Ipaf-D Method (Integrate, Predict, Analyze, Formulate-Draw Conclusion) to Enhance Laboratory Exercises on Student's Academic Behavior and Performance In Biology

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Abstract

This study determined the relationships of IPAF-D method (integrate, predict, analyze, and formulate-draw conclusions) to enhance laboratory exercises on student's academic behavior and performance in Biology. Specifically, this study aims to evaluate the level of utilization of the IPAF-D method, its impact on students' academic behavior, students' written tasks and students' performance tasks after using the IPAF-D method. Moreover, the study determined if there is a significant difference in students' written tasks before and after implementing the IPAF-D method and whether the method significantly affects students' academic behavior and performance tasks. Additionally, it determined the specific factors that influenced students' academic performance before and after the implementation of the IPAF-D method.

This study employed a mixed-method approach combined with a quasi-experimental design. In this study, a purposive sampling technique was used in choosing the respondents. The respondents of the study were composed of four (4) sections with a total of one hundred fifty-five (155) Grade 11 STEM students in Kapayapaan Integrated School. The instruments used in the study are a self-made checklist survey questionnaire, open-ended interview questions, and a pretest and posttest for data collection.

From the study's data analysis, the overall statistical analysis revealed several key findings. The level of utilization of the IPAF-D method was consistently interpreted at a very high level. Additionally, the data showed that the level of students' academic behavior was interpreted at a high level, while the level of students' written tasks was rated as very satisfactory. Moreover, the level of students' performance was interpreted as outstanding. Importantly, there is a significant difference in the students' written tasks, academic behavior, and performance tasks after the utilization of the IPAF-D method. Also, it was observed that students enhanced their focus and engagement, which were influential factors in their improved performance.

In line with findings of the study it can be concluded that there is a significant effect on the learner's academic behavior, thus rejecting the first hypothesis. The use of the IPAF-D method in laboratory exercises has a significant effect on the learner's performance, thus rejecting the second hypothesis. Lastly, use of the IPAF-D method in laboratory exercises has a significant difference in the learner's academic behavior and performance, thus rejecting the last hypothesis. It means that the implementation of the IPAF-D method in laboratory exercises significantly impacts learners' academic behavior and performance in biology, thus rejecting all null hypotheses.

Based on the findings and conclusions, the researcher came up with this recommendation. It is highly encouraged that teachers should consider incorporating more structured training and practice sessions focused on these dimensions to further reinforce students' skills and sharing best practices within and across disciplines to enhance the effectiveness of the IPAF-D method in educational settings.

Keywords: Academic behavior; performance; biology

1. Introduction

The IPAF-D Method which stands for integrate, predict, analyze, and formulate-draw conclusions is an innovative teaching method designed to enhance laboratory exercises in teaching Biology concepts. With the help of this method, students can actively participate in real experiments while developing their analytical and critical thinking abilities within a disciplined framework.

Traditional laboratory exercises often lack a systematic method that encourages students to think critically and draw meaningful conclusions. This could result in a passive learning environment that impedes the acquisition of critical academic abilities. The challenge is to close this knowledge gap and investigate the ways in which the IPAF-D Method can enhance students' performance and academic behavior in laboratory exercises.

Miller and Driver (2018) describe experimenting as an integrated process skill that includes other process skills like observation, interpretation, planning, and reporting. Integrated process skills are involved when learners conduct experiments. They formulate hypothesis, design experiments, and make a generalization after collecting data. A central feature of experimentation is said to be the idea of control in order that possible alternate interpretations of a situation may be eliminated.

Moreover, the American Chemical Society (2019) claimed that hands-on laboratory science experiences are very important to the learning processes across all areas of study. Also, the society said that research has shown that students who were exposed to well-designed laboratory experiences develop problem-solving and critical-thinking skills, as well as gain exposure to reactions, materials, and equipment in a lab setting.

This study embarks on a compelling exploration, traversing the realms of education and STEM, to investigate the transformative potential of laboratory exercises enriched with the IPAF-D (Integrate, Predict, Analyze, Formulate-Draw) method. The IPAF-D is an innovative teaching method designed to enhance the academic behavior and performance of Grade 11 STEM students, specifically in the realm of biology. It is an approach grounded in the principles of active learning, inquiry-based pedagogy, and empirical exploration.

Most Importantly, this paper aims to know the impact of the IPAF-D method on students' academic behavior and performance in Biology laboratory exercises, to observe changes in students' academic behavior, in terms of engagement, enthusiasm, focus, self-efficacy, and task completion, to evaluate the impact of the IPAF-D method on students' performance in terms of written task and performance task and to measure the overall effect of the IPAF-D method on students' academic behavior and performance of Grade 11 STEM students in Kapayapaan Integrated School under the Schools Division of Calamba Laguna. This is important on how to contribute valuable insights into effective pedagogical method in enhancing laboratory exercises in Biology education, with the potential to inform future teaching methodologies and curriculum development.

1.1 Statement of the Problem

Specifically, this sought answers to the following questions.

1. What is the level of utilization of the IPAF-D method in terms of:
   - 1.1 Integration of Prior Knowledge;
   - 1.2 Predicting Outcome;
   - 1.3 Analyzing Data; and
   - 1.4 Formulate-draw conclusions?
2. What is the level of student's academic behavior in terms of:
   - 2.1 Engagement;

2.2 Enthusiasm;
2.3 Focus;
2.4 Self- efficacy; and
2.5 Task completion?

3. What is the level of student's written tasks before and after utilization of:
   3.1 Analytical Skills;
   3. 2 Application; and
   3. 3 Critical thinking?
4. What is the level of student's performance tasks after using IPAF-D method?
5. Is there a significant difference in the student's written tasks before and after using IPAF-D method?
6. Does the utilization of IPAF-D method have significant effect on student's academic behavior?
7. Does the utilization of IPAF-D method have significant effect on student's performance tasks?

2. Methodology

The research design utilized in this study is a mixed-method approach combined with a quasi-experimental design. The researchers sought to assess the causal relationship between the implementation of the IPAF-D method in laboratory exercises and its effects on students' academic performance and behavior.

Creswell (2017) states that quasi-experiment is experimental situations in which the researcher assigns, but not randomly, participants to groups because the experimenter cannot artificially create groups for the experiment. Quasi-experimental design is a research method that aims to assess the causal impact of an intervention or treatment. Researchers typically cannot randomly assign participants to groups, so they use existing groups or naturally occurring conditions.

3. Results and Discussion

This chapter enumerates the different results and discusses the results that were yielded from the treatment of the data that was gathered in this study. The following tabular presentations and discussions will further characterize the significant effect of utilization of IPAF-D (integrate, predict, analyze, formulate-draw conclusions) method on student's academic behavior and performance.

Level of utilization of the IPAF-D method

The study focused on level of utilization of the IPAF-D method, specifically in terms of integration of prior knowledge, predicting outcome, analyzing data and formulate-draw conclusions.

The following table shows the statement, mean, standard deviation and the verbal interpretation. Mean score and standard deviation obtained from the points given by the respondents for each statement can be remarked as always, often, sometimes, rarely and never.

This section focused on the level of utilization of the IPAF-D method in terms of the integration of prior knowledge presents an exploration of how effectively the IPAF-D method. This assessment specifically examines its role in enhancing comprehension, activating pre-existing knowledge, interpreting problems through connections to previous lessons, and leveraging learning connections to solidify understanding of biology concepts.

Table 1 Level *of utilization of the IPAF-D method in terms of Integration of Prior Knowledge*

STATEMENTS	MEAN	SD	REMARKS
Enhances the understanding of the lesson	4.17	0.74	Often
Understand further by activating my prior knowledge	4.37	0.65	Always
Interprets the situation of the word problem by linking to previous lesson	4.14	0.72	Often
Use learning connections to remember and understand biology concepts	4.18	0.79	Often
Use of integration of prior knowledge to be motivated and engaged in learning biology concepts	4.43	0.70	Always
Weighted Mean		*4.26*	
SD		*0.57*	
Verbal Interpretation		*Very High*	

Table 1 illustrates the level of utilization of the IPAF-D method in terms of Integration of Prior Knowledge. This demonstrates the high effectiveness of the IPAF-D method in integrating prior knowledge, as evidenced by a weighted mean score of 4.26 and a standard deviation of 0.57, receiving a verbal interpretation of "Very High." This indicates that the method is consistently successful in helping students connect new information with their existing knowledge base, enhancing their understanding and retention of educational content. The score reflects a widespread acceptance and effective application of the IPAF-D method among the respondents.

This section evaluates the effectiveness of the IPAF-D method in enhancing students' ability to predict outcomes within laboratory settings. It includes statements that assess how the method aids students in understanding experiments, forming expectations about results and principles, and boosting their confidence in experimental concepts. This table aims to measure how well the IPAF-D method prepares students for successful experimentation and enriches their overall learning experience in the course.

Table 2 *Level of utilization of the IPAF-D method in terms of Predicting Outcome*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
helps me understand experiments in this course.	4.15	0.77	Often
before conducting experiments helps me form a better understanding of the expected results and underlying principles.	4.45	0.69	Always
enhances my overall learning experience in this course.	4.43	0.66	Always
makes me feel more confident in understanding of experimental concepts and principles.	4.26	0.72	Always
can result in successful conducting experiments and achieving meaningful results.	4.34	0.74	Always
Weighted Mean **SD** **Verbal Interpretation**	4.33 0.56 Very High		

Table 2 demonstrates that the IPAF-D method is highly effective in enhancing students' ability to predict outcomes in their course work, as indicated weighted mean score of 4.33 and a standard deviation of 0.56, with a verbal interpretation categorized as "Very High." This indicates that students are significantly benefiting from the method, as it reliably improves their predictive capabilities and understanding of experimental concepts, contributing positively to their learning experiences.

Overall, the weighted mean score shows a very high level of utilization of the IPAF-D method in

predicting outcomes among the respondents shows that the IPAF-D method significantly boosts students' predictive skills within their coursework, highlighting its efficacy in enhancing students' understanding and preparation for experimental results. The method's effectiveness in enhancing students' understanding of experimental concepts and increasing their confidence in handling scientific predictions is clear, marking it as a valuable educational tool in laboratory settings.

This section assesses the effectiveness of the IPAF-D method in the context of data analysis within laboratory exercises. It explores how the method enhances students' abilities to derive meaningful insights from raw data, influences their critical thinking, and deepens their understanding of complex biological concepts. By incorporating data analysis into students' learning processes, the IPAF-D method is examined for its role in improving comprehension, engagement, and study habits in biology coursework.

Table 3 *Level of utilization of the IPAF-D method in terms of Analyzing Data*

STATEMENTS	MEAN	SD	REMARKS
It provides meaningful insights from raw data to support decision-making.	4.40	0.66	Always
It influences my critical thinking skills and approach to understanding experimental concepts.	4.22	0.72	Always
It improves my comprehension and increase your engagement with course materials.	4.26	0.81	Always
It uses analysis of data in helping me understand complex biology concepts and theories	4.23	0.73	Always
It incorporates data analysis into my learning process, which influences my study habits and engagement with biology.	4.10	0.84	Often
Weighted Mean		*4.24*	
SD		*0.56*	
Verbal Interpretation		*Very High*	

Table 3 illustrates the level of utilization of the IPAF-D method in terms of Analyzing Data. The level of utilization of the IPAF-D method in terms of Analyzing Data attained a weighted mean score of 4.24 and a standard deviation of 0.56 and was Very High among the respondents. This indicates that students effectively utilize the method to enhance their ability to analyze data, which is critical in understanding and engaging. Overall, the weighted mean score demonstrates a very high level of utilization of the IPAF-D method in analyzing data among the respondents, highlighting its efficacy in enhancing students' ability to derive insights and make informed decisions based on data analysis in biology.

The students who actively engaged in data analysis before drawing conclusions from chemical experiments exhibited improved problem-solving abilities. Analyzing data systematically and drawing meaningful conclusions enhanced their scientific reasoning (Li & Zhang, 2019).

This section demonstrates the IPAF-D method's effectiveness in helping students formulate and draw conclusions during science experiments, with statements indicating it enhances their understanding and improves critical thinking within scientific contexts. The statements collectively underscore how the method not only deepens students' comprehension but also equips them with practical skills to apply theoretical knowledge in laboratory settings.

Table 4 *Level of utilization of the IPAF-D method in terms of Formulate-Draw Conclusions*

STATEMENTS	MEAN	SD	REMARKS
enhances my understanding of science experiments	4.15	0.73	Often
improves my critical thinking skills in the context of science experiments.	4.33	0.65	Always
necessary for the successful completion of science experiments.	4.12	0.71	Often
influences my ability to retain knowledge from biology concepts	4.15	0.78	Often
influences my ability to apply knowledge gained from science laboratory experiments.	4.43	0.68	Always
Weighted Mean **SD** **Verbal Interpretation**	4.24 0.55 Very High		

Table 4 illustrates the level of utilization of the IPAF-D method in terms of Formulate-Draw Conclusions. The level of utilization of the IPAF-D method in terms of Formulate-Draw Conclusions attained a weighted mean score of 4.24 and a standard deviation of 0.55 and was Very High among the respondents. This indicates that respondents effectively use the method to enhance their ability to synthesize and conclude from experimental data.

Overall, the weighted mean score indicates a very high level of utilization of the IPAF-D method in formulating and drawing conclusions, highlighting its effectiveness in promoting critical thinking in scientific contexts. The findings suggest that the IPAF-D method is a valuable tool in scientific education, significantly aiding students in achieving deeper analytical and conclusion-drawing skills. The IPAF-D method improves students' immediate learning outcomes and equips them for future scientific undertakings. This ensures that students may apply their information effectively in a variety of circumstances.

This section explores the level of student engagement in academic activities, particularly in the context of laboratory settings. The table assesses various behaviors such as active participation in lab activities, collaboration and communication with peers, curiosity about scientific topics, initiative in learning, and a desire to deepen understanding of scientific concepts.

These statements aim to gauge how engaged students are in a hands-on and collaborative learning environment, which is crucial for fostering a deep and proactive approach to science education.

Table 5 *Student's level of academic behavior in terms of Engagement*

STATEMENTS	MEAN	SD	REMARKS
I actively participate in laboratory activities, taking a hands-on approach.	4.16	0.67	Agree
I communicate and collaborate with my peers, sharing ideas, discussing findings, and working together to achieve common goals.	3.94	0.87	Agree
I exhibit a natural curiosity about the subject matter.	4.06	0.76	Agree
I take the initiative to delve deeper into the subject matter.	4.02	0.78	Agree
I have a desire to explore scientific concepts further.	4.00	0.79	Agree
Weighted Mean		*4.03*	
SD		*0.65*	
Verbal Interpretation		*High*	

Table 5 illustrates the student's level of academic behavior in terms of Engagement. The student's level of academic behavior in terms of Engagement attained a weighted mean score of 4.03 and a standard deviation of 0.65 and was High among the respondents. The findings reveal a generally high level of engagement among students, as evidenced by their active participation in laboratory activities and their natural curiosity about the subject matter.

Overall, it clearly shows that the students generally exhibit high engagement, as reflected in their active involvement and curiosity about scientific concepts. This engagement is critical in fostering a deeper understanding and retention of course material. The high score also indicates effective pedagogical strategies that encourage students to participate actively and collaborate with peers in learning settings.

Students' academic engagement depends on a variety of factors that are related to personal learner characteristics, the teacher, the teaching methodology, peers, and other features in the learning environment. Positive interpersonal relationships enhance individuals' enthusiasm for learning which benefits sustainable learning success and self-confidence. (Mercer and Dörnyei, 2020)

This section assesses the level of students' academic behavior in terms of enthusiasm within laboratory settings, focusing on their zest for exploration, passion for science, resilience in facing challenges, collaborative spirit, and their ability to inspire others. This table reflects how students channel their enthusiasm into productive scientific inquiry and peer interaction.

Table 6 *Student's level of academic behavior in terms of Enthusiasm*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
curious and eager to explore scientific phenomena through experimentation.	4.31	0.73	Strongly Agree
exhibit a genuine passion for science and view experiments as opportunities to fuel their interest and excitement.	4.18	0.70	Agree
demonstrate resilience when faced with challenges or setbacks during experiments.	4.32	0.68	Strongly Agree
eagerly collaborate with peers and recognizing that sharing ideas enhances the overall experience.	4.31	0.70	Strongly Agree
inspire others, creating a positive and engaging atmosphere in the laboratory.	4.21	0.72	Strongly Agree
Weighted Mean **SD** **Verbal Interpretation**	4.27 0.56 Very High		

Table 6 illustrates the student's level of academic behavior in terms of Enthusiasm. The student's level of academic behavior in terms of Engagement attained a weighted mean score of 4.27 and a standard deviation of 0.56 and was Very High among the respondents. The findings indicate a very high level of enthusiasm among students, as evidenced by their strong agreement with statements related to curiosity, passion for science, resilience, and collaboration.

Overall, the students' responses strongly indicates that their eagerness to explore scientific phenomena, genuine passion for science, and resilience in overcoming experimental challenges significantly contribute to their learning experience. Additionally, their willingness to collaborate and inspire others enhances the educational environment, making it more conducive to active and engaging scientific inquiry. This high level of enthusiasm not only fosters a positive and stimulating laboratory atmosphere but also likely influences their overall academic success in science. Therefore, nurturing these traits could be pivotal in enhancing educational outcomes across similar academic settings.

This section assesses the level of students' academic behavior in terms of Focus, showcasing how students can maintain concentration and attention during their laboratory experiments. The statements examine various aspects of student focus, such as their ability to minimize distractions, their interest in learning, consistent engagement, and meticulous attention to experimental procedures.

Table 7 *Student's level of academic behavior in terms of Focus*

STATEMENTS	MEAN	SD	REMARKS
exhibit a high level of concentration and remain attentive.	4.21	0.90	Strongly Agree
minimize distractions during experiments	4.10	0.71	Agree
show interest and a desire to learn, rather than external factors.	4.28	0.70	Strongly Agree
maintained a high level of engagement throughout the experiment.	4.26	0.67	Strongly Agree
pay close attention to experimental procedures, ensuring accuracy and precision in data collection.	4.15	0.72	Agree
Weighted Mean **SD** **Verbal Interpretation**	4.20 0.59 High		

Table 7 illustrates the student's level of academic behavior in terms of Focus. The student's level of academic behavior in terms of Focus attained a weighted mean score of 4.20 and a standard deviation of 0.59 and was Very High among the respondents. The findings implies that students are not only able to maintain their engagement but also apply their knowledge meticulously, which is indicative of deep learning and thorough understanding of the laboratory exercises.

Overall, the weighted mean score indicates a very high level of academic behavior in terms of focus, highlighting students' commitment to attentive and engaged learning experiences in the laboratory. This level of focus is crucial for the successful execution of complex tasks and accurate
data collection, contributing significantly to the overall quality of experimental work. They pay close attention to experimental procedures, ensuring accuracy and precision in data collection.

This section evaluates the student's level of academic behavior in terms of Self-Efficacy, focusing on key attributes such as independent working, confidence in experimental procedures, problem-solving abilities during unexpected challenges, willingness to explore, and the application of critical thinking in evaluating results. This assessment helps to gauge how students perceive their own capabilities in navigating and succeeding in scientific experiments effectively.

Table 8 *Student's level of academic behavior in terms of Self - Efficacy*

STATEMENTS	MEAN	SD	REMARKS
can work independently	4.25	0.77	Strongly Agree
exhibit confidence in my ability to plan, conduct, and analyze scientific experiments.	4.25	0.72	Strongly Agree
demonstrate strong problem-solving skills when unexpected challenges arise during experiments.	4.20	0.78	Agree
am willing to explore and discover through experimentation.	4.23	0.73	Strongly Agree

can apply critical thinking skills to evaluate experimental results and draw meaningful conclusions.	4.15	0.79	Agree
Weighted Mean **SD** **Verbal Interpretation**	4.22 0.62 Very High		

Table 8 illustrates the student's level of academic behavior in terms of Self- Efficacy. The student's level of academic behavior in terms of Self-Efficacy attained a weighted mean score of 4.22 and a standard deviation of 0.62 and was Very High among the respondents. The data clearly show that students feel highly capable and self-assured in their experimental skills. This high self-efficacy not only boosts their confidence in planning and conducting experiments but also in tackling complex problems and making informed conclusions from experimental data. These results underline the importance of nurturing self-efficacy within educational settings to enhance students' overall academic performance and their proactive engagement in scientific learning.

The findings indicate that students show strong problem-solving skills and a willingness to explore and discover through experimentation. Although critical thinking skills application received slightly lower scores, students still show agreement in this aspect. This high level of self-confidence empowers students to effectively plan, conduct, and analyze experiments, enhancing their problem-solving skills and ability to draw meaningful conclusions.

This section assesses students' level of academic behavior in terms of Task Completion. It focuses on how effectively students organize their work, adhere to experimental protocols, understand task sequences, demonstrate determination to complete tasks, and manage time during laboratory exercises. This evaluation helps illuminate the students' ability to efficiently navigate through and complete complex scientific tasks within their learning environment.

Table 9 *Student's level of academic behavior in terms of Task Completion*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
am organize and work efficiently	4.12	0.76	Agree
can carefully follow experimental procedures, adhering to established protocols and guidelines	4.13	0.73	Agree
understand the sequence of tasks in an experiment	4.14	0.76	Agree
have the determination to see a task through to completion.	4.27	0.69	Strongly Agree
can manage my time effectively to complete each step of the experiment within the allotted timeframe.	4.15	0.73	Agree
Weighted Mean **SD** **Verbal Interpretation**	4.16 0.59 High		

Table 9 illustrates the student's level of academic behavior in terms of Task Completion. The student's level of academic behavior in terms of Task Completion attained a weighted mean score of 4.16 and a standard deviation of 0.59 and was High among the respondents. This indicates that students are generally proficient at organizing their work, following experimental procedures diligently, and managing their time

effectively to complete tasks within set deadlines. The data confirms that the students' capability to handle and complete tasks efficiently contributes significantly to their academic success in laboratory settings.

Overall, the weighted mean score suggests a high level of academic behavior in terms of task completion, indicating students' commitment and perseverance in completing laboratory tasks efficiently and effectively. This achievement not only underscores the importance of structured task management in educational settings but also highlights the students' ability to apply their learning practically and effectively.

Table 10 *Level of student's written tasks before and after utilization as to Analytical Skills*

Score	Before		After		Descriptive Equivalent
	F	%	F	%	
10	1	0.65	39	25.16	Outstanding
7 – 9	34	21.93	101	65.16	Very Satisfactory
4 – 6	93	60	15	9.68	Satisfactory
1 – 3	27	17.42	0	0	Fairly Satisfactory
0	0	0	0	0	Did not meet Expectation
Total	*155*	*100*	*155*	*100*	
Weighted Mean	*5.13*		*8.25*		
SD	*1.65*		*1.35*		
Verbal Interpretation	*Satisfactory*		*Very Satisfactory*		

Table 10 proves the level of student's written tasks before utilization as to Analytical Skills. Out of total number of one hundred and fifty-five respondents "4 to 6" received the highest frequency of ninety-three (93) or 60.00% of the total population with descriptive equivalent of Satisfactory. The scores "7 to 9" received the frequency of thirty-four (34) or 21.93% of the total population with descriptive equivalent of Very Satisfactory**.** While the scores "10" received the lowest frequency of one (1) or 0.65% of the total population with descriptive equivalent of Outstanding. With a (Weighted Mean = 5.13, SD = 1.655) it shows that the level of student's written tasks before utilization as to Analytical Skills has a descriptive equivalent of Satisfactory.

The level of student's written tasks after utilization as to Analytical Skills. Out of total number of one hundred and fifty-five respondents "7 to 9" received the highest frequency of one hundred and one (101) or 65.16% of the total population with descriptive equivalent of Very Satisfactory. The scores "10" received the frequency of thirty-nine (39) or 25.16% of the total population with descriptive equivalent of Outstanding**.** While the scores "4 to 6" received the lowest frequency of fifteen (15) or 9.68% of the total population with descriptive equivalent of Satisfactory. With a (Weighted Mean = 8.25, SD = 1.35) it shows that the level of student's written tasks after utilization as to Analytical Skills has a descriptive equivalent of Very Satisfactory.

Initially, most students demonstrated satisfactory performance, with fewer achieving very satisfactory or outstanding levels. However, post-utilization, a significant shift occurred, with a substantial increase in students reaching very satisfactory and outstanding levels, indicating a marked improvement in analytical abilities facilitated by the IPAF-D method. This underscores the method's effectiveness in enhancing students' analytical skills and elevating their written task performance.

Table 11 *Level of student's written tasks before and after utilization as to Critical Thinking*

Score	Before		After		Descriptive Equivalent
	F	%	F	%	
10	0	0	19	12.25	Outstanding
7 – 9	24	15.48	100	64.52	Very Satisfactory
4 – 6	89	57.42	36	23.23	Satisfactory
1 – 3	42	27.1	0	0	Fairly Satisfactory
0	0	0	0	0	Did not meet Expectation
Total	*155*	*100*	*155*	*100*	
Weighted Mean	*4.68*		*7.66*		
SD	*1.71*		*1.41*		
Verbal Interpretation	*Satisfactory*		*Very Satisfactory*		

Table 11 proves the level of student's written tasks before utilization as Critical Thinking. Out of total number of one hundred and fifty-five respondents "4 to 6" received the highest frequency of eighty-nine (89) or 57.42% of the total population with descriptive equivalent of Satisfactory. The scores "7 to 9" received the frequency of twenty-four (24) or 15.48% of the total population with descriptive equivalent of Very Satisfactory**.** While the scores "10" received the lowest frequency of zero (0) or 0.0% of the total population with descriptive equivalent of Outstanding. With a (Weighted Mean = 4.68, SD = 1.71) it shows that the level of student's written tasks before utilization as to Critical Thinking has a descriptive equivalent of Satisfactory.

The level of student's written tasks after utilization as to Critical Thinking. Out of total number of one hundred and fifty-five respondents "7 to 9" received the highest frequency of one hundred (100) or 64.52% of the total population with descriptive equivalent of Very Satisfactory. The scores "10" received the frequency of nineteen (19) or 12.25% of the total population with descriptive equivalent of Outstanding**.** While the scores "4 to 6" received the lowest frequency of thirty-six (36) or 23.23% of the total population with descriptive equivalent of Satisfactory. With a (Weighted Mean = 7.66, SD = 1.41) it shows that the level of student's written tasks after utilization as to Critical Thinking has a descriptive equivalent of Very Satisfactory.

Prior to implementation, most responses fell within the "Satisfactory" range, with a weighted mean score of 4.68, indicating an acceptable level of critical thinking. Conversely, after the implementation, a significant improvement was observed, with most responses categorized as "Very Satisfactory," showcasing a higher level of critical thinking skills, as evidenced by the weighted mean score of 7.66. This indicates a marked enhancement in students' ability to apply critical thinking skills effectively in their written tasks, reflecting the positive impact of the intervention on their academic performance.

Table 12 *Level of student's written tasks before and after utilization as to Application*

Score	Before		After		Descriptive Equivalent
	F	%	F	%	
10	0	0	5	3.23	Outstanding
7 – 9	5	3.23	89	57.42	Very Satisfactory
4 – 6	60	38.71	61	39.35	Satisfactory
1 – 3	81	52.26	0	0	Fairly Satisfactory
0	4	2.58	0	0	Did not meet Expectation
Total	*155*	*100*	*155*	*100*	
Weighted Mean	*3.48*		*6.81*		
SD	*1.75*		*1.36*		
Verbal Interpretation	*Fairly Satisfactory*		*Very Satisfactory*		

Table 12 proves the level of student's written tasks before utilization as to Application. Out of total number of one hundred and fifty-five respondents "1 to 3" received the highest frequency of eighty-one (81) or 52.26% of the total population with descriptive equivalent of Fairly Satisfactory. The scores "7 to 9" received the frequency of five (5) or 3.23% of the total population with descriptive equivalent of Very Satisfactory**.** While the scores "10" received the lowest frequency of zero (0) or 0.0% of the total population with descriptive equivalent of Outstanding. With a (Weighted Mean = 3.48, SD = 1.75) it shows that the level of student's written tasks before utilization as to Application has a descriptive equivalent of Satisfactory.

The level of student's written tasks after utilization as to Application. Out of total number of one hundred and fifty-five respondents "7 to 9" received
the highest frequency of eighty-nine (89) or 57.42% of the total population with descriptive equivalent of Very Satisfactory. The scores "10" received the frequency of five (5) or 2.23% of the total population with descriptive equivalent of Outstanding**.** While the scores "4 to 6" received the lowest frequency of sixty-one (61) or 39.35% of the total population with descriptive equivalent of Satisfactory. With a (Weighted Mean = 6.81, SD = 1.36) it shows that the level of student's written tasks after utilization as to application has a descriptive equivalent of Very Satisfactory.

Initially, most responses fell within the "Fairly Satisfactory" category, with a weighted mean score of 3.48, indicating a moderate level of application. However, post-implementation revealed a notable improvement, with most responses categorized as "Very Satisfactory," demonstrating a heightened proficiency in application, as evidenced by the weighted mean score of 6.81. This shift reflects the positive impact of the intervention on students' ability to effectively employ application strategies in their written tasks, highlighting their enhanced academic performance.

The section assesses the performance task levels of students after the implementation of the IPAF-D method, focusing specifically on the five (5) performance task involving enzyme concentration and temperature, Ph-potential for hydrogen factor, substrate concentration, role of chlorophyll in photosynthesis and fruit wine making. These five (5) performances evaluate four (5) key criteria: execution of the experiment, data collection, data analysis, communication of the results, and overall laboratory etiquette. This study also used four (4) rating scale for the criteria: 4 for excellent, 3 for proficient, 2 for basic and 1 for limited with a total of twenty (20) points. These metrics collectively gauge how effectively students apply the IPAF-D method to enhance their practical laboratory skills and comprehension of the scientific process in a structured experimental context.

Table 13 *Level of students' performance task after using IPAF-D method*

	PERFORMANCE TASK 1			PERFORMANCE TASK 2			PERFORMANCE TASK 3			PERFORMANCE TASK 4			PERFORMQNCE TASK 5		
CRITERIA	MEAN	SD	REMARKS	MEAN	SD	REMARKS	MEAN	SD	REMARKS	MEAN	SD	REMARKS	MEAN	SD	REMARKS
Execution of the experiment	3.37	0.50	Proficient	3.42	0.50	Proficient	3.54	0.51	Excellent	3.63	0.49	Excellent	3.71	0.46	Excellent
Data collection	3.58	0.50	Excellent	3.67	0.48	Excellent	3.79	0.41	Excellent	3.79	0.41	Excellent	3.79	0.41	Excellent
Data analysis	3.88	0.33	Excellent	3.88	0.34	Excellent	4.00	0	Excellent	3.92	0.28	Excellent	3.92	0.28	Excellent
Communication of the results	3.92	0.28	Excellent	4	0	Excellent	4.00	0	Excellent	4	0	Excellent	4.00	0	Excellent
Overall laboratory etiquette	4.04	0.20	Excellent	4	0	Excellent	4.00	0	Excellent	4	0	Excellent	4.00	0	Excellent
Weighted mean	*3.76*			*3.79*			*3.87*			*3.87*			*3.88*		
SD	*0.13*			*0.25*			*0.25*			*0.23*			*0.22*		
Verbal Interpretation	Outstanding			Outstanding			Outstanding			Outstanding			Outstanding		

Table 13 provides a result of student performance tasks after implementation of the IPAF-D method. This is based on enzyme concentration and temperature, pH factor, substrate concentration, role of chlorophyll in the photosynthesis and fruit wine making.

The data shows that the performance task 1 of the students attained a weighted mean score of 3.76 and a standard deviation of 0.13 and marks a verbal interpretation of an 'Outstanding'. This indicates that most of the students were able to meet or exceed the expectations set by the performance criteria. Given these scores, the overall descriptive equivalent for the performance can be considered 'Outstanding', demonstrating that students have a strong grasp of the material, strong comprehension, and application of the IPAF-D method in enhancing student capabilities in laboratory exercises.

The performance in Task 2, with a weighted mean score of 3.79 and a standard deviation of 0.25, distinctly places the overall student performance in the 'Outstanding' category. These results indicate that students not only have a solid understanding of pH concepts but also excel in applying them effectively in laboratory settings. The relatively low standard deviation signifies consistent performance among the students, reinforcing the reliability of these high scores. This outcome highlights the efficacy of the IPAF-D method in significantly enhancing students' comprehension and practical application of scientific skills and concepts. The data demonstrates the success of this instructional approach in fostering a deep and functional understanding of pH concepts among students.

Overall, the slight improvement in the mean score from Performance Task 1 (3.71) to Performance Task 2 (3.79) indicates a noticeable enhancement in student performance. This upward trend suggests that students were better prepared or more familiar with the expectations and requirements of the second task. The increase in mean score may reflect an effective adaptation to the testing format and subject matter, demonstrating that students are not only improving their understanding but also becoming more proficient in applying their knowledge. This positive change highlights the success of the instructional methods and the students' growing confidence and competence in handling similar tasks.

Performance Task 3 demonstrates a commendable level of student achievement in applying the IPAF-D method, earning a verbal interpretation of 'Outstanding'. The high weighted mean score of 3.87, coupled with a low standard deviation of 0.25, signifies that student consistently produced high-quality work. This consistent performance across the student group indicates that the tasks were well within their capabilities and effectively assessed their understanding and application skills. The results highlight the students' ability to proficiently utilize the IPAF-D method, showcasing both their strong grasp of the material and their practical application skills. This success underscores the efficacy of the instructional approach in fostering a deep and functional understanding among students, enabling them to perform at an outstanding level.

Comparatively, when viewed against Performance Task 1 and Performance Task 2, there is a

noticeable trend of improvement. Based on the results from the previous performance tasks, it underlines a positive trajectory in student performance across the tasks, suggesting that the IPAF-D method not only enhances student engagement but also effectively improves their capacity to handle more complex scientific concepts and procedures as they progress through the tasks.

Performance Task 4 demonstrates a notable improvement in student outcomes compared to Performance Task 3, maintaining a mean score of 3.87 but with a slightly reduced standard deviation of 0.23. This performance continues to be interpreted as 'Outstanding', consistent with the previous task. The high mean score reflects the students' strong understanding and application of the material, while the lower standard deviation in Task 4 suggests even more consistent performance across the student group. Although the mean scores remained the same, the decreased variation indicates that more students were able to achieve scores close to the high average, showcasing an enhanced uniformity in their high-quality outputs. This improvement underscores the effectiveness of the instructional methods and the students' growing proficiency in applying the IPAF-D method.

Overall, the consistent high scores in Performance Task 4 underscore the effectiveness of the instructional methods and the students' solid grasp of the material. The high concentration of scores at the "Outstanding" level indicates that as the tasks progress, students are becoming increasingly adept at practically applying their knowledge. This trend suggests a positive learning curve, where the students not only understand the theoretical aspects but also excel in translating that understanding into practical applications. The instructional methods are evidently fostering a deeper comprehension and greater confidence among students, enabling them to perform at a consistently high level.

Performance Task 5 highlights the effectiveness of the IPAF-D method focused on Fruit Wine Making, showcasing impressive student performance outcomes. The data reveals a dominant weighted mean score of 3.88 and a standard deviation of 0.22, categorizing their performance as "Outstanding." This high score and low variability indicate that students not only excelled individually but also performed consistently well as a group. The results suggest that the IPAF-D method significantly enhances students' practical skills and understanding, particularly in the context of fruit wine making. This task-specific success underscores the method's capacity to facilitate comprehensive learning and effective application of skills, reflecting the robustness of the instructional approach in nurturing high levels of student competence and achievement.

Overall, Performance Task 5, centered on Fruit Wine Making, emerges as a standout with the highest percentage of students achieving an "Outstanding" rating compared to earlier tasks, underscoring superior mastery and application of the IPAF-D method. This trend suggests a progressive refinement in students' familiarity and proficiency with the IPAF-D method as they advance through sequential tasks. The notable increase in the percentage of students reaching the highest rating signifies a deeper understanding and enhanced ability to apply learned concepts.

This progression reflects positively on the efficacy of the instructional approach and high-quality outcomes as students continue to develop their skills and knowledge.

Performance tasks are not just "add-ons" at the end of instruction. Instead, they are both an integral part of learning and an opportunity to assess the quality of student performance (Ark, 2014). However, teachers are faced with concerns of using performance tasks: the amount of time needed for the completion of tasks and the subjectivity traditionally associated with teacher assessment and assigning grades (Metin, 2014).

This section focuses on the comparative analysis examining the differences in students' written tasks before and after the implementation of the IPAF-D method, specifically focusing on analytical skills, critical thinking, and application. This analysis aims to determine the method's impact on enhancing these crucial cognitive abilities in educational settings.

Table 18 *Test of Difference between the student's written tasks before and after using IPAF D method*

Written tasks	**Before**	**After**				**Sig (2-**

	Mn	SD	Mn	SD	Mean Difference	T	Df	tailed)
Analytical Skills	5.13	1.65	8.25	1.35	3.22	-19.21	154	0.000
Critical Thinking	4.68	1.71	7.66	1.41	2.98	-17.99	154	0.000
Application	3.48	1.75	6.81	1.36	3.33	-19.90	154	0.000

*Legend: *Significant at 0.05*

Shown in Table 18 is the test of difference between the student's written tasks before and after using IPAF-D method.

Data obtained through a paired t-test indicated that the increase in the scores is significant ($p < 0.05$). This implies that the students performed better after using the IPAF-D method. Their level of student's written tasks of IPAF-D method has significantly improved to a Very Satisfactory.

Table 19 *Significant effect of utilization of IPAF-D method on student's academic behavior*

Academic behavior	B	SE	B	T	P
Constant	0.431	0.268		1.605	0.111
Integration of Prior Knowledge		0.064	0.410	6.450*	<0.01
Predicting Outcome		0.061	0.114	1.859	0.065
Analyzing Data		0.054	0.341	6.312*	<0.01
Formulate-Draw Conclusions		0.044	0.014	0.322	0.748
R-squared			0.675		
Adjusted R-squared			0.667		
Standard Error of the Estimate		0.299			
F(4, 150)				78.014*	<0.01

*p < 0.05

The table 19 presents the results of a multiple regression analysis examining the effect between academic behavior and Integration of Prior Knowledge, Predicting Outcome, Analyzing Data and Formulate-Draw Conclusions. The regression model explains 67.5% of the variance in academic behavior (R-squared = 0.675). Integration of Prior Knowledge has a significant positive effect with academic behavior ($\beta = 0.410$, $p < 0.01$), and Analyzing Data has a significant positive effect with academic behavior ($\beta = 0.341$, $p < 0.01$), indicating that Integration of Prior Knowledge, and Analyzing Data has a significant positive effect with academic behavior.

The F-test of the overall model is significant, indicating that the regression model is a good fit for the data. The standard error of the estimate is 0.299, reflecting the average deviation between observed and predicted academic behavior.

Table 20 *Significant effect of utilization of IPAF-D method on student's performance tasks*

Performance tasks	B	SE	β	t	P
Constant	100.099	3.219		31.095*	<0.01
Integration of Prior Knowledge		0.762	-0.35	-0.460	0.646
Predicting Outcome		0.733	-0.56	-0.764	0.446
Analyzing Data		0.647	0.755	1.167	0.245

Formulate-Draw Conclusions	0.529	-0.87	-1.637	0.104
R-squared		0.030		
Adjusted R-squared		0.004		
Standard Error of the Estimate	3.589			
F(4, 150)			1.149	0.336

*p < 0.05

The table 20 presents the results of a multiple regression analysis examining the effect between performance tasks and Integration of Prior Knowledge, Predicting Outcome, Analyzing Data and Formulate-Draw Conclusions. The regression model explains 3% of the variance in performance tasks (R-squared = 0.030). Integration of Prior Knowledge, Predicting Outcome, Analyzing Data and Formulate-Draw Conclusions has no significant effect with performance tasks.

The F-test of the overall model is significant, indicating that the regression model is not a good fit for the data. The standard error of the estimate is 3.589, reflecting the average deviation between observed and predicted performance tasks.

This section will highlight the effects of the IPAF-D method on the student's academic behavior and performance in biology. The study will serve as the foundation for the formulation of the teacher's enhanced implementation of the IPAF-D method. As the result of the study, three themes emerged: students, perception and behavior in using IPAF-D method, Impact of IPAF-D method in students analytical, critical and metacognitive skills and Influence of IPAF-D method on students' performance.

4. Conclusion and Recommendations

On the basis of the foregoing findings, the following conclusion was drawn.

The study shows that the hypothesis stated that the use of the IPAF-D method in laboratory exercises has a significant difference in the learner's academic behavior and performance, thus rejecting the last hypothesis. Meanwhile, use of the IPAF-D method in laboratory exercises has a significant effect on the learner's academic behavior, thus rejecting the first hypothesis. The use of the IPAF-D method in laboratory exercises has a significant effect on the learner's performance, thus rejecting the second hypothesis. It means that the implementation of the IPAF-D method in laboratory exercises significantly impacts learners' academic behavior and performance in biology, thus rejecting all null hypotheses.

Lastly, the implementation of the IPAF-D method such as integrating, predicting, analyzing, and formulating conclusions, the student can synthesize their findings effectively. The student highlights how the method aids in expanding their ideas further, indicating a deeper level of critical thinking, analytical skills and idea refinement. The students also enhanced their focus and engagement as factors influenced their academic behavior after the utilization of the IPAF-D method in their laboratory exercises. The IPAF-D method has demonstrated significant benefits for students' academic development.

Based on the findings and conclusion drawn, the following were recommended:

1. Teachers may consider incorporating more structured training and practice sessions focused on these dimensions to further reinforce students' skills and sharing best practices to enhance the effectiveness of the IPAF-D method in educational settings.
2. Teachers may encourage students to capitalize on their demonstrated enthusiasm and self-efficacy by continuing to engage deeply with laboratory exercises and to develop specific strategies like setting clear goals, organizing study schedules, and minimizing distractions during study sessions.

3. School heads may encourage to support and continue the development of curriculum and training that foster analytical skills, critical thinking, and metacognitive abilities among students.

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