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RESEARCH-BASED LEARNING: EFFECTS ON THE METACOGNITIVE AWARENESS OF SENIOR HIGH SCHOOL STUDENTS

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Abstract

This research study assessed the effects of research-based learning (RBL) on the metacognitive awareness of senior high school (SHS) students, specifically metacognitive knowledge and metacognitive regulation, and the correlation between their subcomponents. Fifty-six (56) Grade 12 students who have taken research subjects were obtained as respondents using purposive sampling. The respondents answered a 52-item metacognitive awareness inventory (MAI) with 17 items on metacognitive knowledge and 35 items on metacognitive regulation. Findings show that RBL developed a high level of conditional, procedural, and declarative knowledge among SHS students. The learning approach also developed a very high level of debugging strategies, and a high level of planning, information management system, evaluation, and comprehension monitoring. Furthermore, there is a weak or a moderately significant positive correlation between some subcomponents of metacognitive knowledge and metacognitive regulation as the effect of RBL. In conclusion, RBL has a considerable impact on the metacognitive awareness subcomponents of Grade 12 students.

Keywords: metacognitive awareness inventory (MAI), metacognitive knowledge, metacognitive regulation, research-based learning; senior high school (SHS)

Introduction

In the Philippines, research subjects are offered in the Senior High School (SHS) curriculum of the K-12 program as applied track subjects. These subjects are offered in both Grade 11 and 12 levels. These subjects include Practical Research 1 (PR1), Practical Research 2 (PR2), and Inquiries, Investigations and Immersion (III). It is evident that SHS curriculum is a research-based learning (RBL).

It is a learning model that enables the students to analyze, synthesize and evaluate their integration of knowledge and its application in real life (Susiani et al., 2018). RBL is also characterized as an authentic learning that used problem-solving, cooperative learning, hands-on, and inquiry-based discovery approach with a basis on constructivist philosophy (Poonpan & Suwanmankha, 2005; Amelia, 2018; Susiani et al., 2018). Research-based learning engages students to formulate questions, generate hypotheses, search for related literature, plan and execute methods such as collection and analysis of data, and interpretation of findings, draw conclusion/s, report and present results (Poonpan & Suwanmankha, 2005; Susiani et al., 2018).

The benefits of RBL as a learning approach are the following: improves student motivation and enthusiasm; develops critical, problem-solving, and analytical-thinking skills; promotes the student's active learning and academic performance; allows the students to discover the significance of the knowledge and skills they learned; molds the learner's abilities and skills necessary for professional and personal life (Arora et al.,2017); and improves the skills in communication, leadership, and management (Sumbawati & Anistyasari, 2018).

Although there are studies on the effects of RBL on the learning process and academic performance of students, there are no research studies about its effects to the metacognition of the learners. Metacognition has been considered as a significant factor on the success of learning among students (Savira & Laksmiwati, 2017). Metacognition is the knowledge or awareness, and the ability of the person to monitor and regulate one's own cognition, knowledge, processes, and affective states (Balcikanli, 2011; Cihanoglu, 2012). It has been reported that students who are metacognitively aware can regulate and engage their learning process enthusiastically. Therefore, these learners are motivated and have high self-satisfaction (Cihanoglu, 2012). Furthermore, metacognition is involved in all learning phases which include understanding new concepts or information and in problem solving (Kallio et al., 2017).

Metacognition has two basic components, which are knowledge of cognition and regulation of cognition (Balcikanli, 2011; Feiz, 2016; Limueco & Prudente, 2018). Knowledge of cognition, or metacognitive knowledge, is the individual's knowledge of their own cognition (Balcikanli, 2011; Feiz, 2016). Metacognitive knowledge has the following subcomponents: declarative knowledge, procedural knowledge, and conditional knowledge (Balcikanli, 2011; Feiz, 2016; Limueco & Prudente, 2018). Declarative knowledge refers to the person's knowledge of his or her cognitive processes such as abilities, skills, and intellectual resources. Procedural knowledge refers to the person's knowledge on how to apply or use one's own cognitive process, and implement it using strategies. Conditional knowledge refers to the person's knowledge of condition and circumstances and about when and why to use learning procedures or strategies (Schraw & Dennison, 1994; Feiz, 2016).

On the other hand, regulation of cognition, or metacognitive regulation, refers to the actions that facilitate the learning process (Balcikanli, 2011; Feiz, 2016). It is composed of five (5) subcomponents that include planning, information management strategies, comprehension monitoring, debugging strategies, and evaluation (Feiz, 2016; Limueco & Prudente, 2018). Planning involves selecting appropriate learning procedures (strategies) and cognitive processes (Young & Fry, 2008). Information Management Strategies involves the skills and the learning procedures (strategies) in processing information more effectively

(Schraw & Dennison, 1994). Comprehension monitoring refers to the awareness of one's own learning procedures or strategies used or performed (Schraw & Dennison, 1994; Balcikanli, 2011). Debugging strategies comprise of learning procedures (strategies) that can be used for correcting errors on comprehension and performance (Schraw & Dennison, 1994). The last subcomponent is evaluation, which refers to the appraisal of the effectiveness of performance and regulatory processes of one's own learning (Schraw & Dennison, 1994; Balcikanli, 2011).

Because metacognition is a significant factor in all phases of learning, it is very important to assess this among students. Apparently, this will be the first report to determine the metacognitive awareness of senior high school students as an effect of research-based learning they obtained from the three (3) research subjects/courses. The findings of this research study will be of great help to educators to evaluate RBL as a learning approach, not on the academic achievement which was already reported by several research studies, but on metacognitive awareness which has not been reported. This will promote or negate RBL as a learning strategy that improves knowledge of cognition or regulation of cognition.

This research study was conceptualized to assess the effects of research-based learning (RBL) on the metacognitive awareness of senior high school (SHS) students. Specifically, this study aimed to determine the effects of RBL on the metacognitive knowledge and metacognitive regulation of SHS students, and the correlation between their subcomponents as an effect of RBL.

Method

This quantitative research used a cross-sectional study design wherein it assessed the effects of research-based learning (RBL) on the metacognitive awareness, specifically metacognitive knowledge and metacognitive regulation, of senior high school (SHS) students.

The participants of the study included fifty-six (56) Grade 12 students who already took the applied track subjects' Practical Research 1 and Practical Research 2, and who are currently taking up Inquiries, Investigations, and Immersion (III) subject. Purposive sampling was used to obtain the 56 respondents.

The 52-item metacognitive awareness inventory (MAI) developed by Schraw and Dennison (1994) was used to measure the student's knowledge of cognition (metacognitive knowledge) and regulation of cognition (metacognitive regulation). MAI measures metacognitive knowledge that includes 8 items on declarative knowledge (DK), 4 items on procedural knowledge (PK), and 5 items on conditional knowledge (CK). On the other hand, MAI determines metacognitive regulation that includes 7 items on planning (P), 10 items on information management strategies (IMS), 7 items on comprehension monitoring (CM), 5 items on debugging strategies (DS) and 6 items on evaluation (E).

Statistical mean, percentage score, and standard deviation were computed using Microsoft Excel to descriptively analyze the results of metacognitive awareness inventory (MAI). Pearson's correlation analysis between the subcomponents of metacognitive knowledge and metacognitive regulation was performed using Statistical Package for the Social Science (SPSS) Version 22 (IBM Corporation, 1 New Orchard Road Armonk, New York, United States).

The ranges of percentage scores on the student response in MAI are as follows: Very High (81% - 100%), High (61% - 80%), Medium (41% - 60%), Low (21% - 40%), and Very Low (< 21%) (Lusiana & Andari, 2019).

The strength of correlation was based on the guide proposed by Evans (1996) for the absolute value of r: 0.00 – 0.19 (very weak); 0.20 – 0.39 (weak); 0.40 – 0.59 (moderate); 0.60 – 0.79 (strong); and 0.80 – 1.0 (very strong).

Findings and Discussion

Table 1 shows the mean, maximum and percentage scores, and standard deviations of metacognitive awareness subcomponents of Grade 12 students. All metacognitive knowledge subcomponents have high percentage scores with the highest percentage score on conditional knowledge (CK), followed by procedural knowledge (PK), and declarative knowledge (DK) with the lowest score. Among metacognitive regulation subcomponents, only the debugging strategies (DS) has very high percentage score, and all other subcomponents have high percentage scores.

Table 1. Mean, maximum, and percentage scores, and standard deviations of metacognitive awareness subcomponents of senior high school (SHS) students

	Mean Score	Maximum Score	Percentage Score (%)	Standard Deviation
Declarative Knowledge (DK)	4.84	8	60.50	1.67
Procedural Knowledge (PK)	2.88	4	72.00	0.88
Conditional Knowledge (CK)	3.96	5	79.20	1.03
Planning (P)	5.52	7	78.86	1.46
Information Management System (IMS)	7.45	10	74.50	1.64
Comprehension Monitoring (CM)	5.09	7	72.71	1.56
Debugging Strategies (DS)	4.46	5	89.20	0.83
Evaluation (E)	4.38	6	73.00	1.34

Table 2 shows the Pearson correlation between the subcomponents of metacognitive awareness. There is a weak significant positive correlation of DK with PK, CK, CM, and E; PK with IMS; CK with P, DS, and E; P with CM; and IMS with DS. However, there is a moderately significant positive correlation of PK with CK and P; CK with CM; and CM with E. The results show that as one metacognitive subcomponent increases, the other subcomponent also increases in a weak or moderate level.

Table 2. Pearson correlation between the subcomponents of metacognitive awareness.

		DK	PK	CK	P	IMS	CM	DS	E
Declarative Knowledge (DK)	r Sig	1	0.371** 0.005	0.283* 0.035	0.153 0.259	0.139 0.305	0.277 * 0.039	0.015 0.910	0.327* 0.014
Procedural Knowledge (PK)	r Sig		1	0.461** 0.000	0.434** 0.001	0.306* 0.022	0.247 0.066	0.131 0.335	0.257 0.056
Conditional Knowledge (CK)	r Sig			1	0.315* 0.018	0.085 0.532	0.432** 0.001	0.318* 0.017	0.327* 0.014
Planning (P)	r Sig				1	-0.143 0.292	0.368** 0.005	0.113 0.408	0.140 0.304
Information Management System (IMS)	r Sig					1	0.055 0.687	0.286* 0.033	0.220 0.103
Comprehension Monitoring (CM)	r Sig						1	0.135 0.319	0.399** 0.002
Debugging Strategies (DS)	r Sig							1	0.232 0.085
Evaluation (E)	r Sig								1

*Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

The high percentage scores of senior high school (SHS) students on conditional knowledge (CK), procedural knowledge (PK), and declarative knowledge (DK) are contributed by the learning activities they experienced in research subjects. CK refers to the knowledge of the person about why and when to use strategies or learning procedures. PK refers to how strategies or learning procedures can be used or implemented. DK refers to what factual knowledge the learner needs to acquire before it can be used in cognitive process (Schraw & Dennison, 1994; Feiz, 2016). In the learning competencies of research subjects, students learned what factual knowledge is needed, and when, why, and how to use strategies or learning procedures during their understanding of the following topics: design a research project related to daily life; state research questions; and choose appropriate qualitative and quantitative research designs, sampling, data collection, and analysis.

Very high score on debugging strategies (DS), and high scores on planning (P), information management system (IMS), evaluation (E), and comprehension monitoring (CM) have been obtained possibly because the curricula of research subjects engage the learners to competencies and activities that will enhance or strengthen their learning and memory, or the cognitive regulation skills. Metacognitive regulation, as enhanced by RBL, refers to the control of the learner to its own cognitive processing (Kallio et al., 2018). In RBL, students were able to regulate cognition by the prediction of an action or an event, monitor ongoing research activities, evaluate the results of their actions and strategies, test the real outcomes, coordinate and control attempts in solving and answering the problems.

The findings on weak or moderately significant positive relationships in some subcomponents of metacognitive knowledge and metacognitive regulation indicate an effect by RBL. According to Imafuku et al. (2015), research activity contributes a high-impact on the skills and attitudes of learners through a student-centered, and inquiry-based learning. RBL encourages the students to be actively involved in their learning process, thus shaping their scientific attitudes, through problem-solving, authentic learning, cooperative learning, and inquiry-discovery approach (Amelia, 2018). RBL was able to affect the metacognition of SHS students, which according to Dulger & Bekiroglu (2018), is a higher-order mental process that requires skills and strategies in solving a problem. In research, students are tasked to pose research questions or investigative problems, or to state the objectives or purposes of the study, in which they are required to answer, address, or solve through qualitative or quantitative methods. It is suggested that there is a moderate positive correlation between the learner’s metacognitive awareness and their problem solving skills (Dulger & Bekiroglu, 2018).

RBL also teaches the students on how to take new information and utilize them in different ways in real life. Learning research can engage the students to integrate or incorporate various learning principles (Khuana et al., 2017). Aside from integrating research, RBL enables the students to learn the role of research, understand the generic research skills and processes, foster environmental research, and promote inquiry-based activity. These components of RBL, based on the report of Khuana et al. (2017), support the metacognition of SHS students. RBL supports the learners’ thinking about their own learning and mental processes. As a result, metacognition is developed and becomes an important factor that improves self-regulation, critical thinking and problem solving skills, which are all directly enhanced by research activities.

If learners developed their metacognitive knowledge and metacognitive regulation, they become high-performing in the academics (Akman & Alagoz, 2018). It was found out that the subcomponents of metacognitive knowledge and metacognitive regulations have positive relationship with academic achievement. These findings are based on the observations that students with enhanced metacognitive awareness can perform academically better and strategically think more than the learners with weak metacognitive awareness. RBL is an applicable learning approach to improve and develop metacognitive awareness, because research provides opportunities and experiences for students to integrate theoretical concepts learned inside the classroom and apply them in practical activities. As a result, the learning process becomes more meaningful, thus engages the interest of students to search for knowledge (Granjeiro, 2019). Along with the learning process engaged by RBL, metacognition comes in as an important factor for the success of that learning. Metacognition allows learners to plan, adjust, and monitor their learning process effectively (Savira & Laksmiwati, 2017).

It was also reported by Amelia (2018) that research improves or enhances the quality of learning through activities such as formulating research problems, implementing methods or procedures, solving problems, and disseminating results. RBL probably improves metacognition with these learning opportunities or experiences, because it allows the learners to use different thinking skills. With these opportunities or experiences, students become aware of their knowledge, and they know why, when, where, and how to utilize this knowledge to different learning situations (Tok et al., 2010). The findings of this study suggest that RBL promotes metacognitively aware individuals. Based from Tok et al. (2010), ineffective learning strategies result to weak metacognitively aware learners, which are students that have undeveloped analytical and problem solving skills to address classroom challenges. Furthermore, poor metacognition results to non-autonomous learners, which are individuals that can't control, plan or monitor their own learning strategies and progress. This study suggests that RBL is one the learning approaches that supports and enhances the metacognition of learners, both in knowledge of cognition and regulation of cognition, specifically among SHS students.

Conclusion

Research-based learning (RBL) is a learning approach that develops high conditional, procedural, and declarative knowledge among senior high school (SHS) students. RBL also develops a very high level of debugging strategies, and a high level of planning, information management system, evaluation, and comprehension monitoring among the learners. Furthermore, there is a weak or a moderately significant positive correlation between some subcomponents of knowledge of cognition (metacognitive knowledge) and regulation of cognition (metacognitive regulation) as the effect of RBL.

References

Akman, O., & Alagoz, B. (2018). Relation between metacognitive awareness and participation to class discussion of university students. *Universal Journal of Educational Research, 6*(1), 11-24.

Amelia, T. (2018). The implementation of research-based learning on biology seminar course in Biology Education Study Program of FKIP UMRAH. *IOP*

Conference Series: Materials and Engineering. 335. Retrieved from https://iopscience.iop.org/article/10.1088/1757-899X/335/1/012095/pdf.

Arora, V.P.S., Saxena, P., & Gangwar, N. (2017). Project based learning (PBL) and Research based learning. In Manna, M.S. (ed.), *Higher education faculty career orientation and advancement: Curriculum based on primary research*. (pp. 76-91). Centre for Education Growth and Development.

Balcikanli, C. (2011). Metacognitive awareness inventory for teachers (MAIT). *Electric Journal of Research in Educational Psychology*, *9*(3), 1309-1331.

Cihanoglu, M.O. (2012). Metacognitive awareness of teacher candidates. *Procedia – Social and Behavioral Sciences, 46*(2012), 4529-4533.

Dulger, Z., & Bekiroglu, F.O. (2018). Examination of students' metacognitive awareness and their physical problem solving strategies. *The Eurasia Proceedings of Educational & Social Sciences*, *9*, 59-63.

Evans, J.D. (1996). *Straightforward statistics for the behavioral sciences*. Pacific Grove, CA: Brooks/Cole Publishing.

Feiz, J.P. (2016). Metacognitive awareness and attitudes toward foreign language learning in the EFL context of Turkey. *Procedia – Social and Behavioral Sciences*, *232*, 459-470.

Granjeiro, E.M. (2019). Research-based teaching-learning method: a strategy to motivate and engage students in human physiology classes. *Advances in Physiology Education*, *43*, 553-556.

Imafuku, R., Saiki, T., Kawakami, C., & Suzuki, Y. (2015). How do students' perceptions of research and approaches to learning change in undergraduate research? *International Journal of Medical Education*, *6*, 47-55.

Kallio, H., Virta, K., Kallio, M., Virta, A., Hjardemaal, F.R., & Sandven, J. (2017). The utility of the metacognitive awareness inventory for teachers among in-service teachers. *Journal of Education and Learning*, *6*(4), 78-91.

Kallio, H., Kallio, M., & Virta, K. (2018). Modelling the components of metacognitive awareness. *International Journal of Educational Psychology, 7*(2), 94-122.

Khuana, K., Khuana, T., & Santiboon, T. (2017). An instructional design model with the cultivating research-based learning strategies for fostering teacher students' creative thinking abilities. *Educational Research and Reviews, 12*(15), 712-724.

Limueco, J., & Prudente, M. (2018). Predicting progression trends of scientific reasoning skills and metacognitive awareness among secondary level students. DLSU Research Congress. Retrieved from https://www.researchgate.net/publication/327818460_Predicting_Progression_Trends_of_Scientific_Reasoning_Skills_and_Metacognitive_Awareness_among_Secondary_Level_Students.

Lusiana, R., & Andari, T. (2019). Developing an Algebra textbook based on problem solving to improve student' learning achievement. Al-Jabar. *Jurnal Pendidikan Matematika, 10*(2), 293-306. Retrieved from https://www.researchgate.net/publication/338135906_Developing_an_Algebra_Textbook_Based_on_Problem_Solving_to_Improve_Student'_Learning_Achievement.

Poonpan, S., & Suwanmankha, S. (2005). Indicators of research-based learning instructional process: A case study of best practice in a primary school. Paper presented at the AARE Annual Conference. Retrieved from https://www.aare.edu.au/data/publications/2005/poo05581.pdf.

Savira, S.I., & Laksmiwati, H. (2017). Self-assessment to assess student's performance in academic task to improve metacognition. *Advances in Social Science, Education and Humanities Research*, *118*, 80-86.

Schraw, G., & Dennison, R.S. (1994). Assessing Metacognitive Awareness. *Contemporary Educational Psychology*, *19*, 460-475. Retrieved from https://services.viu.ca/sites/default/files/metacognitive-awareness-inventory.pdf.

Sumbawati, M.S., & Anistyasari, Y. (2018). The impact of research-based learning on student's academic performance and motivation. *IOP Conference Series: Materials Science and Engineering*, *296*(2018). Retrieved from https://iopscience.iop.org/article/10.1088/1757-899X/296/1/012043/pdf

Susiani, T.S., Salimi, M., & Hidayah, R. (2018). Research based learning (RBL): How to improve critical thinking skills? *SHS Web of Conference*, *42*(2018). Retrieved from https://www.shs-conferences.org/articles/shsconf/pdf/2018/03/shsconf_gctale2018_00042.pdf

Tok, H., Ozgan, H., & Dos, B. (2010). Assessing metacognitive awareness and learning strategies as positive predictors for success in a distance learning class. *Mustafa Kemal University Journal of Social Science Institute*, *7*(14), 123-134.

Young, A., & Fry, J.D. (2008). Metacognitive awareness and academic achievement in college students. *Journal of the Scholarship of Teaching and Learning*, *8*(2), 1-10.