Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

ISSN 1989 – 9572

DOI: 10.47750/jett.2023.14.03.025

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Ruby L. Mamauag[1]

Journal for Educators,Teachers and Trainers, Vol. 14 (3)

https://jett.labosfor.com/

Date of reception: 05 Feb 2023

Date of revision: 12 Mar 2023

Date of acceptance: 01 Apr 2023

Ruby L. Mamauag (2023). Probing Students' Self-Efficacy, Creativity and Performance in Biology through Metacognitive Blogging.*Journal for Educators, Teachers and Trainers*,Vol. 14(3). 210-220.

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Probing Students' Self-Efficacy, Creativity and Performance in Biology through Metacognitive Blogging

Ruby L. Mamauag[1]
[1]Isabela State University, Cabagan, Isabela
Email: ruby.l.mamauag@isu.edu.ph

ABSTRACT
The purpose of this study was to investigate, in two different fourth year high school biology classes, the impact that using a metacognitive blogging teaching approach had on students' overall performance in the subject of biology, as well as their sense of self-efficacy and their creative potential. The research design that was utilized was a two-group, pretest-posttest quasi-experimental design. Both metacognitive and traditional teaching strategies were utilized during the course of the study. The purpose of the path analysis was to determine how the various teaching strategies impacted the students' sense of self-efficacy, creativity, and overall performance in Biology. According to the findings of the research, the teaching method has the most significant impact on biology performance, while self-efficacy also has a significant impact on biology performance. The study also found that creativity has a significant connection to the teaching method, but that creativity only has an indirect impact on biology performance. The relationship between creative ability and self-efficacy is not particularly strong. According to the results of the research, using a metacognitive blogging teaching style is a successful method for boosting students' performance in Biology as well as their creative output. As a consequence of conducting a route analysis, the emergent framework for teaching biology through the use of metacognitive blogging reveals these links. For the purpose of improving learners' metacognition, it could be beneficial to conduct additional research on the usage of blogs as a metacognitive tool. In addition, researchers might look at other factors that, if improved, might result in higher levels of self-efficacy, creativity, and academic performance among students studying Biology.

Keyword: metacognitive blogging , self-efficacy , creativity , performance in Biology

INTRODUCTION

In recent decades, there has been a significant uptick in the number of efforts focused on enhancing science education. This points to the fact that there is a crisis that is worsening in the field of science education. To further the goal of bettering the teaching of science, various constructivist-based pedagogical innovations have been conceived of and put into practice (Cakir, 2008). The meaning of the objective to improve scientific education has been to make the students active participants in their own learning, with the final goal of empowering them to become dynamic and productive citizens who are able to compete according to the requirements of a changing world. In this context, the Partnership for 21st Century Skills, also known as P21, was established as a reaction to the growing need to generate learners who satisfy the knowledge and skills requirements of the 21st century in order for them to be successful as citizens. Creativity and invention, critical thinking and problem solving, communication and cooperation, information literacy, media literacy, and information and communication technology literacy, as well as life and career skills, are among the skills that have been highlighted (P21, 2009). In support of P21, the National Science Teachers Association (NSTA) has issued a position statement that acknowledges the need for and importance of 21st century skills in science education and that the population should possess these skills in order to be able to cope with the rapidly changing technology-based world (NSTA, 2011). According to the National Science Teachers Association (NSTA), incorporating skills relevant to the 21st century into science education should be a top goal, but this should not come at the expense of traditional science teaching. One of the guiding concepts for how students should study science was established by the National Research Council five years earlier, and it was presented in the work that Galluci (2006) did. This principle is the utilization of metacognitive methods.

The theory of metacognition is based on constructivism, which requires students to employ various strategies in order to keep track of what they are learning and direct their attention appropriately. Students are given the opportunity to practice self-regulated learning, which empowers them to take responsibility for their own education. According to D'avanzo (2003), it can be defined as the awareness of what is understood and what is

not known through the utilization of self-teaching skills and the utilization of student-centered activities to assist students in thinking critically, creatively, and flexibly. It has been demonstrated that the implementation of metacognition tactics can improve a variety of classroom settings and instruction, as well as the overall performance of students in a variety of scenarios and contexts. Blank (2000), Coutinho (2008), Crispino (2012), Ganaden (1994), Georghiades (2000), Keogh and Naylor (1999), Recede et al. (2020), and Schraw's (2004), works present the findings of a number of studies that demonstrate the importance of including metacognitive activities and enhancing students' metacognition in order to improve students' performance in specific tasks. These findings were presented in the authors' works .

One of the abilities deemed necessary for the 21st century is creativity, which is also one of the outcomes that may be anticipated from using a metacognitive approach. The activity of one's mental processes in such a way as to result in the production of something original that is functional, appropriate, and of a high quality is another definition of creativity (Halford & Wilson, 2002). In the article written by Yager (2000), it was emphasized that there is a need for the adoption of teaching methods that place a greater emphasis on creative thinking into scientific classrooms. Bull and Davis (1980) and Torrance both talk about the significance of creativity and its importance (1992). Ai (1999) and Danipog (2008) have shown that creativity is linked to student performance, and Davis and Rim (1998), Hargrove (2013) have discussed the significance of metacognition and its role in student creativity.Danipog (2008) also demonstrated a link between creativity and student performance. Students can be encouraged to tap into their metacognitive and creative thinking skills by participating in self-regulated learning and question-centered classroom activities. This is one technique to accomplish this goal. Students are able to exercise active control over their own education and become engaged participants as a result. They can concentrate on difficult problems and respond to them in a way that is critical, thoughtful, and creative by writing in journals, diaries, letters, or stories; alternatively, they can use blogs, which is a more sophisticated and up-to-date method. Writing web logs, often known as blogs, is the practice that is known as blogging. Students can use blogging as a way to improve their metacognitive skills since it encourages introspective thinking as well as creative thinking. A blog is an online journal that enables users to share their opinions on a particular topic. Blogging may also improve the number of possibilities for students to receive feedback, as well as the number of interactions that can take place both within and outside of the classroom. Blogging may also allow and encourage connections amongst students. Because this research makes use of blogging as a method to encourage the application of metacognitive skills, the practice has been given the name "metacognitive blogging." Through question-centered activities, the metacognitive blogging technique encourages students to engage in critical and creative thinking about the biology-related activities and ideas they have acquired. The technique has the students participate in a science project that builds upon the use of metacognition as well as creativity, which is one of the essential P21 abilities. This helps students increase their sense of self-efficacy and enhances their overall performance.

In the works of McBride and Luehmann (2008), Colombo and Colombo (2007), Howard (2011), and Sawmiller, it is suggested that the use of blogging is significant in improving classroom instruction, student interaction, and differentiated classroom instruction. This is indicated by the fact that the use of blogging has been suggested to be important in improving classroom instruction (2010). On the other hand, Duda and Garett (2008) and Halic (2009) investigated the use of blogging as a reflective online journal and a tool to develop metacognitive skill. Blogging was used in both of these studies as a tool (2010). Research conducted by Placing (2005) and Turnbull (2004) investigated the important relationship between blogging and academic success.

The consequences of the previous research are what motivate the objective of the current investigation, which is to provide metacognitive blogging technique as a new intervention to improve biology instruction and, as a result, student performance. In the field of biology education, not a lot of research has been done on the effectiveness of the metacognitive blogging technique and its connection to the three variables of creativity, student performance, and self-efficacy. In order to close this knowledge gap, it is necessary to conduct this research in order to give actual data on the application of the metacognitive blogging technique.

Blogging as a tool to increase metacognition among students is called metacognitive blogging. It encourages children to think critically, creatively, and reflectively by providing them with activities and scenarios that are centered on questions. It is anticipated that the students will improve their sense of self-efficacy, develop their creative abilities, and achieve higher levels of success in Biology as a result of the implementation of the technique.

Figure 1 presents the conceptual framework for this research project, which seeks to answer the question, "Would the metacognitive blogging strategy or the conventional method of instruction have a significant effect on the following variables that are under study: students' self-efficacy, creativity, and performance in Biology?" The framework outlines the primary goals of the investigation, which are to determine whether the metacognitive blogging strategy or the conventional method of instruction would have a significant effect on In addition, the figure demonstrates whether or not the qualities in question, namely creativity and self-efficacy, are powerful predictors of biology success.

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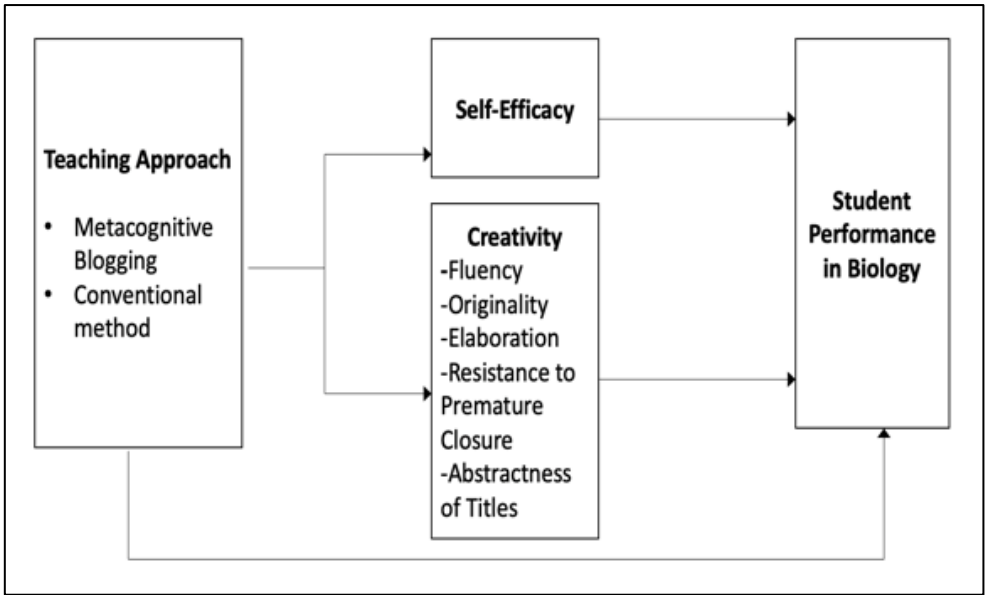


Figure 1: The conceptual framework

Research Questions

This study aimed to answer the following:

1. Do teaching strategy, students' self-efficacy, and creativity have direct effects on performance in Biology?
2. Is there a relationship among teaching strategy, students' self-efficacy, and creativity?

METHODOLOGY

Research Design

The research design used in the study was a two-group, pretest-posttest quasi–experimental design. The two groups were assigned to these teaching approaches: metacognitive blogging strategy and the conventional method.

The Sample

The participants of the study were 65 fourth year high school students of a Science and Technology High School during the School Year 2014-2015. The two heterogenous sections in the fourth year were randomly assigned to the two teaching methods. One group was exposed to the metacognitive blogging strategy while the other group was taught using the conventional method. The teacher-researcher taught each class in the presence of one external class observer. Prior to the conduct of the study, a parent's consent form was distributed to each student.

The Instruments

There were three instruments used in this study, namely, Biology Performance Test, Torrance Test for Creative Thinking, and the Self-Efficacy Test. All instruments were administered as pretest and posttest. Only the biology test instrument was subjected to pilot testing prior to administration and subjected to Cronbach's Alpha test for reliability. Torrance Test for Creative Thinking was used to determine student creativity as suggested by the panel of evaluators. The self-efficacy standardized questionnaire was used as suggested by the research panel during the outline examination.

Biology Performance Test

The researcher-made test on biology student performance is used to assess the students' comprehension amd problem-solving skills in the concepts in Bology particularly in the area of genetics which covers the following topics: Variation, Dominance and Recessive Gene Expression, Mendelian Inheritance, Non-Mendelian Inheritance, Interaction of genes with their Environment, and Pedigree Analysis. The instrument was initially made up of 40 items. This was subjected to content validation by two subject experts. The instrument was revised based on the comments and suggestions of the subject experts and was pilot tested. The final instrument was a 25-item multiple choice type of test with a Cronbach alpha of 0.89. It was administered to the participants before and after the study as pretest and posttest.

Torrance Test for Creative Thinking
The researcher administered the standardized test personally for both pretest and posttest. The standardized test was administered according to the instructions in the manual including the time allotted for each task. General instructions and preliminaries were read before each activitiy. The answer sheet of each student was scored according to the directions and to the scoring guide provided in the Directions Manual and Scoring Guide within the library premise. Each of the creativity components was given scores following the criteria of scoring provided in the kit across the components. Using the scoring guide, raw scores were given to each output in the different activities for each component. Raw scores were translated to national percentile and standardized scores using the Torrance Figural Norms for each component. The creativity index was determined by adding the average standard scores of all components and the bonus points as determined based on the scoring guide.

Self-Efficacy Test
The researcher used a locally made standardized self-efficacy instrument. This instrument was adopted from the dissertation of Ilagan (1999). The researcher adopted this particular instrument since its reliability is 0.87. This instrument consisting of 70 items had a three-point scale where the highest possible summated score is 210 and the lowest possible summated score is 70.

The Teaching Approaches
An intervention study for eight (8) weeks was conducted in the two heterogenous classes of fourth year high school biology classes. One class was taught using the metacognitive blogging strategy while the other class was taught using the conventional method. The researcher taught and devised materials for both classes. The intervention involved the following five topics in Biology: Variation, Dominance and Recessive Gene Expression, Mendelian Laws of Inheritance, Non-Mendelian Laws of Inheritance, Interaction of Genes with their Environment, and Pedigree Analysis.The two classes were exposed to the same instructional activities such as laboratory activities, problem-solving activities, lecture-discussion, and group activities. The two classes also received similar quizzes, long exams, problem sets, and periodic exam. The only difference between the two classes is that the intervention group or the metacognitive blogging class was asked to perform additional in-class activities approximately 10-minutes and off-classroom activities designed to facilitate metacognition and creative thinking. After the intervention, both the metacognitive blogging strategy class and the conventional method class were given a posttest to measure the extent to which they learned the concepts and to measure their biology performance.

The Intervention: Metacognitive Blogging Strategy
The students under the metacognitive blogging strategy were asked to perform additional off-classroom activities designed to facilitate metacognition and creative thinking. They required to post metacognitive blogs via a platform of their choice. Prior to the introduction of the metacognitive strategy to be used in the study, the teacher-researcher explained the strategy to the class and the students were given opportunities for practice using the strategy. An external class observer who is an expert in the field of Biology supervised each instruction period. The following steps patterned from Kramarski and Maravech (2003) were used to facilitate metacognitive blogging strategy in the intervention group:
Step 1. Concept Check-up;
Step 2. Strategy Awareness;
Step 3. Connection to Previous Activity; and
Step 4. Concept Realization
The guide questions to the four (4) steps given to the students served as their guide to create their metacognitive blog post. To promote creativity in the student blogs, they were asked to present their outputs in the most creative way i.e., use of visual imagery, diagrams, illustrations, video, and concept mapping. All outputs in the form of student blogs were posted online through a website available for the other students and the public for further feedback.

Data Collection Procedure
Pretests measuring the biology performance, creativity, and self-efficacy level of students were administered before the study. Posttests were administered, again measuring performance, creativity, and self-efficacy level of students after exposure to the strategy.

Data Analysis Procedure
Path analysis using R Statistics was used to determine the effect of the teaching appproaches: metacognitive blogging strategy or the conventional method on the following variables under study: students' self-efficacy, creativity, and performance in Biology and to show whether the variables – creativity and self-efficacy are strong predictors of biology performance. The hypotheses of the study were tested at 0.05 level of significance.

RESULTS AND DISCUSSION

The Effects of Teaching Strategy, Self- Efficacy, and Creativity on Student Performance in Biology

Based on the conceptual framework, the following path model is tested:

The model contains three functions written in each row. The first function analyzes the effect of self-efficacy, creativity, and the teaching approach (group) on the biology performance. The second function studies the effect of teaching approaches and creativity on self-efficacy. The third function studies the effect of teaching approaches on creativity.

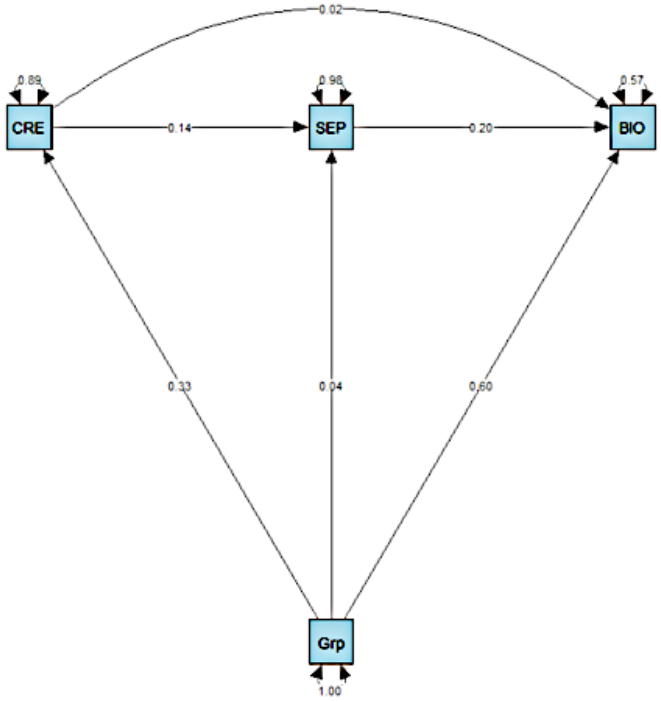
Model =
"Biology performance ~ Teaching Approach (Group) + Self-efficacy + Creativity
Self-efficacy~Teaching Approach (Group) + Creativity
Creativity~ Teaching Approach (Group)"

Table 1 is the summary statistics of the model. The column "estimates" are the coefficients of the model. The last column P(>|z|) are called p-values and to be compared with the level of significance (0.05). If the p-value is less than or equal to 0.05, the effect of the exogenous variable on the dependent variable is significant. Otherwise, when p-value is greater than 0.05, there is not enough evidence to conclude that the effect of the exogenous variable is significant. Based on the conceptual framework, the variable that has the strongest effect on the biology performance is the teaching approach. It has the largest path coefficient equal to 6.025 and since its p-value = 0 is less than 0.05, its effect is also significant. The second variable with strong significant effect on the biology performance is self-efficacy with path coefficient = 0.140, and p-value = 0.041. The variable creativity has the weakest effect on the biology performance with a path coefficient = 0.007 and it is not significant since its p-value = 0.843 which is greater than 0.05. However, it is noted that creativity and teaching approach are significantly related with p-value = 0.006 which is less than 0.05, and therefore, it is concluded that creativity has an indirect effect on biology performance. Based on the results, the effect of teaching approach on self-efficacy is not significant (p-value = 0.772> 0.05). Also, the effect of creativity on self-efficacy is not significant (p-value = 0.303 > 0.05).

Table 1: The Parameter Estimates of the Path Model based on the Conceptual Framework

Regressions	Estimate	Std. Err	z-value	P (>| z |)
Biology performance~				
Teaching Approach	6.025	1.020	5.907	0.000*
Self-efficacy	0.140	0.069	2.048	0.041*
Creativity	0.007	0.034	0.198	0.843
Self-efficacy ~				
Teaching Approach	0.553	1.904	0.290	0.772
Creativity	0.064	0.062	1.030	0.303
Creativity ~				
Teaching Approach	10.093	3.689	2.736	0.006*

Figure 2 shows the path diagram based on the conceptual framework. The numeric values in the diagram correspond to the standardized parameter estimates. The standardized parameter estimates were used in the diagram so that the reader can easily compare the degree of effect of the three exogenous variables on biology performance. Looking at the estimates in the diagram, it can be said that the teaching approach has the greatest effect on biology performance, followed by self-efficacy. The variable creativity has the least effect on biology performance.



Legend: Grp- Teaching Approach
CREA- Creativity
SEP- Self-efficacy
BIO- Biology Performance

Figure 2: The Path Diagram Showing Variables Affecting Biology Performance

Further analysis has been employed to discard the insignificant variables from the model. There is no need to include these insignificant exogenous variables to the model. The final model is as follows:

```
model <- Biology Performance ~Teaching Approach + Self-efficacy
         Creativity~Teaching Approach
```

The model now contains two functions written in each row. The first function analyzes the effect of self-efficacy, and the teaching approach (group) on the biology performance. The second function studies the effect of teaching approaches and creativity.
Table 2 is the table of path coefficients for the final model. The two exogenous variables: teaching approach and self-efficacy have significant direct effect on biology performance (with p-values < 0.05). The variable creativity and teaching approach are significantly related (p-value = 0.006, less than 0.05). Therefore, creativity has indirect effect on biology performance.

Table 2: Path Coefficients for the Final Model

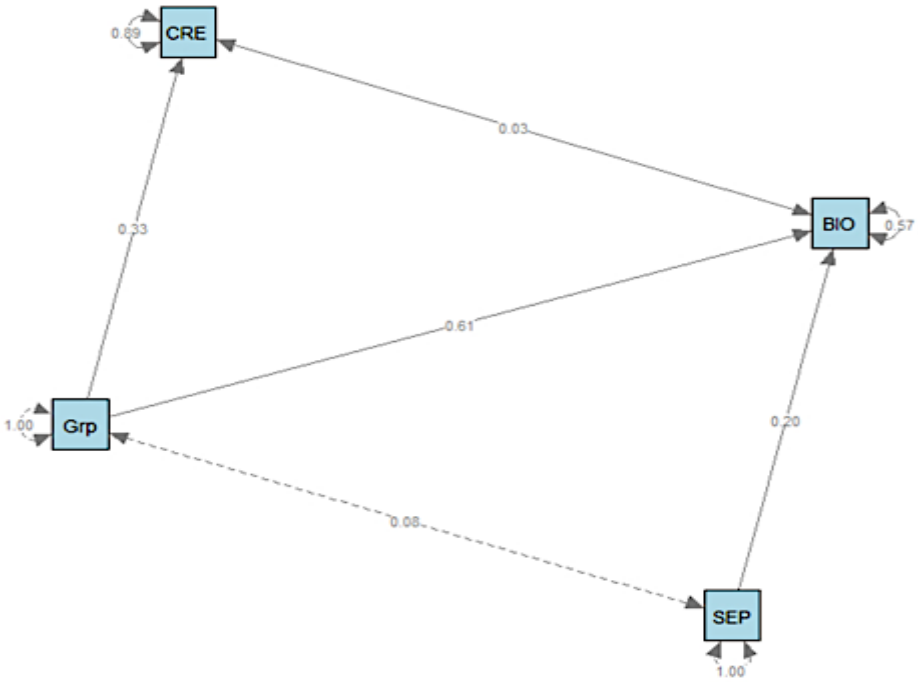
Regressions	Estimate	Std. error	z-value	p (>|z|)
Biology performance ~				
Teaching Approach	6.093	0.966	6.309	0.000*
Self-efficacy	0.140	0.068	2.066	0.039*
Creativity~				
Teaching Approach	10.093	3.689	2.736	0.006*

The final model is achieved by making sure all exogenous variables are significant.All exogenous variables that are not significant were removed from the model. The goodness of fit statistics such as BIC and Akaike criterion were compared. The final model has a lower BIC and Akaike criterion compared to the first model. The lower the BIC and Akaike criterion, the better is the model's fit (Table 3).

Table 3: BIC and Akaike Criterion of Path Models

Path Model	BIC	AIC
1 Based from Conceptual Framework	1280.917	1261.920
2 Final Path Model	857.766	845.101

Figure 3 is the path diagram of the final model. The standardized coefficients in the diagram indicate which of the variables have the strongest effect on biology performance. The greater the coefficient, the stronger is the effect of the exogenous variable on biology performance. The variable which has the strongest effect on the students' performance in Biology is the teaching approach. The variable creativity is related to teaching approach. It is noted that part of the correlation between teaching approach and the perfomance in Biology is attributed to the effect of creativity on teaching approach. Meaning, creativity has an indirect effect on students' performance. Self-efficacy has a direct signicant effect on the students' performance. Self-efficacy has a weak relationship with the teaching approach.



Legend: Grp- Teaching Approach
CREA- Creativity
SEP- Self-efficacy
BIO- Biology Performance

Figure 3: Final Path Model

The Emergent Framework — A Reconfiguration for Biology Instruction

Based on the results and findings established in Figure 3 showing the final model of the path analysis, the emergent framework is presented in Figure 4.

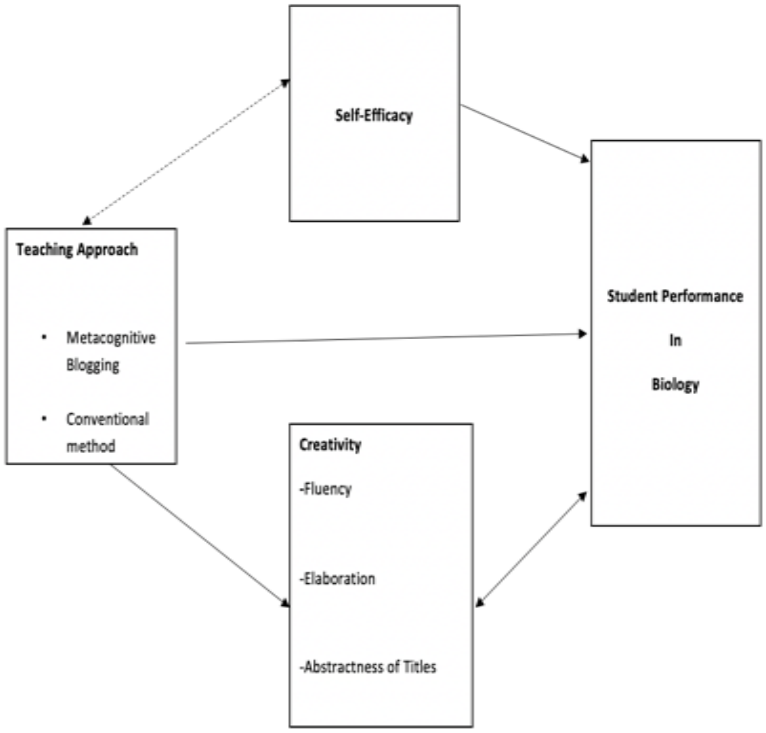


Figure 4: The emergent framework

Based on the emergent framework, the first notable finding is that the teaching approach demonstrated a significant effect on student performance in Biology. Path model analysis in this study identified that the greatest predictor of the students' performance in Biology is the teaching approach. This implies that a teaching strategy that builds upon the cultivation of the metacognitive skills of the students can lead to a positive effect on the performance of students in science. The metacognitive blogging strategy uses blogging as a self-reflection tool of the students to plan, monitor, evaluate, and assess their learning. It is evident in the metacognitive blogs that students identified the different metacognitive strategies they have used in order to understand the lesson well. This result of the study finds support in the works of Colombo and Colombo (2007), Howard (2011), McBride and Luehmann (2008), and Sawmiller (2010) for the role of blogging in improving classroom and student interactions. On the other hand, the studies of Duda and Garett (2008), Halic (2010), and Tan (2010) support blogging as a tool for self-reflection to increase metacognitive skills.

Based on the above figure, self-efficacy also has a significant direct effect on the performance of students in Biology. The significant role of self-efficacy in the performance of students in Biology in this study is backed up by the study of Schunk and Metacognitive strategies were higly evident in the students blogs as well as their desire to learn more, despite having difficulties in understanding the lessons.

The students valued their discussions with their classmates to have deeper understanding of the subject matter. In this case, students put emphasis on the collaborative effort and brainstorming to undertand the subject matter.

It is noted that there is a weak relationship between the teaching approach and self-efficacy as presented by the jagged lines. But the fact that self-efficacy has a strong effect on the student performance, and that teaching approach has a direct effect on student performance, therefore, self-efficacy is the mediating factor. It was also found out in the study of Coutinho (2008) that metacognition and performance are fully mediated by self-efficacy where students with effective metacognitive strategies have a strong belief in their capabilities to perform better.

The teaching approach has a significant effect on creativity. The data show that students exposed to the metacognitive-driven intervention have higher creativity scores based on the result of the studyThis implies that as students engage in their metacognitive blogging, their creativity is also being stimulated. This finds support in the student blogs where some of the students identified connections of their blogging with creativity through expressing their thoughts and ideas in writing. One of the students wrote that the blogs made her unique and creative. This similar result has been presented in the study of Hargrove (2013). In this study, Hargrove presented that the students who were exposed to strategies based on metacognition had significantly higher levels of creative thinking.

However, creativity in this study has been found to have an indirect effect on student performance in Biology as represented by the line with two arrowheads. This may be attributed to the data that only the following components of creativity – fluency, elaboration, and abstractness of titles are found to have a significant difference between the two groups of students in favor of the metacognitive group.

Having all these results and findings, the study presented a new framework to explain how metacognitive blogging approach, self-efficacy, and creativity improve the performance of students in Biology. This study provided empirical data on the use of blogs to activate metacognitive strategies in order to improve student performance in Biology. The reflective nature of blogging can help activate metacognitve strategies among students, thus the strategy coined in this study was metacognitive blogging.

The metacognitive-blogging teaching appproach and its effect on the performance of the students in Biology is deemed important in the field of biology education research. This teaching approach provides valuable contibution on ways to improve learning and student perfomance in Biology. The metacognitive blogs provide significant insights on how students learn Biology. By reading the metacognitive blogs, teachers can identify students' challenges and struggles. In this way, knowing the insights, challenges and struggles, teachers can readily provide an immediate intervention.

The metacognitive blogs of the students provide teachers an avenue to detect misconceptions and in this way, once confronted with these information, teachers can immediately correct and act on it by providing necessary and immediate feedback. The metacognitive blogging teaching approach provides the field of biology education a new instructional approach to promote greater student engagement in their own learning. This teaching approach is equally important in the conduct of remote lesson delivery where students are left on their own to direct their own learning. Through metacognitive blogs, teachers can readily monitor student learning, their challenges, struggles, and misconceptions.

This intervention can strengthen instruction in the New Normal Biology Education as it highly supports the remote learning and blended learning modes. The metacognitive blogging strategy can encourage students to continue to learn on their own, to reflect on their learning, and find ways to improve their learning.Through the metacognitive blogs, teachers can understand students better and derive insights to effectively facilitate learning. In this strategy, the students become empowered to plan, monitor, and evaluate their own learning. Metacognitive blogging strategy promotes creativity, increases self-efficacy, and improves student performance in Biology.

CONCLUSIONS AND RECOMMENDATIONS

Based on the study, it was revealed that the teaching approach has the strongest significant effect on biology performance whereas self-efficacy has a strong significant effect on biology performance; creativity is significantly related to teaching approach but creativity has an indirect effect on biology performance. Creativity and self-efficacy are not significantly related. Findings of the study indicate that the metacognitive blogging teaching approach is effective in enhancing students' creativity and performance in Biology. Thus, the emergent framework for Biology Instruction using metacognitive blogging highlights these relationships as a result of path analysis. It is recommended that metacognitive blogging strategy be adopted as a new strategy to enhance biology instruction. It is also recommended that this strategy be used in other biology disciplines as well as science subjects to improve students' performance. Researchers may also investigate other variables that may lead to the improvement of self-efficacy, creativity, and student performance in Biology.

REFERENCES

1. Blank, L. M. (2000). A metacognitive learning cycle: a better warranty for student understanding. Science Education, 84(4), 486-506.
2. Bull, K.S. and G.A. Davis. (1980). Evaluating creative potential using the statement of past creative activities. Journal of Creative Behavior, 14(4), 249-257.
3. Cakir, M. 2008. Constructivist approaches to learning in science and their implications for science pedagogy: A Literature Review. International Journal of Environmental & Science Education, 3 (4), 193-206.
4. Colombo, W.G. and P. D. Colombo. (2007). Blogging to improve instruction in differentiated science classrooms. Phi Delta Kappan.
5. Coutinho, S. (2008). Self-efficacy, metacognition and performance. North American Journal of Psychology, 10(1),165-172.
6. Crispino, M.T. (2012). Reflective idea-image connections: effects of pupils' metacognitive awareness and conceptual understanding.
7. Danipog, D. 2008. Art-based chemistry activities; effects on students' conceptual understanding and attitude.

8. D'avanzo, C. (2003). Application of research on learning to college teaching: ecological examples. Bioscience, 53(11),1121-1128.
9. Duda, G. and K. Garrett. (2008). Blogging in the physics classroom: A research–based approach to shaping students' attitudes toward physics. American Journal of Physics, 76(11), 1054–1065.
10. Gallucci, K. (2006). Learning concepts with cases. Journal of College Science Teaching, 36(2), 16-20.
11. Ganaden, M. S. (1994). Knowledge organization and metacognition enhancement for problem solving in high school physics.
12. Georghiades, P. (2000). Beyond conceptual change learning in science education: focusing on transfer, durability and metacognition. Educational Research, 42(2), 119-139.
13. Halic, O. (2010). To blog or not to blog: student perceptions of blog effectiveness for learning in a college-level course. Internet and Higher Education, 13(4), 206-213.
14. Halford, G. S. and Wilson, W. H. (2002). Creativity, relational knowledge, and capacity: Why are humans so creative? In T. Dartnall (Ed.), Creativity, cognition, and knowledge: An interaction (pp. 153–180). Praeger Publishers/Greenwood Publishing Group.
15. Hargrove, R. (2013). Assessing the long-term impact of a metacognitive approach to creative skill development. International Journal of Technology and Design Education, 23(3)489-517.
16. Howard, M. E. (2011). Not an "unfeasible extra": Science and Children, 49(4), 32-35.
17. Ilagan, M. L. G. (1999). Self-efficacy and academic achievement of college students.
18. Jacobs, J. and Paris, S. (1987). Children's metacognition about reading: Issues in definition, measurement, and instruction. Educational Psychologist, 22, 255–278.
19. Keogh, B. and S. Naylor.(1999). Concept cartoons, teaching and learning in science: an evaluation. International Journal of Science Education, 21 (4), 431-446.
20. Kramarski, B. et. al. (2002). The effect of metacognitive instruction on solving with authentic tasks. Educational Studies in Mathematics, 49, 228-250.
21. McBride, R. and A. Luehmann.(2008). Capitalizing on emerging technologies: a case study of classroom blogging. School Science and Mathematics. 168(5), 173-183.
22. National Science Teachers Association (NSTA). (June 2011). NSTA Position Statement: Quality science education and 21st century skills.
23. Partnership for 21st Century Skills (P21). (2009).Framework for 21st Century Learning. Retrieved February1,2014, from http://www.p21.org/our-work/p21-framework.
24. Pintrich, P.R., Smith D.A.F., Garcia T. & McKeachie W.J. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ), Educational and Psychological Measurement., 53, 801-803.
25. Recede, R.A., Capati, A.R. Yangco, R.T. and M. A. Castro. 2020. Metacognitive Analogy Instruction: Effects on Students' Reflective Thinking in Learning Biology. Jurnal Pendidikan MIPA. 21 (1), 2020, 12-21.
26. Sawmiller A. (2010). Classroom blogging: what is the role in science learning? The Clearing House,83,44-48.
27. Schraw, G., Crippen, K. J., & Hartley, K.(2006). Promoting self-regulation in science education: metacognition as part of a broader perspective on learning. Research in Science Education. 36(1-2), 111-139.
28. Tan, S. M., Ladyshewsky, R. K., & Gardner, P. (2010). Using blogging to promote clinical reasoning and metacognition in undergraduate physiotherapy fieldwork programs. Australasian Journal of Educational Technology, 26(3).
29. Turnbull, G. (2004). The seven-year-old bloggers. BBC News World Edition.
30. Vrugt, A., & Oort, F. J. (2008). Metacognition, achievement goals, study strategies and academic achievement: pathways to achievement. Metacognition and Learning. 30, 123-146. doi:10.1007/s11409-008-9022-4
31. Yager, R.E. (2000). A vision for what science education should be like for the first twenty-five years of a new millennium, School science and Mathematics. 100, 327-341.