6
I used my self-generated flash card.	33	30	66	60	9	8.2	2	1.8
I used the method of rewriting learning outcomes after graduation.	21	19.1	46	41.8	35	31.8	8	7.3
I used the method of reproducing learning outcomes after graduation.	26	23.6	55	50	27	24.5	2	1.8
I used the method of producing my own concept map after teaching.	25	22.9	54	49.5	24	22	6	5.5

*Total N=110

Table 3. Percentage of students on the use of retrieval-based learning elements on Java programming modules.

Elements of "retrieval-based learning" on Java programming modules	Strongly disagree		Disagree		Agree		Strongly agree	
	<i>N</i>	(%)	<i>N</i>	(%)	<i>N</i>	(%)	<i>N</i>	(%)
There is a formative (topical) assessment of the Java programming module provided by the teacher.	16	14.7	27	24.8	58	53.2	8	7.3
There is an emphasis on the text and content requirements provided.	9	10.2	31	27.8	59	53.7	10	8.3
There is an open-ended (subjective) questions on the available modules.	10	8.3	41	28.4	49	54.1	9	9.2
There is an answer or feedback on the module provided.	7	7.2	38	37.6	51	45	13	8.3
Modules have repeated exercises to establish memory.	10	6.4	34	34.9	51	46.8	14	11.9
The module provides a budget for achieving student metacognitive achievement.	13	9.2	54	31.2	40	46.8	3	12.8

Table 4. Percentage of students on the use of online learning on Java programming modules.

Use of online learning on Java programming modules	Strongly disagree		Disagree		Agree		Strongly agree	
	<i>N</i>	(%)	<i>N</i>	(%)	<i>N</i>	(%)	<i>N</i>	(%)
I often complete writing my assignment via online.	13	11.8	54	49.1	40	36.4	3	2.7
I often do online learning discussions.	11	10	39	35.5	50	45.5	10	9.1
I often present my assignment online.	10	9.1	61	55.5	35	31.8	4	3.6
I often answer quiz questions, training and online tests.	8	7.3	59	53.6	37	33.6	6	5.5
I often do field surveys and get data online.	5	4.5	26	23.6	58	52.7	21	19.1

8. Discussion

The results of this study showed that the students at vocational colleges who attended the Diploma Program in Computer Science (Programming) gave an impression that the easiest topic for Java Programming Course was "Basic of the Latest Programming Language" (12.7%), "data types, variable and operators" (28.2%), and "control statement" (45%), while topics that are hard to understand are "Basic of arrays" (60%), "string manipulation" (65.4%), and "class and object" (57.3%). This is because the percentage of difficulty on the topics is over 50% as a whole.

Based on the preliminary study to determine the learning method of students using the "retrieval-based learning" strategy, the students at vocational colleges who attended the Diploma Program in Computer Science (Programming) gave an impression that retrieval-based learning methods were not used previously. Students responded that 71.9% of students did not produce their own practice questions, 77.2% of students did not produce their own quiz questions, 90% of

students did not use flash cards, 60.9% rewritten learning outcomes, 73.6% recalled learning outcomes, and 72.4% as a "retrieval-based learning" strategy in their learning. This may be because students are not exposed to learning retrieval-based learning at school.

The next preliminary study is concerned with the Java Programming learning modules used by vocational college students. The researcher wanted to evaluate whether the "retrieval-based learning" element is implemented in an existing module or not. The questionnaire found no formative evaluation on the module as much as 35.5%, there was no emphasis on the text and content requirements (38%), there was no use of subjective questions (36.7%), there was no answer in the module as much as 34.8%, which is repeated (41.3%) and does not provide access estimates of 40.4%. this may be due to the construction of a non-centric module where lecturers build modules according to their respective vocational colleges.

For the initial study related to online learning, 60.9% of students did not complete online writing, 45.5% of students did not conduct online learning discussions, 64.6% of students did not present their online assignments, 60.9% of students did not answer quiz questions, online training and testing, and only 28.1% of students did not conduct field studies and obtain data or information online. This may be due to the restriction of limited internet access services at vocational colleges and the lack of student exposure on the use of online applications as a whole.

This "retrieval-based learning" strategy is designed to help students master the Java Programming language with confidence and fluency when learning them. Apart from that, "retrieval-based learning" also gives students exposure to learning methods easily and quickly and does not take long to master a learning topic. It is hoped that the preliminary study findings of this "retrieval-based learning" will help vocational college students who take the Java Programming course to enhance their achievement and mastery in programming languages in the future. Through learning strategies using "retrieval-based learning", researchers are confident that vocational college students can be part of the skilled workforce produced by vocational colleges to be more qualified and competent as well as to be a competitor to national development towards the Industrial Revolution 4.0.

9. Conclusion

Retrieval-based Learning technique used by students of Computer Science Programs (Programming) at vocational colleges who follow the subject of Java Programming should be developed in line with the aim of the subject. The preliminary findings have found that there are some difficult topics and not yet mastered by students who take the Java Programming course. Hence, appropriate efforts to improve the level of knowledge and memory of the students so as to produce a program should be done. By diversifying learning activities and the use of online learning modules can increase the level of student memory and increase the level of student knowledge. The findings also show that by using the Retrieval-based Learning strategy, students' performance can be enhanced if they are exposed to appropriate and continuous training and activities either informally or formally particularly in the Java programming learning and facilitating.

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