



## Biology students' academic performance and creative thinking skills through analogy-enhanced instruction

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### Abstract

Across the ages, analogy-enhanced instruction has played a vital role in teaching-learning. This study aimed to examine Biology students' academic performance and creative thinking skills through Analogy-Enhanced Instruction (AEI). The study revealed insignificant results in the Biology students' academic performance when exposed to AEI and NAEI in the pretest and posttest. When exposed to AEI, the students displayed above-average creative thinking skills on all seven (7) factors. Findings showed a slight increase but were comparable in the mean scores of both groups in the posttest. A significant difference was revealed, in favor of the AEI group, in the Biology students' creative thinking skills when exposed to AEI and NAEI.

**Keywords:** Academic performance, creative thinking skills, and analogy-enhanced instruction

### Introduction

Science is a notable channel of knowledge and is essential in preparing competitive, innovative, and creative individuals in society. However, as observed, most students consider science content challenging and complex. The Organization for Economic Cooperation and Development (OECD) in 2018 revealed that students in the Philippines scored lower than the OECD average in Science (PISA 2018 Results). In addition, the results of the 2018 National Achievement Test (NAT Grade 6, 10, and 12) confirmed that Science had been included in the lowest performance among Filipino students, significantly affecting their creativity. Academic performance has always been associated with evaluation test results, which correspond to a student's IQ (Martin *et al.*, 2017). Creative thinking requires imagination and leads to many possible ideas (Rawlinson, 2017)<sup>[43]</sup>. Due to uncertainties, it is essential to have hints on the factors influencing students' academic performance and creative thinking skills acquired during the learning process across different learning contexts.

Specifically, science teaching and learning should integrate many methods and approaches that would allow the students to explore various learning activities that build performance and creativity in a meaningful way. Filipino students must recognize the essence of developing their creative thinking skills to excel academically. The average MPS obtained by the Grade 7 students of Xavier de Kibangay High School during the four (4) quarters of the school year 2021-2022 reflected that the students did not meet the proficiency level in Science. It means that the students' academic performance was low and needs action to attend to for improvement. Based on experience, students memorized verbatim the science concepts taught during discussions in a particular school. When asked questions, not exactly how the ideas were stated during the class but of the same thought, almost panicked and could not answer the question confidently. An instructional approach like analogy-enhanced instruction might help students activate their creative thinking in making analogies by learning through their peers and displaying high performance.

### Methodology

Using analogy-enhanced instruction, the study utilized a quasi-experimental (pretest-posttest) research design to examine the students' Biology performance and creative thinking skills in Grade 9. The two sections covered the same topic (Heredity: Inheritance and Variation) and were discussed within five (5) weeks.

The study was conducted at Xavier de Kibangay High School (XKHS), Kibangay, Lantapan, Bukidnon. A written request letter was addressed to the Junior High School Principal, asking permission to conduct the study. In addition, ethical considerations were ensured throughout the study; the researcher informed the students personally with a consent letter, and the respondents' parents were given a letter of consent informing them that their children would be part of the study.

Descriptive statistics like weighted mean, percentage, and standard deviation were used to determine the level of Biology students' academic performance and creative thinking skills when exposed to Analogy-Enhanced Instruction and Non-Analogy-Enhanced Instruction. Analysis of Covariance (ANCOVA) was used to find any significant differences in Biology students' academic performance when exposed to Analogy-Enhanced Instruction and Non-Analogy-Enhanced Instruction.

This study used an academic assessment consisting eighty (80) item test to measure Grade 9 Biology students' academic performance and a non-academic assessment which consisted of the following: six (6) item statements for the creative personality and curiosity factor, nine (9) item statements for the knowledge and skills expansion factor, four (4) item questions for the connection factor, six (6) item statements for boldness, four (4) item statements for originality, five (5) item statements for fluency, and six (6) item statements for flexibility. The self-assessment questionnaire was adapted from Lehmkuhl *et al.* (2020). Both instruments were content validated by three science experts, pilot tested, and showed reliability of 0.73 and 0.96, respectively.

**Results and Discussion**

This presents the analysis and interpretation of the data gathered from the students' academic performance and creative thinking skills in Biology exposed to Analogy-

Enhanced Instruction (AEI) and non-Analogy-Enhanced instruction (NAEI) relevant for testing the hypothesis of the study. The order of the presentation follows the arrangement of the problems identified in the study.

**Table 1:** Biology Students' Academic Performance in terms of Pretest and Posttest

Raw Score	AEI				NAEI				Qualitative Interpretation
	Pretest		Posttest		Pretest		Posttest		
	N	%	N	%	N	%	N	%	
27-30	0	0	1	2.08	0	0	1	2.44	Outstanding
23-26	0	0	6	12.50	0	0	6	14.63	Very Satisfactory
19-22	0	0	22	45.83	0	0	14	34.15	Satisfactory
15-18	2	4.17	12	25.00	0	0	14	34.15	Fairly Satisfactory
0-14	46	95.83	7	14.58	41	100	6	14.63	Did Not Meet Expectation
Total	48	100	41	100	48	100	41	100	

Overall  $\bar{x}$  = 9.60  $\bar{x}$  = 18.73  $\bar{x}$  = 9.49  $\bar{x}$  = 18.20  
 Mean/ MPS = 32.01% MPS = 62.43% MPS = 31.63% MPS = 60.65%  
 MPS (DNME) (FS) (DNME) (FS)

It was found that during the pretest, students from both groups had a minimal background in the Biology topic. This finding is supported by the study of Riesen *et al.* (2022) [46] that prior knowledge influences the degree to which learners learn new ideas. This is in adherence with Heitzmann (2022) [26], which stated low level of prior knowledge is a delicate matter that should be treated carefully because students would need even more guidance. The minimum pretest results of students imply that they already have stored knowledge about heredity but not to the extent that they can be considered highly knowledgeable (Agon, 2021) [1].

The results suggest that having prior knowledge is a significant advantage to students' academic track because

those with substantial prior knowledge will be able to adapt to the environment and obtain excellent marks (Alipio, 2020) [2]. The recent findings indicate a call for better teaching and effective strategies in delivering the subject matter to assist students with idle background knowledge academically performing well. The present results are aligned with the study of Duman *et al.* (2020) [15], which clarified that the usage status of analogy instruction might change depending on the subject, educational approach, and individual differences. In this regard, the students' posttest results proved that they differed in how the analogy-enhanced instruction helped them improve in the subject matter. Due to individual differences, analogy-enhanced instruction has a varied effect on the students.

**Table 2:** Summary Table of Biology Students' Creative Thinking Skills

Creative Thinking Skills Factors	Aei pretest posttest				Naeipretest posttest			
	MEAN	QI	MEAN	QI	MEAN	QI	MEAN	QI
Connection	4.05	AA	4.14	AA	3.41	A	3.52	AA
Knowledge and Skills Expansion	4.01	AA	4.09	AA	3.36	A	3.44	A
Originality	3.93	AA	4.02	AA	3.23	A	3.29	A
Fluency	3.93	AA	3.93	AA	3.33	A	3.26	A
Flexibility	3.92	AA	4.07	AA	3.30	A	3.43	A
Boldness	3.84	AA	3.97	AA	3.21	A	3.32	A
Creative Personality and Curiosity	3.80	AA	3.89	AA	3.24	A	3.40	A
WEIGHTED MEAN 3.93 AA 4.02 AA 3.30 A 3.38 A								

**Legend**

**Level of Creative Thinking**

- 4.51 – 5.00
- 3.51 – 4.50
- 2.51 – 3.50
- 1.51 – 2.50
- 1.00 – 1.50

**Qualitative Interpretation**

- Excellent (E)
- Above Average (AA)
- Average (A)
- Fair (F)
- Poor (P)

The data reflected that students in the group of AEI think more creatively in terms of connection but less likely in terms of creative personality and curiosity while learning Biology contents. Despite the students' creativity in connecting their pre-existing knowledge to the present, some were still engaging in the effectiveness of making analogies to acquire excellent creative thinking skills fully. This result calls the attention to every teacher that it is necessary to assess and activate students' prior knowledge to make adjustments with recent to have better learning. This is to testify to the study of Dong *et al.* (2020) [14] that

students with more prior knowledge lead to good quality learning.

The current results align with the findings of Gafour and Gafour (2020) [20], which stated that creative thinking techniques are built on experience and knowledge. The present results are also bounded by David Kolb's Experiential Learning Theory (ELT). The Grade 9 respondents came from different family backgrounds with diverse learning experiences. Hence, they vary in their understanding of the concepts and level to construct analogies during the discussion. This diversity of personal

and learning experiences can help gain different points of view regarding the topic and can be the students' basis for constructing their metaphor during classes.

**Table 3:** Analysis of Covariance (ANCOVA) of students' posttest scores

Group	N	Mean	SD
NAEI	41	18.20	3.73
AEI	48	18.73	2.96
Total	89	18.48	3.33

Source	SS	df	MS	F-value	Sig.
Corrected Model	188.52 <sup>a</sup>	2	94.26	10.32	.000
Pre_Ach	182.22	1	182.22	19.95	.000
Group	5.08	1	5.08	0.56	.458
Error	785.70	86	9.14		
Total	31379.000	89			

Based on the results, the difference in the mean scores of 0.53 between the group would indicate that analogy instruction helps develop students' creative thinking skills but shows no significant effect. The current study is also congruent with the conclusion of Weir (2017)<sup>[60]</sup> that AEI is not significantly different from NAEI in improving creativity in science students. The present findings adhere to the study of Weir (2017)<sup>[60]</sup> because, as shown in Table 10, the posttest scores revealed the same level of understanding on the topic of heredity, which implies comparable results. Nonetheless, the results displayed by the present research negate the shreds of evidence in the literature. Moreover, the comparable posttest scores of both groups do not discourage analogy-enhanced instruction. Instead, it is encouraged to continue the practice because the slight difference in the mean scores signifies that it is helpful only that the abrupt implementation and the limited time were some of the concerns why the obtained results were not compared well. In implementing analogy-enhanced instruction, some difficulties were encountered both by the teacher and students. Based on the recent study's results, identifying the appropriate source in the target-source relationship might be difficult (Duman *et al.*, 2020)<sup>[15]</sup>. In addition, making an analogy is tricky and takes time, especially on the tough topics in Biology; hence, it must be carefully used to avoid misconceptions about target-source relationships. Thus, it is a reminder that when making metaphors, using familiar terms is essential for the students to grasp the connections between them slowly.

**Table 4:** Analysis of Covariance (ANCOVA) of Students' Creative Thinking Skills after Intervention Between Classes Exposed to AEI and NAEI

GROUP	N	Mean	SD
NAEI	41	3.38	0.67
AEI	48	4.02	0.37
Total	89	3.73	0.62

Source	SS	df	MS	F-value	Sig.
Corrected Model	17.72 <sup>a</sup>	2	8.86	48.95	.000
Pre_Creative	8.87	1	8.87	49.02	.000
Group	1.10	1	1.10	6.07	.016
Error	15.57	86	0.18		
Total	1268.404	89			

As time progressed in the implementation of the study, it was shown creative thinking skills between students exposed to Analogy-Enhanced Instruction and those in Non-Analogy-Enhanced Instruction significantly differ. The study's results revealed a link to the study conducted by Yaniawati *et al.* (2020)<sup>[63]</sup> that creative thinking can be demonstrated through attitude. Activities involving mental activity, such as asking questions, imply perseverance, personal discipline, and attention. Therefore, the students must have a more comprehensive view of learning and be self-regulated to improve creative thinking.

According to Wijayati *et al.* (2019)<sup>[62]</sup>, creative thinking is a mental process. Therefore, when exposed to AEI, students brought out their different courses of action to grasp the concepts well and use them to bring new ideas to understand various things and ways to solve practical problems. In general, transferable skills such as creative thinking skills are skills developed in one situation to be transferred to other conditions, from classroom learning to real-life situations (Setiawan *et al.*, 2018)<sup>[50]</sup>. The descriptions are apparent in the results of every construct of the creative thinking skills self-assessment tool used in the study.

The different indicators of creativity displayed a high significant p-value. It implies that students were not depending on the teacher's explanation and applied it in practice to strengthen their learning (Rashidov, 2020)<sup>[42]</sup>. Also, the constructs were valid in determining specific and purposeful goals for developing creative thinking skills. According to Gafour and Gafour (2020)<sup>[20]</sup>, the ability to apply creative thinking in both a digital and non-digital environment has become a characteristic of productive students nowadays. It means that despite the students' diversity, their range of pre-existing knowledge, beliefs, skills, and attitudes positively affects how they receive, understand, and organize new knowledge (Diaz, 2017)<sup>[12]</sup>. Moreover, along with their learning journey, they overcame the boundaries of academic challenges and were not afraid to make mistakes (Lehmkuhl *et al.*, 2020). Thus, their creativity produced unusual associations, making them remarkable risk-takers of innovation and having helped them become confident and responsible learners (Handayani *et al.*, 2021)<sup>[25]</sup>.

The indicators of creative thinking skills utilized in this study revealed an important impact on students' creativity. Students' fluency boosts their links between word recognition and comprehension (Rahman, 2017)<sup>[41]</sup>. The unlimited point of view made the flexible students think and discover new potential areas for solving their problems (Nurisalfah *et al.*, 2018)<sup>[38]</sup>.

**Conclusion and Recommendation**

Given the findings of this study, considering the purpose of Science, there is a need to apply AEI to achieve excellent teaching and learning of the subject, which might push through the high academic performance of the students. The level of Biology students' academic performance when exposed to AEI and those in NAEI presented did not meet expectations during their pretest. This means that both groups have limited background knowledge of the topic. In contrast, both groups increased their MPS during the posttest and displayed fairly satisfactory. The level of Biology students' creative thinking skills in terms of creative personality and curiosity, knowledge and skills expansion, connection, boldness, originality, fluency, and

flexibility revealed that originality, making connections, and having fluency were prominent to them. It was followed by flexibility, boldness, creative personality and curiosity, knowledge, and skills expansion.

There was a significant difference in Biology students' creative thinking skills when exposed to AEI and those in NAEI. Therefore, the study rejects the null hypothesis, which states there is no significant difference in Biology students' creative thinking skills who are exposed to Analogy-Enhanced Instruction and those to Non-Analogy-Enhanced Instruction.

The following are suggested based on the current research findings where the school is called to implement appropriate and attainable processes and teaching strategies to encourage and inspire students to develop creative thinking skills toward Biology.

It is suggested that students' prior knowledge must be activated so that teachers know the misconceptions if any, and the aspects that still need improvement.

In developing students' creative thinking skills, based on the results of the indicators used, creative personality and curiosity, and knowledge and skills expansion were the weak points of the students. Therefore, it is suggested that future research consider the factors affecting the low level of students' creativity in terms of these two (2) indicators.

The findings of this study indicate that Analogy-Enhanced Instruction (AEI) helped the students in their academic performance but revealed no significant effect. It is recommended that future research encourage the teacher and the students to continue utilizing the strategy. A long time to implement the strategy and seminars and workshops to train the teachers on the appropriate way of implementing the strategy is also recommended. It is also suggested to continue using AEI as it could improve students' performance, but it must be introduced gradually, especially when dealing with complex concepts in Biology.

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