Development and Validation of an Animated Microlearning Video for Grade 8 Genetics

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ABSTRACT

Genetics is recognized as one of the most difficult Biology topics because many of its concepts are abstract and difficult for students to visualize. To address these learning challenges, this study aimed to develop an animated microlearning video as a supplementary instructional material for teaching Genetics in Grade 8 Biology under the MATATAG Curriculum. A needs assessment was conducted among 29 Grade 9 students and five (5) Science and ICT teachers to identify the least-mastered competencies, learning difficulties, misconceptions, and instructional needs that served as the basis for developing the instructional material. The findings identified Patterns of Inheritance as one of the least-mastered Genetics competencies. Students reported difficulties in learning Genetics because of its abstract concepts, technical terminology, limited visual representations, and instructional pacing, while expressing preferences for visual, collaborative, and multimedia-supported learning. Teachers likewise observed persistent student misconceptions, challenges in teaching abstract concepts, and limited student engagement, and emphasized the need for concise, visually rich, and interactive instructional materials to improve conceptual understanding. Guided by these findings, an animated microlearning video on Patterns of Inheritance was developed and evaluated by Science and ICT experts. The instructional material obtained an overall mean rating of 3.88 (Excellent), indicating high acceptability in terms of content quality, instructional design, technical quality, usability, and student engagement. These findings highlight the potential of animated microlearning as a supplementary instructional resource for making abstract Genetics concepts more accessible, engaging, and meaningful, while supporting the effective implementation of the MATATAG Curriculum in Biology education. It also serves as a foundation for future classroom implementation and effectiveness studies.

Keywords: Genetics Education, Animated Video, Animation

INTRODUCTION

Genetics is a fundamental area of Biology that explains heredity, variation, and the molecular basis of life. Despite its importance, it remains one of the most difficult topics for secondary students because many concepts, including genes, alleles, chromosomes, and inheritance patterns, are abstract and cannot be directly observed. Traditional teacher-centered instruction often emphasizes memorization rather than conceptual understanding, leading to persistent misconceptions and poor knowledge retention (Shana & Abulibdeh, 2020; Wang, 2022; Munna & Kalam, 2021).

These learning difficulties are particularly evident among Filipino students, whose understanding of Genetics is influenced not only by the abstract nature of the concepts but also by linguistic and contextual factors. Although Biology instruction is primarily conducted in English, Filipino students frequently use code-mixing (English and Filipino) when explaining scientific concepts, suggesting that they rely on familiar language to construct meaning from complex biological ideas (Garcia, 2021). Given the technical terminology and abstract nature of Genetics, language may become an additional barrier to conceptual understanding, particularly when students are required

to interpret and communicate complex biological concepts in English. These challenges are further compounded by limited access to laboratory activities, simulations, multimedia resources, and other technology-supported instructional materials in many public schools, thereby reducing students' opportunities to visualize and meaningfully apply genetic concepts (Abdulrahaman et al., 2020; Macayana & Mangarin, 2024).

These instructional challenges are reflected in international assessments. Filipino students consistently performed below global benchmarks in science, ranking 78th out of 79 participating countries in PISA 2018 and 77th out of 81 in PISA 2022 (CPBRD, 2025). Similarly, the 2019 Trends in International Mathematics and Science Study (TIMSS) reported an average science score of 249, substantially lower than the international benchmark (Mullis et al., 2020). Within Biology, Genetics has consistently been identified as one of the least-mastered topics because students struggle to visualize inheritance processes, interpret Punnett squares, and distinguish relationships among genes, alleles, genotypes, and phenotypes (Mussard & Reiss, 2022; Ojo, 2024).

To address these challenges, the Department of Education continues to promote the integration of information and communication technology (ICT) to improve science instruction (Errabo & Ongoco, 2024). One instructional approach that has gained increasing attention is animated microlearning, which delivers concepts through short, focused, and visually supported lessons that reduce cognitive load while enhancing student engagement (Reema, 2025). Recent studies have shown that microlearning improves students' knowledge retention, motivation, and engagement across basic education settings, particularly when lessons are delivered through concise multimedia modules (Silva et al., 2025). Likewise, video-based microlearning has been found to significantly enhance learning performance among middle school students compared with traditional instruction (Alshammari, 2024). In the Philippine context, Calixtro (2023) emphasized that microlearning's modular and adaptable nature makes it particularly suitable for K–12 students. Despite these promising findings, studies focused on the development and validation of locally designed animated microlearning videos specifically for teaching Grade 8 Genetics in Philippine secondary schools remain limited. Therefore, this study developed and validated an animated microlearning video to teach Patterns of Inheritance to Grade 8 students under the MATATAG Curriculum. By grounding the instructional material in the identified learning needs of Filipino students and teachers, the study aims to provide context-specific evidence to support the integration of animated microlearning resources into Biology education.

METHODS

Research Design

This study employed a descriptive mixed-methods design integrated with the 4D Model (Define, Design, Develop, and Disseminate) of instructional development. It aimed to develop an animated microlearning video in Genetics and determine its validity and acceptability through expert evaluation.

In the quantitative phase, a needs assessment was conducted using a questionnaire, survey instruments, and a diagnostic assessment administered to Grade 9 students and Science teachers. This phase sought to identify the least-mastered competencies in Genetics, as well as students' misconceptions, learning difficulties, and preferred instructional approaches. The results served as the empirical basis for selecting the content and designing the animated microlearning video.

The evaluation phase involved expert validation using structured evaluation instruments completed by Science teachers. This phase focused on assessing the content validity, technical quality, user experience and pedagogy, and impact of the developed animated microlearning video.

Research Subjects and Participants

The participants consisted of 29 Grade 9 students from Santiago National High School in Iligan City who had previously completed the Genetics unit. Their responses served as the basis for identifying the least-mastered competencies, misconceptions, learning difficulties, and instructional needs in Genetics. The participants were selected through purposive sampling because they possessed prior knowledge and learning experiences relevant to the study. The findings from the needs assessment informed the development, refinement, and

contextualization of the animated microlearning instructional material designed to support Grade 8 students under the MATATAG Curriculum.

The expert validators consisted of five (5) Science and ICT teachers with experience in Biology instruction, educational technology, and multimedia development. Their evaluations focused on the accuracy of the content, instructional design, technical quality, usability, and student engagement of the developed instructional material.

Data Gathering Procedure (4D Model)

The development and evaluation of the animated microlearning video followed the 4D Model's four phases: Define, Design, Develop, and Disseminate.

Define Phase

The researcher conducted a needs assessment to identify students' least mastered competencies, misconceptions, learning difficulties, and instructional needs in Genetics. Data were gathered through a needs-assessment test, survey questionnaires, and analysis of students' academic performance. Grade 9 students who had already completed the Genetics lessons and Science teachers participated in this phase. The findings served as the foundation for determining the scope, content, and instructional requirements of the animated microlearning video.

Design Phase

Based on the results of the needs assessment, the researcher designed the instructional material including the learning objectives, content outline, storyboard, narration script, visual elements, assessment activities, and multimedia components. The video was structured according to microlearning principles, presenting concepts in short, focused, and engaging segments to facilitate understanding and retention. The content aligned with the MATATAG Curriculum, particularly Life Science Learning Competency 4 on representing patterns of inheritance of simple dominant and recessive characteristics through generations of a family.

Develop Phase

The storyboard and finalized script were endorsed to the animator for the production of the animated microlearning video. The researcher collaborated closely with the animator to ensure that all animations, illustrations, narration, transitions, and instructional elements accurately represented scientific concepts and were appropriate for Grade 8 students. The developed material underwent expert validation by Science and ICT teachers using standardized evaluation instruments. Suggestions and recommendations regarding content accuracy, instructional quality, technical presentation, visual appeal, and usability were incorporated to refine the material. Revisions were made until the video achieved satisfactory validation results.

Data Analysis

Descriptive statistics, including percentages, means, and weighted means, were used to analyze the quantitative data from the needs assessment and expert validation. Open-ended responses from students and teachers were analyzed through content analysis to identify recurring themes related to misconceptions, instructional challenges, and preferred learning strategies.

RESULTS AND DISCUSSION

Needs Assessment for Students

Based on the results of the needs assessment test, the competency identified as the most difficult for students was under Genetics and Heredity, particularly in describing Mendelian patterns of inheritance using Punnett squares and explaining how mutations contribute to genetic variation. This competency had the lowest percentage of correct responses, with only 35% of students answering correctly, making it the least mastered among the assessed Biology concepts.

The identification of Genetics and Heredity as the least mastered competency is consistent with existing literature that highlights genetics as a complex and abstract area in biology. Studies by Wyner and DeSalle (2020) revealed that students commonly experience misconceptions in understanding inheritance patterns, while Focant et al. (2025) emphasized that genetics remains one of the least understood topics in secondary science education. This is further supported by Abulkhair et al. (2024), who found that genetics is one of the most difficult topics for both teachers and students due to its abstract nature. In addition, Barrientos et al. (2026) reported persistent misconceptions in Mendelian genetics, particularly in interpreting inheritance patterns.

To better understand why these topics are difficult, the students' open-ended responses were analyzed and grouped into recurring themes.

Table 1. *Summary of Grade 9 Students' Responses on Genetics Learning Needs and Preferences*

Theme	**Category**	**Mentions**	**Utterances**
Learning Obstacles in Genetics	Abstract Concepts & Visualization Difficulties	23	*"Hard to imagine genes" (NAS1, NAS4, NAS12, NAS16); "can't visualize what happens inside cells" (NAS 8, NAS 13, NAS 14); "Genetics is too abstract" (NAS2, NAS15, NAS6); "I cannot see how traits are passed" (NAS9, NAS17, NAS23); "There were no diagrams" (NAS2, NAS5, NAS11, NAS19); "Hard without visual examples" (NAS20, NAS22, NAS26); "Need more illustrations" (NAS21, NAS23, NAS29)*
	Terminology Overload	18	*"Too many scientific terms"; "I get confused with the words"; "Difficult to remember the terms"; "The vocabulary is hard"*
	Instructional Pace & Clarity Barriers	15	*"The lesson was too fast" (NAS5, NAS8, NAS16, NAS18); "The explanation was not clear" (NAS1, NAS13, NAS15, NAS20); "I could not follow the discussion" (NAS17, NAS23, NAS26); "Teacher moved on quickly" (NAS3, NAS22, NAS28)*
Pedagogical & Media Preferences	Collaborative & Multi-Modal Learning Preferences	17	*"Teacher explanations are helpful"(NAS8, NAS12, NAS13); "Examples help me learn"(NAS5, NAS10, NAS17); "My classmates helped me understand" (NAS4, NAS16, NAS19) ; "I learn better when discussing with friends"(NAS9, NAS20, NAS21); "Group work helped me"(NAS11, NAS13, NAS22); "Friends explained it better" (NAS3, NAS25)*

Table 1 presents the qualitative responses of Grade 9 students regarding their experiences in learning Genetics. Their responses generated two major themes: Learning Obstacles in Genetics and Pedagogical and Media Preferences. Students consistently described Genetics as a difficult subject because of its abstract nature, inability to visualize genetic processes, technical terminology, and the pace of classroom instruction. Many reported difficulty understanding invisible biological processes such as gene expression, DNA, chromosomes, and trait inheritance, while others found scientific terms confusing and challenging to remember. Students also indicated that lessons were sometimes delivered too quickly, making it difficult to follow discussions and fully understand complex concepts. Despite these learning barriers, students expressed a preference for teacher explanations, visual examples, peer discussions, and collaborative learning activities, suggesting that they learn more effectively through interactive and multimodal instruction rather than lecture-based approaches.

Overall, the findings indicate that students' learning difficulties extend beyond memorizing scientific terms and reflect broader conceptual and instructional challenges. At the same time, their responses identify instructional approaches that can help overcome these barriers by making abstract concepts more concrete and engaging. These findings support the development of an animated microlearning video that presents Genetics concepts through concise explanations, clear visual representations, and interactive learning experiences. This finding is consistent with the study of Machová and Ehler (2021), who reported that students often develop misconceptions because

they struggle to connect abstract genetic concepts with observable biological processes. Likewise, Silva et al. (2025) emphasized that microlearning delivers content through short, focused instructional modules that reduce cognitive load while enhancing engagement and conceptual understanding.

Needs Assessment Teachers

Teachers' responses were also examined to provide professional insights into the difficulties students' face and the instructional needs in Genetics.

Table 2. *Summary of Teachers' Observed Challenges on Genetics Instruction and Multimedia-Based Learning*

Theme	Category	Mentions	Utterances)
Instructional & Learning Challenges	Abstract & Technical Concepts	5	*"I find it hard to explain the passing on of traits in a way that the students can understand" (NAST1); "difference between traits, allele and genes, phenotypes and genotypes" (NAST3); "concepts are abstract, vocabulary is highly technical" (NAST4); "using english terms so I tend to do bisaya... cells and DNA are the same" (NAST5)*
	Problem-Solving & Calculation Hurdles	5	*"Mendelian Patterns, Punnett Square, Dihybrid crosses" (NAST1); "punnett squares" (NAST2); "Using dihybrid cross" (NAST3); "students often struggle with probability and problem-solving in genetic crosses" (NAST4); "Punnett square and Patterns of Inheritance" (NAST5)*
	Attention & Time Constraints	4	*"broad topic limited time alloted" (NAST2); "appropriate for students with short attention span" (NAST3); "keeping students' attention" (NAST4); "students are not attentive... short span making this difficult for them" (NAST5)*
	Entrenched Student Misconceptions	5	*"blood typing, especially on heterozygous blood types" (NAST1); "Dominant Traits are always from the father side" (NAST2); "confused... mixing or cross breeding... mendelian and non mendelian" (NAST3); "dominant traits are stronger or more common... believing mutations are always harmful" (NAST4); "Cells and DNA are the same... Mutations are errors and are always a disadvantage" (NAST5)*
	Traditional & Formative Assessment	5	*"Quizzes, oral recitations, summative assessments" (NAST1); "formative assessments, summative test, performance task, oral recitations" (NAST2); "Essays, question and answer portions, quizz" (NAST3); "quizzes, recitations, problem-solving exercises... performance tasks" (NAST4); "Formative assessments, Recitations, and Performance task" (NAST5)*
	YouTube-Centric Digital Delivery	5	*"Youtube" (NAST1); "Youtube Kahoot" (NAST2); "canva, youtube gclassroom" (NAST3); "Youtube" (NAST4); "Google Classroom and Youtube" (NAST5)*
Design Rationale for Microlearning	Validation & Actionable Design Needs	5	*"make the lesson more engaging/interactive... inclusion of simulation" (NAST1); "help students to picture out... aligned with MATATAG Curriculum... Time-conscious" (NAST2); "summarizes a certain topic into a short video... clear visuals, real-life examples, one concept per video" (NAST3); "making abstract Genetics concepts visual, simple... good and clear quality... hope there would be games" (NAST4); "accurate... which they could visually perceive and not imagine things" (NAST5)*

Table 2 presents the qualitative responses of science teachers regarding the challenges they encounter in teaching Genetics and their recommendations for instructional design. Their responses generated two major themes:

Instructional and Learning Challenges and Design Rationale for Microlearning. Teachers consistently described Genetics as one of the most difficult Biology topics because of its abstract concepts, highly technical terminology, and the higher-order thinking skills required to solve inheritance problems. They observed that students frequently confuse concepts such as genes, alleles, genotype, and phenotype, struggle with Punnett squares and probability-based problems, and hold persistent misconceptions regarding dominant traits, mutations, and inheritance patterns. Teachers also identified limited instructional time and students' short attention spans as significant barriers to effective Genetics instruction. To address these challenges, they emphasized the need for instructional materials that incorporate clear visuals, simulations, real-life examples, concise explanations, and one concept at a time. Teachers further indicated that they already utilize digital platforms such as YouTube and expressed readiness to integrate multimedia resources into classroom instruction.

Overall, the findings suggest that teachers recognize both the instructional challenges associated with Genetics and the potential of multimedia-based strategies to improve student learning. Their responses provide a strong rationale for developing an animated microlearning video that simplifies abstract concepts, addresses misconceptions, reduces cognitive load, and promotes sustained student engagement through short, visually rich instructional segments. These findings are consistent with Machová and Ehler (2021), who found that misconceptions in Genetics persist when students fail to develop an accurate conceptual understanding. Similarly, Ojo (2024) noted that students struggle to apply genetic concepts to inheritance problems, underscoring the need for guided instruction. Furthermore, Monib et al. (2024) reported that microlearning reduces cognitive load by delivering instruction in short, focused segments, while Navarrete et al. (2025) demonstrated that well-designed educational videos improve students' comprehension and engagement in science learning.

Developed Microlearning Video

The development of the animated microlearning video was guided by the findings of the needs assessment conducted among Grade 9 students and Science teachers. Based on the results, Patterns of Inheritance under Heredity was identified as one of the least-mastered topics in Genetics and was therefore selected as the focus of the instructional material.

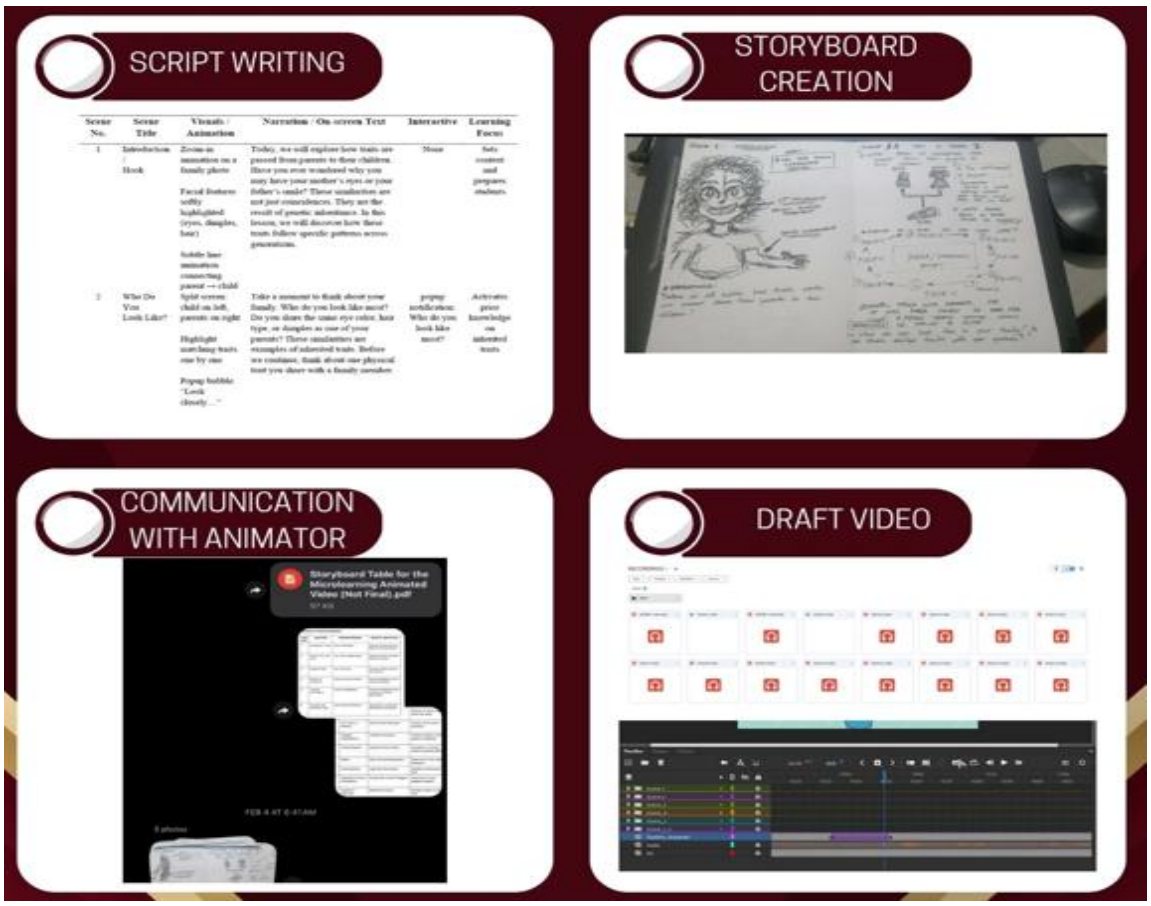

Figure 1. Developed Animated Video Process

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The feedback and recommendations provided by the validators were carefully reviewed and incorporated to improve the final version of the Animated Microlearning Video before its implementation among Grade 8 students.

Table 3. *Summary of Experts' Rating on the Developed Animation Video*

DIMENSIONS	**n**	**E1**	**E2**	**E3**	**E4**	**E5**	**Mean**	**DESCRIPTION**
CONTENT	5	4	4	4	4	4	4.00	Excellent
CONTENT ACCURACY	5	4	4	4	4	4	4.00	Excellent
SPELLING AND GRAMMAR	5	4	4	3	3	3	3.40	Excellent
WORD ACCURACY	5	4	4	4	4	3	3.80	Excellent
VOCABULARY	5	4	4	4	4	4	4.00	Excellent
WORD-PICTURE COMBINATION	5	4	4	4	4	4	4.00	Excellent
GRAPHICS RELEVANCE	5	4	4	4	4	4	4.00	Excellent
BACKGROUND DESIGN	5	4	4	4	4	4	4.00	Excellent
FONT AND FORMATTING	5	4	4	4	4	4	4.00	Excellent
SEQUENCING OF INFORMATION	5	4	4	3	4	4	3.80	Excellent
USER-FRIENDLINESS	5	4	4	4	4	4	4.00	Excellent
FEEDBACK MECHANISM	5	4	4	4	4	3	3.80	Excellent
INTERACTIVITY INTEGRATION	5	4	4	3	4	4	3.80	Excellent
IMPACT	5	4	3	4	4	4	3.80	Excellent
ENGAGEMENT AND MOTIVATION	5	4	4	4	4	4	4.00	Excellent
TOTAL							3.88	Excellent

Legend: Excellent 3.25 – 4.00; Very Good 2.50 – 3.24; Good 1.75 – 2.49; Needs Improvement 1.00 – 1.54

Table 3 presents the evaluation results of five experts for the animated microlearning video developed for Patterns of Inheritance. Overall, the findings revealed that the instructional material obtained an excellent level of validity and acceptability, with an overall mean score of 3.88 interpreted as "Excellent." This indicates that the animated microlearning video met the expected standards in terms of instructional quality, technical presentation, usability, and content delivery. Most of the evaluated dimensions, including content, content accuracy, vocabulary, graphics relevance, background design, user-friendliness, and engagement and motivation, received excellent ratings from the validators. These results suggest that the material was able to effectively presented Genetics concepts through clear explanations, appropriate visuals, and engaging multimedia elements suitable for Grade 8 students.

The experts also highlighted that the animated microlearning video was visually engaging, student-centered, and effective in simplifying abstract Genetics concepts, particularly in Patterns of Inheritance. The use of animations, word-picture combinations, and organized presentation of information was perceived to support conceptual understanding and student engagement. Minor suggestions were also provided regarding improvements in spelling and grammar, interactivity integration, and feedback mechanisms to further strengthen the quality of the instructional material.

The findings support the study of Adil et al. (2025), which reported that animated instructional materials were highly acceptable in terms of content quality, visual presentation, and instructional effectiveness. The study emphasized that animation-based learning resources can enhance student engagement, simplify complex concepts, and improve the overall learning experience through visually stimulating and interactive presentations. Similarly, the excellent evaluation results of the present study suggest that the developed animated microlearning video has strong potential as an effective instructional material for enhancing students' understanding of Genetics concepts and increasing classroom participation.

Developed Animated Video

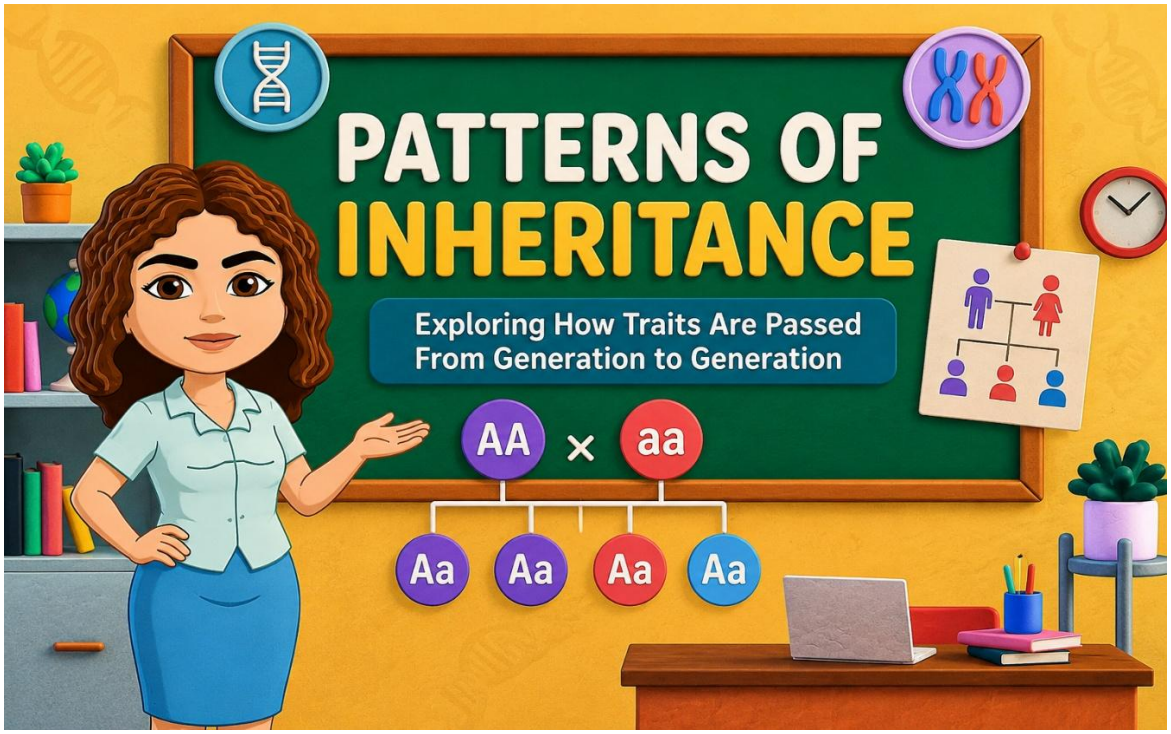

Figure 2. Developed Animated Video within a Microlearning Instructional Strategy in Patterns of Inheritance

Figure 2 presents the developed animated microlearning video in Patterns of Inheritance intended for Grade 8 students under the MATATAG Curriculum. The video incorporates visuals, colorful animations, discussions, and multimedia elements designed to simplify abstract Genetics concepts and increase student engagement. It highlights Mendelian patterns of inheritance through visual representations, symbols, and examples to help students better understand how traits are passed from one generation to another.

CONCLUSION

The study successfully developed an animated microlearning video on Patterns of Inheritance for Grade 8 students based on the identified learning needs of Grade 9 students and Science teachers. The needs assessment revealed that Genetics is perceived as a difficult topic due to its abstract nature, complex terminology, limited visual representation, and challenges in instructional pacing. Teachers further identified persistent student misconceptions, difficulties in problem-solving involving Punnett squares, and low levels of student engagement as major barriers in teaching Genetics.

In response to these identified needs, the instructional material was designed and developed following the 4D instructional development model, ensuring alignment with curriculum standards and microlearning principles. The resulting animated video presented Genetics concepts in simplified, visually rich, and segmented formats intended to support conceptual clarity and student comprehension.

Expert validation results indicated that the developed instructional material obtained an overall mean rating of 3.88, interpreted as “Excellent.” This suggests a high level of acceptability in terms of content quality, instructional design, technical presentation, and usability. The experts further affirmed that the material is appropriate for use as supplementary instructional support in teaching Patterns of Inheritance, particularly in making abstract concepts more visually accessible,

Overall, the study demonstrates that the development of animated microlearning resources is a viable instructional design approach for addressing identified learning difficulties in Genetics. The findings provide empirical support for the use of visual and micro-segmented instructional materials in enhancing clarity and engagement in Biology instruction.

RECOMMENDATIONS

The developed animated microlearning video may be utilized as a supplementary instructional material for teaching Patterns of Inheritance and other abstract Genetics concepts under the MATATAG Curriculum. Science teachers are encouraged to integrate visually engaging and technology-supported instructional approaches to improve students' conceptual understanding and reduce misconceptions.

Future studies should conduct pilot implementation of the instructional material among Grade 8 students using measurable outcomes such as pretest–posttest achievement scores, conceptual understanding, student engagement, misconception reduction, and knowledge retention. Further enhancement of the material through embedded quizzes, interactive simulations, gamified activities, branching scenarios, and immediate feedback mechanisms is likewise recommended to maximize student engagement and instructional effectiveness.

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