

"Effectiveness of 5Ps Authentic Assessment on the Normalized Gained Scores of Grade- 9 Students in Non-Mendelian Genetics"

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Abstract

This study aimed to determine the effectiveness of the 5Ps Authentic Assessment on Normalized Gained Knowledge of grade 9 students. The respondents of the study were the 120 Grade 9 learners in the Division of Cabanatuan City. 20 students per school participated in Camp Tinio National High School, Eastern Cabu National High School, Cesar E. Vergara Memorial High School, Marciano del Rosario National High School, Mayapyap National High School, and San Josef National High School. The respondents were grouped into control and experimental groups. A quasi-experimental research design was used in the study. Both groups took the pre-test and utilized the Self Learning Module. However, the control group was exposed to the 50-item quiz while learners in the experimental group utilized the 5Ps authentic assessment. Pre-test and post-test were used to gauge the respondents' improvement in terms of mean scores. Experiences in using the 5Ps authentic assessment were also gathered from the experimental group. T-tests were used to determine if there was a significant difference in the pre-test and post-test scores of the control and experimental groups. The result showed that there was no significant difference in the pre-test scores of the control and experimental groups with 23.92 and 22.17 mean scores respectively. Meanwhile, the post-test mean scores of the control and experimental group were 28.72 and 35.25 respectively, implying that there was a significant difference in post-test mean scores of the control group. There is a positive correlation between profile variables and authentic assessment, except sex. It has the same result in the relationship between profile variables and Normalized gained knowledge. However, the Normalized gained score has a high positive correlation with authentic assessment. The higher the authentic score, the higher the Normalized gained score. This signifies that the 5Ps authentic assessment is an effective teaching aid to get higher Normalized gained knowledge from the least learned topic in Science which is the Non-Mendelian Genetics.

Keywords: 5Ps Authentic Assessment; Multiple Intelligences; Normalized Gained Knowledge; Non-Mendelian Genetics, Picture-Based Diagram, Poem Making, Portfolio, Probing, Problem Solving, Self-Learning Module

1. Introduction

People are currently living in an era of accelerating change as concerns not only technological developments but education as well. Hence, the skills and competencies needed for work and life in the 21st century are continuously evolving.

Filipino students' poor achievement levels in science have been documented for several years now. For instance, the Philippines ends up in the low 70s in science in the 2018 Programme for International Student Assessment (PISA), a student assessment of 15-year-old learners across 79 countries done by the Organization for Economic Co-operation and Development (OECD).

According to BouJaoude, Hamdan, & Osman (2016), middle and secondary school students exhibit a poor understanding of genetics. Findings showed that patterns of Genetics, the deterministic nature of genes, and

the nature of genetic information were found to be among the most difficult concepts to learn. Students also showed an inadequate understanding of many basic genetic concepts exhibited a low level of genetics literacy. In the Philippines, genetics is considered one of the least mastered skills and competencies among grade 8 students (Balan, 2018). These difficulties originate mainly from the domain-specific vocabulary and terminology, the mathematical content of non-Mendelian genetics, the cytological processes, the complex nature of genetics, and the abstract nature of the subject matter.

Moreover, it criticized the traditional teaching approach and suggested the development of more alternatives. Moreover, among all the learning competencies in Science 9 which were mandated by the Department of Education, S9LT-Id-29 explains the different patterns of Non-Mendelian Inheritance and was also listed in the most recent Comprehensive Analysis on Least Learned Competency in the Division of Cabanatuan last school year 2018-2019.

Concerning this, an additional burden shouldered by the stakeholders of education is the emerging, and rapidly evolving situation of Covid 19. A record from the Manila Times (2020), covid-19 crisis has affected about 27 million learners, 1 million teachers and non-teaching staff, as well as the families of learners in the Philippines. This made way of DepEd Order No. 12 s. 2020 entitled "Adoption of the Basic Education Learning Continuity Plan for School Year 2020-2021 in Light of the Covid-19 Public Health Emergency" streamlines that K to 12 Curriculum. This made way for modular learning, a form of distance learning that employs the use of Self-Learning Modules (SLM). These are based on the Most Essential Learning Competencies (MELCS) provided by DepEd.

As the students study at their own pace using SLM, it would be beneficial when knowledge is gained in a way that promotes the gaining of knowledge. Students forget much of what they learn, therefore they could benefit from learning strategies that yield long-lasting knowledge. Yew and Goh (2016) confirmed that authentic activities are effective teaching and learning approaches, particularly when it is evaluated for long-term knowledge retention and applications. Moreover, another study suggests that student engagement with authentic assessment is sufficient to enhance students' learning gains over the traditional approach, nonetheless, the collaborative component did not make a significant difference to student learning.

Alternative assessment, often called authentic, comprehensive, or performance assessment, is usually designed by the teacher to gauge students' understanding of the material. It usually includes a task for students to perform and a rubric by which their performance on the task will be evaluated. This has been referred to as planning backward.

Grades as feedback, and one factor relates to how the students perceive the general learning environment and subject matter. According to Colleta and Staine (2020), Hake's Normalized Gained Knowledge model has been used by many for the last 20 years to provide that valuable information, which is often used to guide instructors toward the use of more effective methods. If students do not feel that their performance in the assessment procedures of their teachers reflect their actual learning, the students may not be fully attaining the curricular goals and still be passing the science subjects. Thus, there is a need to evaluate the effectiveness of authentic assessment in knowledge retention of the Grade 9 students in Non-Mendelian Genetics.

2. Review of Related Literature

Different Types of Assessment

Traditionally, assessments measure whether the students have met standards set by the state, the district, or the classroom teacher. Diagnostic assessment is crucial in the teaching and learning process as it provides quality control measures by assessing learners' strengths and weaknesses for remediation. Diagnostic assessment specifies learning goals and objectives (Nancy, 2012), as it serves as an indicator of the education system's effectiveness or ineffectiveness (Gani, 2015). Moreover, formative assessment aims to monitor student learning to provide ongoing feedback, and since considered part of the learning, and used during instruction rather than at the end of a unit or course of study (Alber, 2011), they need not be graded as summative assessments are. (Dodge, 2021). Summative assessment is a powerful tool to quantify student learning (Lynch, 2016), but it yields data too late to inform current-year teaching practice (Dyer, 2016). Formative assessment is the only type of assessment that can provide teachers with timely data to help students learn more effectively. Interim assessments are administered over several intervals during the school year to allow educators to compare findings and track the growth of entire classes or institutions (Moody, 2019). Authentic assessment is undeniably formative as it focuses on the direct participants, the teacher and the students, in the present or immediate future points that are expanded in later sections (2011).

Authentic Assessment

Philippine Normal University (2018) defined authentic assessment, often called performance tests or alternative assessments as tool to establish what students can and cannot do rather than what they know. In other words, an alternative assessment focuses on applied skills rather than knowledge. Portfolios, project work, and other tasks needing a rubric are common examples of alternative evaluations. Moreover, Indiana University Bloomington (2019) classified an authentic assignment as one that encourages students to apply what they've learned to a new situation and enables them to make decisions about what information and abilities are important and how they should be used. In addition, findings from the study of Arawiran (2018), authentic assessment provides a holistic approach to classroom assessment. Most students' skills competency profiles are in the very good category, while most knowledge competencies are in the sufficient category. for each problem indicator (Ambiyar et al., 2020). Stern and Kampourakis (2017) mentioned that various innovative methods based on empirical studies suggest that students' learning of genetics could be enhanced, for instance through inquiry games, open-problem solving, peer-teaching of lower-level students, and playful activities involving cats. Authentic assessment is perceived to be more significant and relevant since it boosts motivation, promotes effective learning, and exhibits students' knowledge, skills, and abilities. Authentic assessment improves students' achievement both directly and indirectly (Pantiwati, 2013).

Comparable Studies on Authentic Assessment and Other Types of Assessment

Students were more engaged in the learning process when the standard paper-pencil examination was replaced with realistic evaluation (Azim, 2012), develop flexible groupings and subgroupings (McAfee and Leong, 2011), was able to scaffold the learners to attain what they need in the future and fostered positive attitudes (Rahayu, Sabtiawan and Yuanita, 2019). Hence, the more relevant the assessment to real-world scenarios, the less likely students are to engage in misconduct (Daily, 2019). Moreover, Muller (2014) claimed that students must be allowed to engage in the construction of meaning as well as demonstrating accurately their constructed meaning about what they have been learned. Traditional assessments usually only indicate

whether or not a student can recognize, retain, or "plug in" what they've studied out of context. Authentic evaluations examine at whether a student can produce polished, thorough, and defensible answers, performances, or products (Grant, 2014). In Australia, University of New South Wales (2021) stated that more traditional forms of assessment, such as essays and examinations, have no specific application in most real-world settings, while authentic assessment engages productively and shows boosting the level of capacity

or competency. However, in California, University of the People (2021), claimed that it may work best in combination with tests.

Effects of Assessment to Students Gaining Knowledge

Assessment can be viewed as being a means of helping students to learn, a way of reporting on student progress, and a way of making decisions about teaching. Effective assessment leads direct evidence of student learning (Jimaa, 2011) and it closes the gap between learners' current status and their intended learning goals (Heritage, 2012). It reflects in evaluating stakeholders for whom assessment takes place (Baker et al., 2013). Assessment is intended to assist learning while instruction and learning are taking place. "Nothing we do to, or for our students is more important than our assessment of their work and the feedback we give them on it. The results of our assessment influence students for the rest of their lives... (Race et al., 2014)". Assessment motivates students by emphasizing the need for more critical thinking, reasoning, and reflection, leads to a positive learning environment (Fletcher et al., 2014). Sekeres et al. (2016) peer-to-peer explanation does not only increase retention but also encourages active learning. Moreover, problem solving interleaving forces students to think on their feet, and encodes learning more deeply (Rohrer, Dedrick, & Stershic, 2015), while it is easier to remember what's been read and seen, instead of either one alone (Bui & McDaniel 2015). As mentioned by Khon (2014), an average of 50% of the information you presented will be forgotten by the learners. Within 24 hours, they have forgotten an average of 70% of new information, and within a week, they have forgotten an average of 90%.

Hake's Normalized Gained Knowledge

Hake's Normalized Gained Knowledge, introduced by Hake in 1998, is a rough indicator of a course's effectiveness in promoting conceptual understanding. For the past 20 years, many have used it as a metric for changes in student performance (Colleta and Staine, 2020) and tests of the practical significance of the gains (Miller, 2016). Hake calculates the "average normalized gain," symbolized, as the ratio of the average gain from pretest to posttest to the maximum possible gain (Freeman, 2014). Normalized gain is the change in the class average score divided by the maximum possible gain. Hake (1998) used to gauge the relative effectiveness of various instructional techniques employed in introductory physics courses (Fadaei, 2019). Meltzer (2019) used to explore the relationship between mathematics preparation and concept learning in physics. It is the standard measure which is not prescore biased in differentiating teaching methods, as well as consistent analysis over diverse student populations with widely varying initial knowledge states. (Madsen, McKagan, Sayre, 2017). Since both pre- and post assessment scores are required for the calculation, gain scores were only calculated for students who answered both the pre-exam and final exam version of a particular question Coletta, Phillips, and Steinert (2014). However, Hake's Normalized Gain Knowledge has limitation for it has been criticized normalized gain as being inappropriate for community colleges and other institutions with large drop rates. It is often used at universities with drop rates of 5-10% (Madsen, 2017). Lasry et al. (2017) clarified that normalized gain "implicitly implies that losses are zero" and does not take into account students who perform poorly on both the post-test and the pre-test.

Non-Mendelian Genetics

Learners have limited prior knowledge about Non-Mendelian Genetics which is further supported by Yesilyurt and Gul (2012) who said that students have a difficult time in learning and understanding some of the topics in Biology. Ramesh et al. (2020) affirming that majority of the students have misconceptions on basic topics in Biology. Non-Mendelian inheritance is a general term for any inheritance pattern in which features do not segregate according to Mendel's principles (Aryal, 2018). It plays a role in several disease processes (Finland, 2018) as it reveals the types of interactions that control more complex disease genetics Heyningen, 2011) using the idea of sex-linked traits. Punnett square is a graphical representation that shows possible outcomes for a genetic cross between two individuals (Phelan, 2013). Douglas (2021) differentiated codominance as when the two parent phenotypes are expressed together in the offspring, while codominance is when both phenotypes of parents are expressed. Scoville (2019) elaborated it by giving an example of red and flower produced pink offspring is incomplete dominance, while white and red patches flower is codominance. Multiple alleles involves more than just the typical two alleles and good example of this is human blood type (Scoville, 2018).

Academic Underachievement and Instructional Interventions

Academic underachievement has been a great concern in the field of education. According to the Philippine Center for Gifted Education (PCGE) Inc. (2015), in compliance with DepEd Order No. 8, s. 2013, teachers have to familiarize themselves with the research done on pupil/student underachievement, and familiarize themselves with the research done on pupil/student underachievement. As stated by Cambridge University Press (2014), underachievers are generally believed to be from lower socioeconomic and larger families. Cohen, Dweck, and Lin-Siegler (2016) claimed that building students' perceptions of themselves, their surroundings, and what it takes to excel in intellectual activities can all affect their motivation and, as a result, their academic success. In general, gifted underachievers benefited from the interventions, according to Calvert, Olszewski Kubilius, and Steenbergen-Hu (2020), in terms of increased enthusiasm for learning, enhanced self-regulation, and a more meaningful school experience. Logistic regression analysis in self-efficacy, use of text-reduction strategies, and anxiety were used by Obergriesser, and Stoeger (2015) as intervention among underachievers which resulted in positive intervention effects for learning behavior among gifted underachievers, but no intervention effects on the self. Moreover, Reis (2011) concluded that interventions to reverse gifted underachievement usually fall into two general categories: counseling and instructional interventions. Most counseling interventions concentrate on changing the personal and / or family dynamics that contribute to a student's underachievement. The large percentage of counseling interventions focus on altering personal and or familial dynamics that contribute to a student's academic underachievement.

3. Methodology

This study employed a quasi-experimental design to assess the effectiveness of the 5Ps Authentic Assessment on Grade 9 students' knowledge gain in Non-Mendelian Genetics across six high schools in Cabanatuan City, Philippines. A sample of 120 students was divided into control and experimental groups through purposive sampling and matched based on pre-test scores. Data collection included a pre-test and post-test on genetics concepts and a 5Ps Authentic Assessment rubric, which evaluated skills in problem-solving, diagramming, probing, poem making, and portfolio development. Descriptive statistics summarized participant characteristics, while T-tests and correlation analysis assessed the intervention's impact and its

relationship with normalized gain scores. Ethical protocols were followed, and limitations on generalizability were noted due to the specific focus on Grade 9 science students and non-Mendelian genetics. The reliability and validity of these instruments were established through expert review and pilot testing, resulting in Cronbach's alpha values above 0.80, indicating strong internal consistency. Data analysis includes frequency distribution and percentage, Pearson Correlation, T-test, and weighted mean to determine the average degree of each response.

4. Result and Discussion

Out of 120 students among the 6 high schools in the School Division of Cabanatuan City, 53 were 15 years old, with a percentage of 44.14%, and most of the respondents were female, as shown by the frequency of 79 or 65.83%. Additionally, 83 or 69.17% of the respondents are with their mother/father. Mostly, the respondents have an academic award with honors during their 8th grade, having a frequency of 81 or 67.50%, and respondents' grades in science 8 are in the range of 90 to 100 frequency of 62 or 51.67%. Meanwhile, each chosen school has an equal number of respondents, having a frequency of 20 or 16.67% each.

Table 1. Frequency Distribution of Grade 9 Students in terms of Age, Sex, School, Primary Guardian at Home, Honors Received during 8th Grade, Grade in Science 8 and General Weighted Average

Profile of the Respondents		Frequency	Percentage
Age			
	17	2	1.67
	16	37	30.83
	15	53	44.17
	14	28	23.33
	Total	120	100
Sex			
	Male	41	34.17
	Female	79	65.83
	Total	120	100
School			
	Camp Tinio National High School	20	16.67
	Cesar E. Vergara Memorial High School	20	16.67
	Eastern Cabu National High School	20	16.67
	Mayapyap National High School	20	16.67
	Marciano del Rosario Memorial National High School	20	16.67
	San Josef National High School	20	16.67
	Total	120	100
Primary Guardian at Home			
	Father/ Mother	83	69.17

Grandmother/ Grandfather	22	18.33
Brother/ Sister	8	6.67
Aunt/ Uncle	7	5.83
Total	120	100
Honors Received during 8th Grade		
With Highest Honors	0	0
With High Honors	8	6.67
With Honors	81	67.50
None	31	25.83
Total	120	100
Grade in Science 8		
90-100 (Outstanding)	62	51.67
85-89 (Very Satisfactory)	31	25.83
80-84 (Satisfactory)	26	21.67
75-79 (Fairly Satisfactory)	1	0.83
Below 75 (Did not meet expectations)	0	0.00
Total	120	100

The findings align with DepEd policies (Department of Education [DepEd], 2016, 2018), which emphasize age-appropriate school entry and the value of academic recognition as a means of motivating learners. Female students showed higher participation in academic activities; however, Aguillon et al. (2020) found that male students often exhibited greater participation, especially in classroom discussions. Azubuike and Aina (2020) highlighted how, during the COVID-19 pandemic, parents assumed full responsibility for their children's learning, using both traditional and modern tools despite limited teaching experience. DepEd Order No. 36, s. 2016 reinforces that recognition supports student confidence and motivation. Although few learners attain the highest awards, such systems validate their efforts and offer opportunities for educators to further affirm learner achievement.

Table 2. Pre-test Scores of Control Group

Pre-test of Control Group	Frequency	Percentage
41-50 Outstanding (O)	1	1.67
31-40 Very Satisfactory (VS)	15	25
21-30 Satisfactory (S)	24	40
11-20 Fairly Satisfactory (FS)	14	23.33
0-10 (Did Not Meet Expectation)	6	10
Total	60	100%
Mean Score: 23.92 Satisfactory (S)		

The findings show that most students scored at the "Satisfactory" level on the pre-test, with 40% (24 out of 60) scoring between 21 and 27 out of 50 points. The experimental group's mean score was 23.92, also in the "Satisfactory" range. The assessment consisted of 50 multiple-choice questions on Non-Mendelian Genetics, which the students found particularly challenging, especially regarding Punnett square calculations. All students (100%) scored below the 75% passing mark, with scores ranging from 6 to 37, indicating a limited

understanding of Non-Mendelian Genetics. The exclusive use of a multiple-choice format may have prevented deeper conceptual learning. This aligns with Yesilyurt and Gul (2012), who noted that students struggle with biological concepts, and BouJaoude, Hamdan, and Osman (2016), who found that middle and secondary students lack a solid understanding of genetics due to misconceptions and conceptual difficulties.

Table 3. Pre-test Scores of Experimental Group

Pre-test of Control Group	Frequency	Percentage
41-50 Outstanding (O)	0	0
31-40 Very Satisfactory (VS)	13	21.67
21-30 Satisfactory (S)	24	40
11-20 Fairly Satisfactory (FS)	15	25
0-10 (Did Not Meet Expectation)	8	13.33
Total	60	100%
Mean Score: 22.17 Satisfactory (S)		

The findings reveal that a significant proportion of students are at the "Satisfactory" level of achievement. Specifically, 40% (24 out of 60) of respondents attained raw scores between 21 and 26 on the pre-test, while 21.67% (13 out of 60) achieved a "Very Satisfactory" level with scores from 31 to 35. The experimental group recorded a mean score of 22.17, and no student exceeded a score of 34, indicating that none reached the "Outstanding" level. Despite the majority being classified as "Satisfactory," all 100% (60 out of 60) of respondents scored between 6 and 37, falling below the 75% passing mark. This suggests that most participants in the experimental group are still at the "Approaching Efficient" stage in understanding Non-Mendelian Genetics. According to Department of Education Memorandum Order No. 158, s. 2011, students at this level possess essential knowledge but require support in authentic tasks. Arawiran (2018) noted that authentic assessment offers a holistic framework for evaluation, integrating formative assessments with summative tasks. Additionally, the Programme for International Student Assessment (PISA) 2018 report highlighted that very few students in the Philippines reached the top performance levels in science, underscoring the need for improved proficiency in applying scientific knowledge to diverse contexts.

Table 4. Post-test Scores of Control Group

Post-test of Control Group	Frequency	Percentage
41-50 Outstanding (O)	4	6.67
31-40 Very Satisfactory (VS)	28	46.67
21-30 Satisfactory (S)	16	26.67
11-20 Fairly Satisfactory (FS)	7	11.67
0-10 (Did Not Meet Expectation)	5	8.33
Total	60	100%
Mean Score: 28.72 Satisfactory		

The findings indicate that most students are classified at the "Very Satisfactory" level. Specifically, 46.67% (28 out of 60) of respondents scored between 31 and 39 on the post-test, while 6.67% (4 out of 60) achieved outstanding scores of 41 to 42. The experimental group attained a mean score of 28.72, interpreted as "Satisfactory." Furthermore, the control group, which utilized multiple-choice questions, showed knowledge acquisition, with a mean difference of 4.81 between pre-test and post-test scores, highlighting improved understanding of Non-Mendelian Genetics. These results suggest that regular multiple-choice assessments significantly enhanced students' abilities to answer questions. According to McDermott et al.

(2013) and Abou-Khalil et al. (2021), prioritizing student needs during remote learning is essential. Educators must facilitate effective interaction with students, which allows for diversified instructional strategies, feedback exchange, and clarification of misconceptions.

Table 5. Post-test Scores of Experimental Group

Post-test of Experimental Group	Frequency	Percentage
41-50 Outstanding (O)	17	28.33
31-40 Very Satisfactory (VS)	28	46.67
21-30 Satisfactory (S)	12	20
11-20 Fairly Satisfactory (FS)	2	3.33
0-10 (Did Not Meet Expectation)	1	1.67
Total	60	100%
Mean Score: 35.25 Very Satisfactory		

The findings indicate that a majority of students in the experimental group achieved a "Very Satisfactory" level on the post-test, with 46.67% (28 out of 60) scoring between 31 and 40. Additionally, 28.33% (17 out of 60) reached the "Outstanding" level, with scores ranging from 41 to 47. The mean score for the group was 32.25, also within the "Very Satisfactory" range. These outcomes suggest that the 5Ps Authentic Assessment significantly improved students' understanding of Non-Mendelian Genetics. This approach was particularly effective for students who had previously struggled with the subject. The 5Ps strategy, which included Problem Solving (P1), Picture-Based Diagrams (P2), Probing (P3), Poem Making (P4), and Portfolios (P5), enabled engagement through various modalities. Outputs were evaluated using validated rubrics tailored to each task, fostering critical and creative thinking. Hammon (2010) emphasized that diverse methods of knowledge demonstration enhance student engagement and provide educators with a clearer view of understanding. Clement (2015) noted that integrating research tasks with classroom interactions facilitates real-world application of concepts. Yew and Goh (2016) confirmed that authentic activities effectively promote knowledge acquisition. Furthermore, while collaborative elements may not significantly affect learning gains, engagement in authentic assessments has shown to outperform traditional instructional methods.

Table 6. Normalized Gained Score of Control Group

Normalized Gained Score	Verbal Interpretation	
Control	0.14	Low
LEGEND: -1.00<g<0.00 Decrease g=0.00 Stable 0.00<g<0.030 Low 0.30<g<0.70 Average 0.70<g<1.00 High		

The findings in Table 6 show that the control group achieved a Normalized Gain of 0.14, indicating low conceptual improvement based on Hake's (1998) criteria. Despite a mean gain of 4.81 points, the increase was insufficient to reflect deep learning in Non-Mendelian Genetics. The exclusive use of a 50-item multiple-choice quiz and a Self-Learning Module appeared inadequate in engaging students or addressing varied learning styles. This highlights the need for more inclusive and diversified assessment methods. Especially during the disruptions caused by the COVID-19 pandemic, student-centered approaches are essential. As Madsen, McKagan, and Sayre (2017) noted, Hake's Normalized Gain remains a reliable tool for measuring instructional effectiveness across diverse learner groups.

Table 7. Normalized Gained Score of Experimental Group

Interpretation	Normalized Gained Score		Verbal
	Control	0.46	Average

LEGEND:
 $-1.00 < g < 0.00$ Decrease
 $g = 0.00$ Stable
 $0.00 < g < 0.30$ Low
 $0.30 < g < 0.70$ Average
 $0.70 < g < 1.00$ High

The findings in Table 7 indicate that the experimental group achieved a Normalized Gain of 0.46, categorized as average according to Hake's (1998) framework. This reflects improved conceptual understanding of Non-Mendelian Genetics through the 5Ps Authentic Assessment. By incorporating diverse tasks, this method supported varied learning styles and enhanced student engagement. Hammond (2011) highlighted that offering multiple ways to demonstrate learning improves both achievement and assessment accuracy. Similarly, Stern and Kampourakis (2017) emphasized the value of innovative strategies like inquiry games and peer teaching, while Morgan (2014) affirmed that differentiated instruction benefits all learners by addressing diverse intelligences.

Table 8. 5Ps Authentic Assessment of Experimental Group

5Ps Authentic Assessment	Mean Score	Verbal Description
Problem solving	35.42	Very Satisfactory
Picture-based diagram	33.5	Very Satisfactory
Probing	39.42	Very Satisfactory
Poem making	34.67	Very Satisfactory
Portfolio	37.92	Very Satisfactory
Overall Mean	36.19	Very Satisfactory

Table 8 shows that the experimental group assessed through the 5Ps Authentic Assessment achieved a "Very Satisfactory" mean score of 36.19. Using a researcher-developed Self-Learning Module, students completed tasks targeting multiple intelligences. The *Probing* (P3) activity, involving virtual interviews with science professionals, had the highest mean score of 39.42, reflecting strong interpersonal intelligence—supported by Briggs (2013) and Fernandez et al. (2019), who emphasized the benefits of peer-assisted and inquiry-based learning. The *Portfolio* (P5) task, with a mean score of 37.92, engaged students in real-world observation and application of non-Mendelian inheritance, fostering naturalistic intelligence. Ahvan and Pour (2016) found such intelligences positively linked to academic achievement. Supporting this, Kuo (2017) noted that outdoor learning improves performance and motivation, especially among underserved students. Hammond (2016) and Gardner's multiple intelligences theory further support the use of diverse assessment methods to enhance engagement and recognize varied learner strengths.

Table 9. Correlation between Authentic Assessment and Profile Variables

Profile	Pearson Correlation	Sig. (2-tailed)	N	Verbal Description
Age	0.244*	0.000	60	Significant
Sex	-0.273*	0.000	60	Significant
Primary Guardian at Home	0.737	0.000	60	Significant
Honors Received during 8th Grade	0.835	0.000	60	Significant
Grades in Science 8	0.878	0.000	60	Significant

Legend: *Significant at 0.05 level. There is significant relationship between grade in profile variables of the respondents and authentic assessment. The hypothesis of no significant difference is rejected.

The data in Table 9 highlight several significant correlations between student characteristics and performance in the 5Ps Authentic Assessment. The correlation between age and performance yielded an r value of 0.244 ($p < .001$), indicating a small yet significant positive relationship, where older students demonstrated better performance. This aligns with findings from Kagan, Shapard, and Wurtz (2011), who noted challenges in assessing younger learners, while Artwig (2016) suggested that authentic assessment can reveal developmental understanding in children. Regarding gender, the correlation coefficient was $r = -0.273$ ($p < .001$), indicating a small but significant negative correlation, with male students outperforming female students, possibly due to higher academic self-concept (Cooper, Kieg, & Sara, 2018). This contrasts with Klein et al. (2018) and Volchok (2018), who reported that female students often excel due to greater discipline and motivation. The correlation between parental support and performance was $r = 0.737$ ($p < .001$), reflecting a moderate positive relationship. Students with active parental involvement showed enhanced engagement and achievement, consistent with findings from the National Coalition for Parent Involvement in Education (2019) and others. A strong correlation was found between honors received in Grade 8 and performance on the assessment ($r = 0.835$, $p < .001$), indicating that honor students are more engaged. Research from Beukelen (2016) and James and Steve (2018) supports this idea, as does Adams Becker et al. (2018), who emphasized the motivational benefits of recognition. Lastly, Science 8 grades showed a high positive correlation with assessment performance ($r = 0.878$, $p < .001$), confirming that prior science achievement strongly predicts success in authentic tasks, consistent with Caso (2019).

Table 10. Correlation between Normalized Gained Knowledge and Profile Variables

Profile	Pearson Correlation	Sig. (2-tailed)	N	Verbal Description
Age	0.235	0.000	120	Significant
Sex	-0.291	0.000	120	Significant
Primary Guardian at Home	0.717	0.000	120	Significant
Honors Received during 8th Grade	0.855	0.000	120	Significant
Grades in Science 8	0.919	0.000	120	Significant

A weak but significant positive correlation was found between age and normalized gained knowledge ($r = 0.235$, $p < .001$), indicating that older learners achieved slightly higher gains. This may be due to their cognitive maturity, motivation, and broader experiences, which enhance engagement in various learning tasks (Kagan et al., 2011; National Institute on Aging, 2020). The null hypothesis is rejected. A weak negative correlation between sex and normalized gained knowledge ($r = -0.291$, $p < .001$) suggests male learners performed slightly better. This may be linked to greater engagement in activity-based tasks (Clara, 2020), although global data show females outperform in reading (Balart & Oosterveen, 2019). The null hypothesis is rejected. A moderate positive correlation between primary guardian and normalized gained knowledge ($r = 0.717$, $p < .001$) highlights the positive impact of parental involvement (Chohan & Khan, 2011; Lara & Saracostti, 2019). Learners guided by parents showed higher gains. The null hypothesis is rejected. A strong positive correlation was observed between honors in Grade 8 and normalized gained knowledge ($r = 0.855$, $p < .001$). Recognized students demonstrated greater gains, affirming the motivational role of awards (DepEd Order No. 36, s. 2016). The null hypothesis is

rejected. A very strong positive correlation between Science 8 grades and normalized gained knowledge ($r = 0.919$, $p < .001$) underscores the influence of prior knowledge on current achievement (Barron et al., 2019). The null hypothesis is rejected.

Table 11. Correlation Between Authentic Assessment and Normalized Gained Knowledge

		Normalized Gained Knowledge	Verbal Description
Authentic Assessment	Pearson Correlation	0.970	
	Sig. (2-tailed)	0.000	
	N	60	
			Significant

Legend: *Significant at 0.05 level. There is significant relationship between authentic assessment and Normalized gained knowledge. The hypothesis of no significant difference is rejected.

Table 10 shows a strong positive correlation ($r = 0.970$, $p = .000$) between authentic assessment and normalized gained knowledge, indicating a significant relationship and supporting the rejection of the null hypothesis. The results suggest that higher authentic assessment scores align with greater knowledge gains. The 5Ps Authentic Assessment framework, grounded in Gardner's Multiple Intelligences theory, helps students analyze Non-Mendelian Genetics by leveraging their individual strengths. This approach supports differentiated instruction and promotes knowledge transfer from modules to real-world contexts. Authentic assessments encourage metacognition and boost academic performance (Mitchell, 2015). Recognizing diverse intelligences enhances student motivation and comprehension. As noted by Magda and Moati (2016), this theory effectively addresses learning needs and fosters engagement through problem-solving and critical thinking.

Table 12. Comparison Between Pre-test of Both Control and Experimental Group

Pre-test Scores

Control	Experimental	t-value	p-value	Verbal Description
23.92	22.17	1.097	0.275	Not Significant

Legend: * Significant at 0.05 level. There is no significant difference between the pre-test and post-test of the respondents in the experimental group. The hypothesis of no significant is accepted.

Table 12 reveals that the control group had a higher mean score (23.92) than the experimental group (22.17), with a p-value of 0.275—indicating no significant difference and supporting the null hypothesis. Among 120 learners, 11.67% did not meet expectations, 24.17% were “Fairly Satisfactory,” 40% were “Satisfactory,” 23.33% were “Very Satisfactory,” and only 0.83% reached “Outstanding.” While most scored at a “Satisfactory” level, none met the 75% benchmark, showing limited understanding. Students primarily demonstrated Lower Order Thinking Skills (LOTS), reflecting gaps in remembering, understanding, and applying concepts, as noted in Bloom's taxonomy. Misconceptions, language barriers, and limited hands-on experience hindered learning (Ramesh et al., 2020). Traditional lecture-based instruction contributed to these challenges, highlighting the need for more engaging and effective teaching strategies (Rugumamu, 2021). Similar issues were reported by BouJaoude et al. (2016), stressing the need to revise curricula to address misconceptions in genetics education.

Table 13. Comparison Between Post-test of Both Control and Experimental Group

Post-test Scores

Control	Experimental	t-value	p-value	Verbal Description
28.72	35.25	-4.240	0.000	Significant

Note: Significant at 0.005 level. There is a significant difference between the post-test scores of control and experimental group. The hypothesis of no significant is rejected.

Table 13 shows that the experimental group (mean = 35.25) outperformed the control group (mean = 28.72) by 6.53 points, with a p-value of 0.000—indicating a significant difference and supporting the effectiveness of the 5Ps authentic assessment. In the experimental group, 28.33% were rated "Outstanding" and 46.67% "Very Satisfactory," compared to only 6.67% and 25% in the control group, respectively. Just 1.67% of the experimental group did not meet expectations, versus 10% in the control group. These results highlight how the 5Ps approach fosters deeper learning, supports diverse learners, and promotes well-being. By connecting lessons to real-life scenarios, it enhances problem-solving and reflects multiple intelligences. Unlike traditional multiple-choice tests, authentic assessments emphasize cognitive engagement, reflection, and real-world application (Thompson). Combining research with class discussions deepens understanding (Clement, 2015), while focusing on critical thinking and problem-solving prepares students for lifelong learning and societal challenges (King, 2016; Kinay & Bagceci, 2016).

Table 14. Comparison Between Normalized Gained Knowledge of Control and Experimental Group

Control	Experimental	t-value	p-value	Verbal Description
0.14	0.46	10.938	0.000	Significant

Note: Significant at 0.005 level. There is a significant difference between Normalized gained knowledge of control and experimental group. The hypothesis of no significant is rejected.

Table 14 shows a normalized gain of 0.46 for the experimental group and 0.14 for the control group, indicating a significant improvement with the 5Ps authentic assessment and supporting the rejection of the null hypothesis. The 0.32 mean difference suggests deeper understanding and active learning beyond the module. Authentic assessments promote real-world application, unlike traditional tests that often lead to short-term retention (Thompson). Allowing students to choose learning strategies boosts metacognition, which strongly influences outcomes (Mitchell, 2015). As Parker (2021) notes, authentic tasks help students connect theory to real-life, making assessment a key part of meaningful learning.

Table 15. Comparison of Pre-test and Post-test of Control Group

Control Group's Scores

Pre-test	Post-test	t-value	p-value	Verbal Description
23.92	28.72	-3.827	0.000	Significant

Note: Significant at 0.005 level. There is a significant difference between the pre-test and post-test of the respondents in the control group. The hypothesis of no significant is rejected.

Table 15 shows a significant improvement in the control group's scores, from a pre-test mean of 23.92 to a post-test mean of 28.72, leading to the rejection of the null hypothesis. Despite a 6.55-point gain, the group's performance remained "Satisfactory." However, there were notable shifts: a 16.67% drop in those who "Did

Not Meet Expectations," a 50% drop in "Fairly Satisfactory," and increases in both "Outstanding" (75%) and "Very Satisfactory" (46.42%). These results support the effectiveness of Self-Learning Modules, even without the 5Ps framework. Studies by Padmapriya (2015), Lim (2016), and Bhamani et al. (2020) highlight their role in improving learning outcomes, especially with parental support. Well-crafted modules foster comprehension, critical thinking, and personalized learning (Khasanah et al., 2017; Nurdyanshah, 2018).

Table 16. Comparison Between Pre-test and Post-test of Experimental Group

Experimental Group's Scores

Pre-test	Post-test	t-value	p-value	Verbal Description
22.17	35.25	-10.9469	0.000	Significant

Note: Significant at 0.05 level. There is a significant difference between the pre-test and post-test of the respondents in the experimental group. The hypothesis of no significant is rejected.

Table 16 presents a significant increase in the experimental group's mean score from 22.17 to 35.25 (mean gain = 13.08), resulting in the rejection of the null hypothesis. This shift reflects an improvement from "Satisfactory" to "Very Satisfactory." Notable gains include an 87.5% reduction in the "Did Not Meet Expectations" category and a 28.33% increase in "Outstanding" performance. The results suggest that the 5Ps authentic assessment effectively promotes critical thinking, creativity, and problem-solving. Grounded in active learning principles, this method fosters metacognitive engagement through tasks such as problem-solving (P1), visual representation (P3), and self-expression (P4). As supported by Yew and Goh (2016), authentic assessments enhance knowledge retention and encourage higher-order thinking, offering a meaningful alternative to rote learning.

Table 17. Student-Respondents' (Experimental Group) Experiences in Utilizing 5Ps Authentic Assessment in terms of Creativity

Indicator Statement	Mean	Verbal Description
I remain to focus on facts and ideas about Non-Mendelian Genetics as I do the authentic activities.	3.67	Highly Effective
I can break down knowledge into its smallest components and assess how well they work together and separately	3.37	Highly Effective
I challenge myself to identify the evidence that forms my belief and assess whether the data is credible.	3.28	Highly Effective
In each example, I analyze the data and draw conclusions based on the raw data.	3.23	Effective
I can see what information is most relevant, meaningful and applicable to my output.	3.28	Highly Effective
Overall Weighted Mean	3.37	Highly Effective

LEGEND:

3.25 - 4.00 Highly Effective (HE)
 2.50- 3.24 Effective (E)
 1.75- 2.49 Moderately Effective (ME)
 1.00- 1.74 Not Effective (NE)

Table 17 shows a positive overall weighted mean of 3.36, indicating that learners found authentic assessment effective in fostering creativity. The highest-rated item which maintaining focus on Non-Mendelian Genetics during authentic tasks was deemed "Highly Effective," while data analysis and

conclusion-drawing were rated “Effective.” The findings support that authentic assessment enhances student achievement and creativity. Learners demonstrated prior knowledge, applied key concepts through problem-based diagrams, and expressed understanding via poetry and photography. Such tasks align with Drapeau’s (2021) view that creative thinking goes beyond recall and requires both divergent and convergent thinking.

Authentic assessment promotes self-monitoring and deep engagement with content. As Robinson (2011) noted, creativity involves not just generating ideas but evaluating them. Fisher and Frey (2013) further argue that creative instruction must integrate essential standards, allowing students to showcase understanding. The Probing (P3) component received the highest mean among the 5Ps, highlighting the value of guided inquiry. Social interactions also play a role; Ljapunova (2019) emphasized that creativity flourishes in environments with collaborative support and communication among peers.

Table 18. Student-Respondents’ (Experimental Group) Experiences in Utilizing 5Ps Authentic Assessment in terms of Critical Thinking

Indicator Statement	Mean	Verbal Description
I remain to focus on facts and ideas about Non-Mendelian Genetics as I do the authentic activities.	3.57	Highly Effective
I can break down knowledge into its smallest components and assess how well they work together and separately.	3.40	Highly Effective
I challenge myself to identify the evidence that forms my belief and assess whether the data is credible.	3.57	Highly Effective
In each example, I analyze the data and draw conclusions based on the raw data.	3.50	Highly Effective
I can see what information is most relevant, meaningful and applicable to my output.	3.60	Highly Effective
Overall Weighted Mean	3.53	Highly Effective

LEGEND:

3.25 - 4.00 Highly Effective (HE)

2.50- 3.24 Effective (E)

1.75- 2.49 Moderately Effective (ME)

1.00- 1.74 Not Effective (NE)

Table 18 reveals an overall weighted mean of 3.53, indicating that learners effectively developed critical thinking skills through the 5Ps authentic assessment. The highest-rated item, identifying relevant and meaningful information, scored 3.60, while the lowest, which is analyzing knowledge components, was still scored a strong 3.40; both were rated “Highly Effective.” These results affirm that authentic, real-world tasks promote critical thinking by requiring students to apply prior knowledge to novel problems. As Drapeau (2021) explains, such tasks foster both divergent and convergent thinking essential to real-life problem-solving. Students demonstrated critical thinking across multiple 5Ps components. In Problem Solving (P1), they applied genetics concepts logically. Through Picture-Based Diagrams and Probing (P3), they made interdisciplinary connections and synthesized information. Poem Making (P4) and Portfolio (P5) activities revealed their ability to construct and evaluate knowledge creatively and analytically. Supporting these findings, Yew and Goh (2016) highlight authentic assessments as effective for deep learning and knowledge application. While engagement significantly boosts outcomes, research suggests that collaboration alone does not have a substantial impact on learning gains.

Table 19. Student-Respondents' (Experimental Group) Experiences in Utilizing 5Ps Authentic Assessment in terms of Engagement

Indicator Statement	Mean	Verbal Description
I am happy to show off what I have created or the progress I have made. I take pride in the quality of the work I did.	3.73	Highly Effective
I am more focused and happier to be involved in the activities.	3.70	Highly Effective
Activities allow us to seek out additional knowledge and learn more beyond what has been given in the module	3.53	Highly Effective
I am trying harder to achieve bigger and better things because they will be invested in my learning process.	3.70	Highly Effective
I am patient in accomplishing tasks because I am learning and enjoying at the same time.	3.63	Highly Effective
Overall Weighted Mean	3.66	Highly Effective

LEGEND:

3.25 - 4.00 Highly Effective (HE)

2.50- 3.24 Effective (E)

1.75- 2.49 Moderately Effective (ME)

1.00- 1.74 Not Effective (NE)

Table 19 reports an overall weighted mean of 3.66, indicating a high level of student engagement in the 5Ps authentic assessment. The highest-rated statement—"I am pleased to showcase what I have created or the progress I have made"—scored 3.73, while the lowest—"Activities allow us to seek out additional knowledge and learn beyond what has been provided"—still achieved a strong 3.53. Both were classified as "Highly Effective." The experimental group's strong engagement contributed significantly to task completion and improved post-test performance. Active learning strategies encouraged learners to analyze complex scenarios, integrate key concepts, reflect on expert feedback, and express understanding through creative outputs such as poetry and visual representations of Non-Mendelian Genetics. Research supports these findings. According to the University of Washington (2021), student engagement enhances focus, supports higher-order thinking, and promotes meaningful learning. As Sean (2013) emphasizes, effective education depends on relational pedagogy—fostering intellectual, emotional, behavioral, and social connections. Sustained engagement, therefore, is essential for achieving long-term academic growth and deeper understanding.

Table 20. Student-Respondents' (Experimental Group) Experiences in Utilizing 5Ps Authentic Assessment in terms of Information Process

Indicator Statement	Mean	Verbal Description
I can relate and understand better the examples and activities which are connected to real-life situations.	3.57	Highly Effective
I can better understand when I was given a task, not merely focusing on paper and pencil tests.	3.63	Highly Effective
I can evaluate my learnings by making an output that requires an original composition.	3.48	Highly Effective
Activities provide me a more valuable base to remember the concept of Non-Mendelian Inheritance.	3.67	Highly Effective

I am attentive and interested in the given activities in lined with Non-Mendelian Inheritance.	3.63	Highly Effective
Overall Weighted Mean	3.60	Highly Effective

LEGEND:

3.25 - 4.00 Highly Effective (HE)
 2.50- 3.24 Effective (E)
 1.75- 2.49 Moderately Effective (ME)
 1.00- 1.74 Not Effective (NE)

Table 20 shows an overall weighted mean of 3.60, indicating improved recall and understanding through real-world activities. The highest-rated statement, "Activities provide me with a more valuable foundation to remember the concept of Non-Mendelian Inheritance," scored 3.67 and was classified as "Highly Effective." Muller (2015) notes that authentic assessments enhance learning by requiring students to recall relevant facts. The statement "I can evaluate my learning by producing an output that requires original composition" scored 3.48, also deemed "Highly Effective." Post-test results reveal increased engagement from learners involved in the 5Ps authentic assessment. Active learning encouraged participation through scenario analysis (P1), idea development (P2), reflection on feedback (P3), original compositions (P4), and real-world exploration (P5). Using the Self-Learning Module alongside authentic tasks supports Broudy's (2020) balanced approach, providing a well-rounded understanding of concepts and practical applications. Authentic assessments promote direct knowledge use, better preparing students for independent application of concepts and skills in real-life contexts.

Table 21. Student-Respondents' (Experimental Group) Experiences in Utilizing 5Ps Authentic Assessment in terms of Problem Solving

Indicator Statement	Mean	Verbal Description
I can see problems as challenges and try to learn from them.	3.67	Highly Effective
I rely on Non-Mendelian Inheritance's concepts to gain facts and justify my answers about the problems and eventually find a solution.	3.70	Highly Effective
I can transform it into excellent and realistic solutions. I see more than one solution and look for new creative and productive ways to address the problem.	3.33	Highly Effective
I acknowledge the importance of setting realistic expectations to evaluate the solutions I have identified for the problem.	3.75	Highly Effective
I can simplify complicated problems to find solutions.	3.42	Highly Effective
Overall Weighted Mean	3.57	Highly Effective

LEGEND:

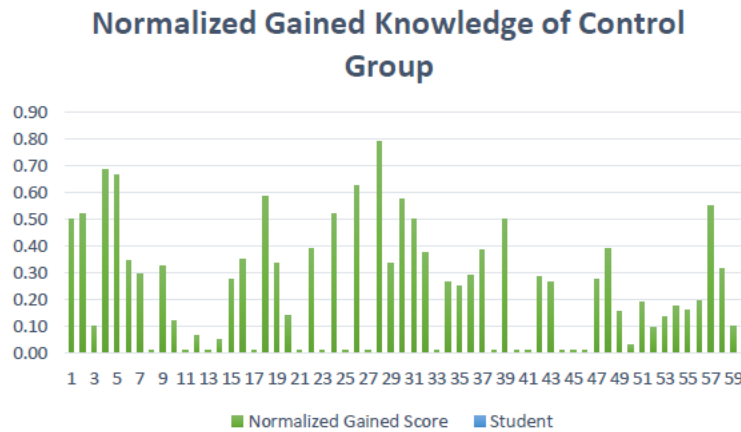
3.25 - 4.00 Highly Effective (HE)
 2.50- 3.24 Effective (E)
 1.75- 2.49 Moderately Effective (ME)
 1.00- 1.74 Not Effective (NE)

Table 2 reveals an overall weighted mean of 3.57, indicating notable improvement in learners' problem-solving skills through authentic assessment activities. The highest-rated statement, "I acknowledge the importance of setting realistic expectations to evaluate the solutions I have identified for the problem," scored 3.75 and was rated "Highly Effective." The lowest-rated, "I can transform it into excellent and realistic solutions. I see more than one solution," received a 3.33, yet remained within the "Highly Effective" range.

Students demonstrated sound decision-making by offering evidence-based responses to genetics problems (P1), identifying concept relationships (P2), seeking expert input (P3), composing original poems (P4), and applying real-world examples to textbook scenarios (P5). Research supports these findings. Mills and Kim (2017) emphasize that explicit instruction is necessary for the transfer of problem-solving skills. Birsen and Ismael (2016) found that engaging students in meaningful problem-solving tasks strengthens these competencies. Despite challenges such as accessing expert input and managing peer collaboration, students made notable progress.

To further enhance problem-solving abilities, Yaşar (2014) recommends integrating applied problem-solving tasks into higher education to build transferable, real-world skills.

Figure 1. Output of Normalized Gained Knowledge in both Control Group and Experimental Group



The data in Figure 1 show that the control group's highest Normalized Gain Score is 0.79 ("High Level"), while the lowest is 0.01 ("Low Level"). The group's overall normalized gain is 0.14, categorized as "Low Level." Based on Hake's (1998) classification, only 1.67% (1 of 60) of students reached a high level of knowledge gain, 36.67% fell into the average range, and the majority—61.67%—remained at a low level. While post-test scores improved, the limited gain reflects the constraints of a single assessment type. A 50-item quiz may indicate content recall but lacks the depth to assess higher-order thinking or real-world application (Thompson, 2016). To maintain data integrity, students with unchanged pre- and post-test scores were excluded unless they achieved perfect scores. Learners with zero on both tests were also removed, as their scores did not fall within the valid measurement range.

Figure 2. Computed Normalized Gained Knowledge of Experimental Group

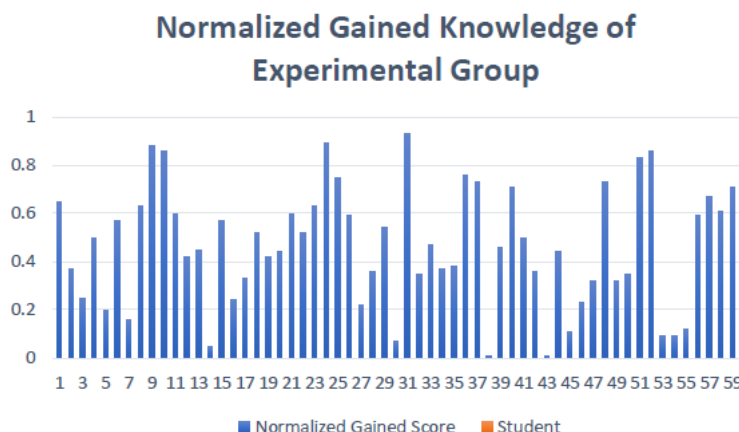


Figure 2 shows that learners in the experimental group achieved a maximum Normalized Gain Score of 0.93 ("High Level") and a minimum of 0.01 ("Low Level"), with an overall average of 0.46, indicating an "Average Level" of knowledge gain based on Hake's formula. Of the 60 learners, 21.67% reached a high level, 55% were in the average range, and 23.33% remained at a low level. These results suggest that the 5Ps authentic assessment effectively enhances knowledge acquisition for most students. Supporting studies highlight that real-world, varied assessments improve engagement and learning (Hammond, 2011), reduce academic dishonesty (Daily, 2019), and develop both skills and content mastery (Ambiyar et al., 2020). Overall, Hake's framework affirms the 5Ps approach as a reliable and impactful learning strategy.

5. Conclusions

1. A typical Grade 9 student in the Division of Cabanatuan City is 15 years of age, female, residing and guided by their mother/ father, having an academic award of with honors, and has a prior grade in science 8 range of 90-100 (Outstanding).
2. Improvement in test-scores from pre-test to post-test was shown in experimental group, from "Satisfactory" level to "Very Satisfactory" level than the control group who remained in "Satisfactory" level.
3. Experimental group gained more knowledge as they utilized the 5Ps authentic assessment than control group who answered 50-item quiz.
4. Skills of the under who were administered to accomplish 5Ps authentic assessment were rated as "Very Satisfactory." Probing shows the significant highest mean score wherein interpersonal skills of the learners is being developed.
5. All of the profile variables have shown positive correlation to the authentic assessment, except sex. Data shown that the authentic assessment has more impact to male learners as compared to female learners. Moreover, honors received during 8th grade and Grade in Science 8 show high positive correlation. The higher the honors and the higher the grade they have during their 8th grade, the more they excel in Non-Mendelian Genetics.
6. All of the profile variables have shown positive correlation to the Normalized gained knowledge, except sex. Data shown that male learners gained higher Normalized gained knowledge as compared to female learners. Moreover, honors received during 8th grade and Grade in Science 8 show high positive correlation. The higher the honors and the higher the grade they have during their 8th grade, the higher Normalized gained knowledge they achieved also.
7. The higher the result of the 5Ps authentic assessment of the learners, the higher Normalized gained knowledge they attained.
8. Division of respondents in control and experimental groups shows no bias. The respondents were divided equally and equity.
9. The post-test scores of the experimental group under the utilization of 5Ps authentic assessment proved to be significantly higher than the obtained scores of control group. This is sufficient evidence that the said type of assessment is effective to ease the least-learned topic of the Grade 9 students, Non-Mendelian Genetics.
10. The Normalized gained knowledge of the experimental group proved to be significantly higher than the obtained scores of control group. Hence, 5Ps authentic assessment leads the learners to cope with the lessons easier, and allow them to seek out additional knowledge and learn more beyond what has been given in the module.
11. The pre-test and post-test scores of both control and experimental group has significant differences. Hence, the instruments used are all effective in gaining higher Normalized gained knowledge.
12. Respondents who were evaluated after taking 5Ps authentic assessment were able to have positive learning experience in terms of creativity, critical thinking, engagement, information process, and problem-solving skills.

6. Recommendations

Based on the gathered findings and conclusions, the following recommendations were drawn:

1. A similar study for a more accurate and comprehensive result considering wider scope of respondents to attain more reliable and more valid result regarding the effectiveness of 5Ps authentic assessment in Normalized gained knowledge of the students.
2. Students should be taught study skills so that they can cultivate good and effective study skills by administering an engaging activities and lessons prepared by the teachers.
3. Maintain the parents and teachers warm and cordial relationship in order to monitor the progress of the students.
4. Parents should be facilitating learners in answering Self-Learning modules as well as imparting support especially to those students who are struggling in academics.
5. It would be worthwhile for all stake holders in education to encourage students in their respective areas of responsibilities, such as providing study materials, conducive place of study, recognizing excellence, appreciating students hard work as soon as possible among others.
6. There is the need for curriculum developers and teachers to take the availabilities of different facilities of their respective area into account when developing curriculum and designing instructions.
7. Teachers should consider the utilization of 5Ps authentic assessment in other topics in science which were perceived difficult by the students.
8. Stakeholders should motivate the students positively towards their study and academic achievement especially now we are dealing with global pandemic, covid 19.
9. Parents and teachers should improve the level of control and care of their children, show more interest and concern in the academic work and providing conducive atmosphere for studies, proving materials for studies and helping students in their studies.
10. For Department of Education, should provide programs and specialized trainings for science teachers on how to cope with the least learned topics in science.
11. Department of Education shall lead a revised and improved types of assessing the learners especially the one who are in the "Needs Improvement" level.
12. Consider other multiple intelligences in making any other authentic assessment which will lead learners to attain high Normalized gained knowledge.

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References

- Aguillon S., Siegmund G., Petipas R., Drake A., Cotner S., Ballen C., (2020) Gender Differences in Student Participation in an Active-Learning Classroom. Retrieved from <https://www.lifescied.org/doi/pdf/10.1187/cbe.19-03-0048>
- Ahvan Y., and Pour H (2016). The correlation of multiple intelligences for the achievements of secondary students. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1091511.pdf>
- Alber R., 2011, Why Formative Assessments Matter. Retrieved from <https://www.edutopia.org/blog/formative-assessments-importance-of-rebecca-alber>
- Alelaimat & Ghoneem (2012). The Effect of Educational Modules Strategy on the Direct and Postponed Study's Achievement of Seventh Primary Grade Students in Science, in Comparison with the Conventional Approach. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1081470.pdf>
- Alkharusi, Hussain (2011). Effects of Classroom Assessment Practices on Students' Achievement Goals. *Educational Assessment*, 13(4), 243–266. doi:10.1080/10627190802602509
- Ambayon(2020). Modular-Based Approach and Students' Achievement in Literature. Retrieved from TX_1:ABS~AT/TX_2:ABS~AT (ed.gov)
- Ambiyar et al 2020 Effectiveness e-authentic assessment in computer network course. Retrieved from <https://sci-hub.do/10.1088/1742-6596/1481/1/012131>
- Anderson D. (2016). Authentic Assessment: A Critical Tool for Early Childhood Educators. Retrieved from https://earlychildhoodny.org/blog/authentic-assessment-a-critical-tool-for-early-childhood-educators/?fbclid=IwAR2om_jQeyPiFJsKznQHSHZTaB8QvTOsjaqb_-qudLPrxgLJuFBNSec2HIQ
- Arco-Tirado, José L.; Fernández-Martín, Francisco D.; Hervás-Torres, Miriam (2019). Evidence-based peer-tutoring program to improve students' performance at the university. *Studies in Higher Education*, (), 1–13. doi:10.1080/03075079.2019.1597038
- Azim K (2012) Authentic assessment: An instructional tool to enhance students learning. Retrieved from "Authentic assessment: An instructional tool to enhance students learni" by Sher Azim and Mohammad Khan (aku.edu)

- Banerjee, Pallavi Amitava; Lamb, Stephen (2016). A systematic review of factors linked to poor academic performance of disadvantaged students in science and maths in schools. *Cogent Education*, 3(1), 1178441–. doi:10.1080/2331186x.2016.1178441
- Bergmark, Ulrika; Westman, Susanne (2018). Student participation within teacher education: emphasising democratic values, engagement and learning for a future profession. *Higher Education Research & Development*, (), 1–14. doi:10.1080/07294360.2018.1484708
- Bernardo, Limjap , Roleda (2011). Allan B. I. Bernardo Auxencia A. Limjap Maricar S. Prudente Lydia S. Roleda Retrieved from <https://files.eric.ed.gov/fulltext/EJ835201.pdf>
- Berwick (2019). What Does the Research Say About Testing? Retrieved from <https://www.edutopia.org/article/what-does-research-say-about-testing>
- Black, Steve; Allen, James D. (2018). Part 7: Rewards, Motivation, and Performance. *The Reference Librarian*, (), 1–14. doi:10.1080/02763877.2018.1499164
- Brooks A. (2019). Experts Discuss the Importance of Positive Parental Involvement in Education. Retrieved from <https://www.rasmussen.edu/degrees/education/blog/parental-involvement-in-education/>
- Chen, S.-W., Yang, C.-H., Huang, K.-S., & Fu, S.-L. (2017). Digital games for learning energy conservation: A study of impacts on motivation, attention, and learning outcomes. *Innovations in Education and Teaching International*, 1–11. Retrieved from Sci-Hub | Digital games for learning energy conservation: A study of impacts on motivation, attention, and learning outcomes. *Innovations in Education and Teaching International*, 1–11 | 10.1080/14703297.2017.1348960 (sci-hub.se)
- Church E., Honig A., Miller S. (2021). Ages & Stages: How Curiosity Leads to Learning. Retrieved from https://www.scholastic.com/teachers/articles/teaching-content/ages-stages-how-curiosity-leads-learning/?fbclid=IwAR3SbHNey91GJfW4e2oqbm25TRW_bFLhwNJRbSpvhxnnTccY_DanDtovuAc
- Cimer, A (2012) What makes biology learning difficult and effective: Students' views. Retrieved from Sci-Hub || 10.5897/ERR11.205 (sci-hub.se)
- Clement A, (2015). Gaining Knowledge: Creating Activities for Students by Students. Retrieved from https://cornerstone.lib.mnsu.edu/ctamj/vol35/iss1/7/?fbclid=IwAR1eG9rzw21j_fL-7ZeXfcjJY1I9b_ALzFF8C3WSOWYpv52lGceTtjL_BGY
- Colleta V., & Steinert J (2020) Why Normalized gain should continue to be used in analyzing preinstruction and postinstruction scores on concept inventories. Retrieved from <https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.16.010108?fbclid=IwAR2uxAXo8udfRU7FMvSWmV64qqM3uPRQwZIVF3IaeVyaWZ0Wqq1V42UQF3U>

- Cooper, Katelyn M.; Krieg, Anna; Brownell, Sara E. (2018). Who perceives they are smarter? Exploring the influence of student characteristics on student academic self-concept in physiology. *Advances in Physiology Education*, 42(2), 200–208. doi:10.1152/advan.00085.2017
- Darling-Hammond, Linda; Flook, Lisa; Cook-Harvey, Channa; Barron, Brigid; Osher, David (2019). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, (), 1–44. doi:10.1080/10888691.2018.1537791
- Dat T (2016). The Effects of Jigsaw Learning on Students' Knowledge Retention in Vietnamese Higher Education. Retrieved from Contents (ed.gov)
- Dyer K. (2016). Three Reasons to Prioritize Formative Assessment in the Classroom. Retrieved from <https://www.nwea.org/blog/2016/three-reasons-to-prioritize-formative-assessment-in-the-classroom/>
- Harvard Medical School (2017). How Memory Change and Thinking Ability Change with Age. Retrieved from <https://www.health.harvard.edu/mind-and-mood/how-memory-and-thinking-ability-change-with-age?fbclid=IwAR0Zbr1070jeg5mdvOcTuWr5wCpgek5skbbuYvii3-Jaje02rBuQ6Z1Wffl>
- Hoerr (2021). The Theory of Multiple Intelligences. Retrieved from <http://www.ascd.org/publications/books/100006/chapters/The-Theory-of-Multiple-Intelligences.aspx>
- Hulleman, C. S.; Harackiewicz, J. M. (2009). Promoting Interest and Performance in High School Science Classes. *Science*, 326(5958), 1410–1412. doi:10.1126/science.1177067
- Husain, NEO; Abdelhalim, IMO (2010). Pre/post-testing in evaluation of students' gain of content knowledge from a blood and lymph course. *Sudan Journal of Medical Sciences*, 5(1), –. doi:10.4314/sjms.v5i1.56031
- Hypnosis P. (2018) Why is Academic Success Important. Retrieved from Why is Academic Success Important? | Philly Hypnosis Performance (wordpress.com)
- Jimaa, S. (2011). The impact of assessment on students learning. *Procedia - Social and Behavioral Sciences*, 28, 718–721. doi:10.1016/j.sbspro.2011.11.133
- Kingsepp E. (2020). Analyzing the Retention of Knowledge Among General Chemistry Students. Retrieved from https://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=9432&context=etd&fbclid=IwAR2jViw_o09wcuC_DGpRQi7GH5nLnhiJMh3EQggLu_wlerU_otRJrSKcsks
- Kinoshita, T. J., Knight, D. B., & Gibbes, B. (2015). The positive influence of active learning in a lecture hall: an analysis of normalised gain scores in introductory environmental engineering. *Innovations in Education and Teaching International*, 54(3), 275–284. doi:10.1080/14703297.2015.1114957
- Kool, A.; Mainhard, M. T.; Jaarsma, A. D. C.; Brekelmans, M.; van Beukelen, P. (2016). Academic success and early career outcomes: Can honors alumni be distinguished from non-honors alumni?. *High Ability Studies*, 27(2), 179–192. doi:10.1080/13598139.2016.1238818

- Lara and Saracostt (2019). How Student-Teacher Relationships Impact Student Engagement and Learning. Retrieved from <https://all4ed.org/when-students-trust-their-teachers/?fbclid=IwAR0Zbr1070jeg5mdvOcTuWr5wCpgek5skbbuYvii3-Jaje02rBuQ6Z1Wffl>
- Ler, X., Dweck, C. S., & Cohen, G. L. (2016). Instructional interventions that motivate classroom learning. *Journal of Educational Psychology*, 108(3), 295–299. doi:10.1037/edu0000124
- Lim E. (2016). Effectiveness of Modular Instruction in Word Problem Solving of BEED Students. Retrieved from G1205075965.pdf (iosrjournals.org)
- Lin-SiegSteenbergen-Hu, S., Olszewski-Kubilius, P., & Calvert, E. (2020). The Effectiveness of Current Interventions to Reverse the Underachievement of Gifted Students: Findings of a Meta-Analysis and Systematic Review. *Gifted Child Quarterly*, 64(2), 132–165. doi:10.1177/0016986220908601
- Lynch M. 2016. The Five Major Features of Summative Assessments. Retrieved from <https://www.theedadvocate.org/five-major-features-summative-assessments/>
- Macy, Marisa; Bagnato, Stephen J. (2010). Keeping It “R-E-A-L” with Authentic Assessment. *NHSA Dialog*, 13(1), 1–20. doi:10.1080/15240750903458105
- Madkour, Magda; Mohamed, Rafik Ahmed Abdel Moati (2016). Identifying College Students’ Multiple Intelligences to Enhance Motivation and Language Proficiency. *English Language Teaching*, 9(6), 92–. doi:10.5539/elt.v9n6p92
- Madsen A., McKagan S., Sayre E. (2017). Normalized gain: What is it and when and how should I use it? Retrieved from https://www.physport.org/recommendations/Entry.cfm?ID=93334&fbclid=IwAR2om_jQeyPiFJsKznQSHSZTaB8QvTOSjaqb_-qudLPrxgLJuFBNSec2HIQ
- Mazrekaj & Mazrekaj (2019). The effect of modular education on school dropout. Retrieved from Sci-Hub || 10.1002/berj.3569
- Melody Douglas (2021). Incomplete Dominance vs Codominance: What's the Difference? Incomplete Dominance vs Codominance: What's the Difference? Retrieved from (prepscholar.com)
- Miller M, 2016 An Investigation of a Forest Field Trip for Elelmen Elelmentary Studen Y Students: What Strategies were Used Tegies were Used, and to What Extent were these Strategies Effective in Strive In Supporting Student Learning? Retrieved from <https://digitalcommons.mtu.edu/cgi/viewcontent.cgi?article=1359&context=etdr>
- Mitchell (2015) Metacognition: Nurturing Self-Awareness in the Classroom. Retrieved from <https://www.edutopia.org/blog/8-pathways-metacognition-in-classroom-marilyn-price-mitchell>
- Moody J. (2019) Interim Assessment. Retrieved from <https://edulastic.com/blog/interim-assessment/>
- Moore (2015). Master Teachers as Instructional Leaders: An Instrumental Case Study Retrieved from <https://core.ac.uk/download/pdf/58826302.pdf>

- Morten K., Ringsted C. (2019) How effective is multiple choice quizzing? Retrieved from <https://researchschool.org.uk/durrington/news/how-effective-is-multiple-choice-quizzing-a-very-effective-b-effective-c-ineffective>
- Murray, Dakota; Boothby, Clara; Zhao, Huimeng; Minik, Vanessa; BÃ©rubÃ©, Nicolas; LariviÃ©re, Vincent; Sugimoto, Cassidy R.; Origo, Federica Maria (2020). Exploring the personal and professional factors associated with student evaluations of tenure-track faculty. PLOS ONE, 15(6), e0233515-. doi:10.1371/journal.pone.0233515
- Nieminen P., Savinainen A., Viiri J., (2012) Gender Differences in Learning of the Concept of Force, Representational Consistency, and Scientific Reasoning. Retrieved from https://link.springer.com/article/10.1007/s10763-012-9363-y?fbclid=IwAR2jViw_oo9wcuC_DGpRQi7GH5nLnhiJMh3EQggLu_wlerU_otRJrSKcsks
- Obergriesser, S., & Stoeger, H. (2015). The role of emotions, motivation, and learning behavior in underachievement and results of an intervention. High Ability Studies, 26(1), 167–190. doi:10.1080/13598139.2015.1043003
- Olaf (2012). What We Lose in Winning the Test Score Race. Retrieved from <https://eric.ed.gov/?id=EJ983680>
- Omidi M., Sridhar Y., Azizmalayeri K. (2012). Effectiveness of Assessment patterns in chemistry Learning. Retrieved from www.lifesciencesite.com/ljsj/life0903/285_10522life0903_1979_1982.pdf?fbclid=IwAR09KPFx8B-TzS8-q1s9P6dYQ7-B5V62B6nBZpCGqiIhNf-mlNzZab74E7g
- Osman, E., BouJaoude, S., & Hamdan, H. (2016). An Investigation of Lebanese G7-12 Students' Misconceptions and Difficulties in Genetics and Their Genetics. Retrieved from Sci-Hub | An Investigation of Lebanese G7-12 Students'
- Misconceptions and Difficulties in Genetics and Their Genetics Literacy. International Journal of Science and Mathematics Education, 15(7), 1257–1280 | 10.1007/s10763-016-9743-9 (sci-hub.se)
- Padmapriya P., (2015) Effectiveness of Self Learning Modules on Achievement in Biology Among Secondary School Students. Retrieved from [ij11 \(ijep.org\)](http://ij11.ijep.org)
- Pantiwati Y. (2013). Authentic Assessment for Improving Cognitive Skill, CriticalCreative Thinking and Meta-Cognitive Awareness. Retrieved from <https://core.ac.uk/download/pdf/234634525.pdf>
- Paris J (2019) Programme for International Student Assessment (PISA) Retrived from Philippines ranks among lowest in reading, math, and science in 2018 study (rappler.com)
- Penfield, T., Baker, M. J., Scoble, R., & Wykes, M. C. (2013). Assessment, evaluations, and definitions of research impact: A review. Research Evaluation, 23(1), 21–32. doi:10.1093/reseval/rvt021

- Phelan J., (2013) Punnett Square. Retrieved from <https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/punnett-square>
- Rahayu Y., Sabtiawan W., Yuanita L. (2019) Effectiveness of Authentic Assessment: Performances, Attitudes, and Prohibitive Factors Retrieved from <https://tused.org/index.php/tused/article/view/87>
Retrieved from https://greatergood.berkeley.edu/article/item/six_ways_nature_helps_children_learn?fbclid=IwAR0nyjSgTSXYdNwAp8dLJ4UXRvofFiWvDIId-jNUSv7Lh-WzL9glD5yTrK4
- Ricci, Katrina E.; Salas, Eduardo; Cannon-Bowers, Janis A. (2016). Do computer-based games facilitate knowledge acquisition and retention?. *Military Psychology*, 8(4), 295–307. doi:10.1207/s15327876mp0804_3
- Scoville H, 2018. Law of multiple alleles. Retrieved from <https://www.thoughtco.com/multiple-alleles-definition-and-examples-1224504>
- Shinnick, Julia K.; Raker, Christina; Hampton, B. Star; Eger, Renee (2020). Randomized crossover study investigating resident retention of menopause-related knowledge after completion of learning modules. *Menopause*, 27(1), 95–101. doi:10.1097/gme.0000000000001417
- Sotiriadou, P., Logan, D., Daly, A., & Guest, R. (2019). The role of authentic assessment to preserve academic integrity and promote skill development and employability. *Studies in Higher Education*, 1–17. doi:10.1080/03075079.2019.1582015
- Stern, F., & Kampourakis, K. (2017). Teaching for genetics literacy in the post-genomic era. *Studies in Science Education*, 53(2), 193–225. Retrieved from Sci-Hub | Teaching for genetics literacy in the post-genomic era. *Studies in Science Education*, 53(2), 193–225 | 10.1080/03057267.2017.1392731 (sci-hub.se)
- Steve (2017). Paper and pencil help retain Knowledge. Retrieved from <https://www.lse.ac.uk/News/Latest-news-from-LSE/2017/02-February-2017/University-study>
- Swaffield, Sue (2011). Getting to the heart of authentic Assessment for Learning. *Assessment in Education: Principles, Policy & Practice*, 18(4), 433–449. doi:10.1080/0969594X.2011.582838
- Theobald, R., & Freeman, S. (2014). Is It the Intervention or the Students? Using Linear Regression to Control for Student Characteristics in Undergraduate STEM Education Research. *CBE—Life Sciences Education*, 13(1), 41–48. doi:10.1187/cbe-13-07-0136
- Umar, A. M. A.-T. (2018). The Impact of Assessment for Learning on Students' Achievement in English for Specific Purposes A Case Study of Pre-Medical Students at Khartoum University: Sudan. *English Language Teaching*, 11(2), 15. doi:10.5539/elt.v11n2p15
- University of New South Wales (2021) Assessing Authentically Retrieved from <https://teaching.unsw.edu.au/authentic-assessment>

- Volchok, Edward (2018). Differences in the Performance of Male and Female Students in Partially Online Courses at a Community College. *Community College Journal of Research and Practice*, (), 1–17. doi:10.1080/10668926.2018.1556134
- Wiggins, Grant (2014) The case for authentic assessment. *Practical Assessment, Research & Evaluation*, 2(2). Retrieved from <http://PAREonline.net/getvn.asp?v=2&n=2> .
- Yew, Elaine H.J.; Goh, Karen (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, (), S2452301116300062–. doi:10.1016/j.hpe.2016.01.004
Sci-Hub | Problem-Based Learning: An Overview of its Process and Impact on Learning | 10.1016/j.hpe.2016.01.004 (scihubtw.tw)