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## YouTube Video Tutorials and Academic Performance in Learning Biology Genetics among Science Students: Prospects for Food Biotechnology Application

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### ABSTRACT

This study examined the contextual effects of YouTube video tutorials on science students' academic performance in learning Genetics, with prospects for food biotechnology application. A descriptive-correlational quantitative design was used involving 84 Bachelor of Secondary Education major in Science students from Sultan Kudarat State University-ACCESS Campus. Data were collected using a modified Likert-scale questionnaire and students' Genetics grades. Students perceived YouTube video tutorials as very effective in supporting self-paced learning, visualizing biological processes, and improving their understanding and application of Genetics concepts. The food biotechnology prospect highlights the relevance of Genetics concepts to heredity, DNA processes, genetic variation, and food-related biological applications. However, regression analysis showed that the contextual effects did not individually predict academic performance.

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## 1. INTRODUCTION

Digital technology has become an important part of contemporary education because it changes how students access, review, and interact with academic content. In science education, digital resources can support learning by providing visual explanations, flexible access to materials, and opportunities for self-paced study. Among these resources, YouTube has become one of the most accessible platforms for educational video content because students can use it to search for tutorials, demonstrations, animations, and explanations related to difficult topics. YouTube is now widely used not only for informal learning but also as a supplementary tool in formal education [1].

Genetics is one of the science topics that many students find difficult because it involves abstract concepts, technical terminology, and biological processes that are not easily observed directly. Topics such as DNA replication, transcription, translation, mitosis, meiosis, Mendelian genetics, non-Mendelian genetics, and genetic disorders require students to understand both conceptual relationships and visual processes. Previous research has shown that students often experience difficulty in learning biology concepts because of complex terminology, less engaging content, and limited instructional support [2]. The challenge of learning Genetics is also connected to broader issues in science education. In the Philippines, concerns have been raised about students' science performance in international assessments, which highlights the need for more effective teaching strategies and learning resources. Science education aims to develop scientifically literate learners who can apply scientific knowledge to real-life and community issues, but this goal requires instructional approaches that make scientific concepts clearer, more engaging, and easier to apply. In Genetics learning, this connection is especially relevant because genetic concepts are related to food biotechnology applications, such as heredity, variation, crop improvement, genetically modified organisms, nutrition, food production, and community health.

YouTube video tutorials may help address some of these challenges by presenting scientific concepts through animations, visual demonstrations, step-by-step explanations, and repeatable learning experiences. Students can pause, rewind, and rewatch parts of a video, allowing them to learn at their own pace and review topics they find difficult. These features are particularly useful in Genetics because many concepts involve sequences, stages, and processes that can be better understood through visual representation. Technology-supported biology instruction can provide more engaging learning experiences and help students understand biological concepts more effectively [3].

Video tutorials can also support students' perceptions, knowledge, understanding, and application of Genetics concepts. When students view videos that explain difficult topics clearly, they may become more confident in discussing concepts, identifying relationships, and applying what they have learned. Previous studies suggest that video tutorials can improve students' engagement and understanding by making learning more interactive and accessible [4]. However, the use of YouTube video tutorials does not automatically guarantee improved academic performance. Students may differ in how they select videos, how often they use them, how actively they process the content, and how well they connect video-based explanations with classroom instruction.

Some videos may also vary in quality, accuracy, depth, and alignment with course requirements. Therefore, it is important to examine not only whether students perceive YouTube tutorials as useful, but also whether these contextual effects are related to academic

performance in Genetics. This study examined the contextual effects of YouTube video tutorials on the academic performance of Bachelor of Secondary Education major in Science students in learning Genetics at Sultan Kudarat State University-ACCESS Campus, with attention to the prospects of applying Genetics concepts to food biotechnology contexts. Specifically, it described students' academic performance in Genetics, assessed the contextual effects of YouTube video tutorials in terms of students' perceptions, knowledge and understanding, and application of knowledge and understanding, and determined whether these factors predicted academic performance.

The novelty of this study lies in connecting YouTube-supported Genetics learning with the prospective application of food biotechnology. While previous studies have examined the role of video tutorials in improving students' engagement, understanding, and academic performance, limited attention has been given to how video-based Genetics learning may prepare students to relate biological concepts to food-related applications. Genetics concepts such as heredity, genetic variation, DNA processes, protein synthesis, and gene expression are foundational to food biotechnology topics, including crop improvement, genetic modification, food production, nutrition, and community health. Therefore, this study contributes by framing YouTube video tutorials not only as supplementary learning tools for Genetics but also as potential bridges between classroom Biology learning and meaningful food biotechnology contexts.

## 2. METHODS

This study used a descriptive-correlational quantitative research design to examine the contextual effects of YouTube video tutorials on the academic performance of science students in learning Genetics. The descriptive component was used to describe students' academic performance in Genetics and their perceptions of YouTube video tutorials in terms of learning support, knowledge and understanding, and application of knowledge. The correlational component was used to determine whether these contextual effects were related to students' academic performance. The study was conducted at Sultan Kudarat State University-ACCESS Campus, Philippines. The respondents were 84 Bachelor of Secondary Education major in Science students who had already taken Genetics during the first semester of the 2023-2024 academic year. These students were selected because they had direct learning experience with Genetics and were therefore able to evaluate how YouTube video tutorials supported their understanding of the subject. The study was guided by a conceptual framework in which the contextual effects of YouTube video tutorials served as the independent variables, while students' academic performance in Genetics served as the dependent variable. The study also considered the prospective relevance of Genetics learning to food biotechnology applications as an implication of science learning, not as an additional measured variable.

The contextual effects were examined through three dimensions: students' perceptions toward Genetics, students' concepts of knowledge and understanding, and students' application of knowledge and understanding. The data were collected using a modified survey questionnaire adapted from a previous study on video tutorials and academic performance. The questionnaire was designed in Likert-scale format with four response options: strongly agree, agree, disagree, and strongly disagree. It measured students' perceptions of YouTube video tutorials, their knowledge and understanding of Genetics concepts, and their ability to

apply knowledge and understanding after using video tutorials. Students' academic performance was based on their final grades in Genetics.

The questionnaire covered topics related to students' experience in using YouTube video tutorials for learning Genetics. These included the perceived usefulness of video tutorials as supplementary learning resources, the flexibility of watching and rewatching videos, the role of animations and visuals in understanding biological processes, and the application of knowledge in explaining, illustrating, and discussing Genetics concepts. The Genetics topics included DNA replication, translation, protein synthesis, mitosis, meiosis, Mendelian and non-Mendelian genetics, heredity, variation, DNA and RNA sequences, and Punnett square methods, which may also serve as foundational concepts for understanding food biotechnology applications. The collected data were organized and analyzed using descriptive and inferential statistics.

Frequency and percentage were used to describe students' academic performance in Genetics. Mean and standard deviation were used to determine the level of contextual effects of YouTube video tutorials in terms of students' perceptions, knowledge and understanding, and application of knowledge and understanding. Multiple linear regression was used to determine whether the three contextual effect dimensions predicted students' academic performance in Genetics.

Ethical considerations were observed during the conduct of the study. The respondents' academic and survey information was treated with confidentiality and used only for research purposes. The findings were reported in summarized form through statistical tables and narrative interpretation.

### 3. RESULTS AND DISCUSSION

This section presents the findings on students' academic performance in Genetics and the contextual effects of YouTube video tutorials in learning Genetics. The results are based on the responses of 84 Bachelor of Secondary Education major in Science students at Sultan Kudarat State University-ACCESS Campus. The discussion focuses on five areas: academic performance, students' perceptions, knowledge and understanding, application of knowledge and understanding, and the predictive relationship between YouTube video tutorials and academic performance.

The academic performance of science students in Genetics is presented in **Table 1**. Most students obtained above-average grades. The largest group received a grade of 2.00, equivalent to 87–89, representing 36.9% of the respondents. This was followed by students who received a grade of 1.75, equivalent to 90–92, representing 32.1%. Nine students obtained a grade of 1.50, interpreted as Very Good, while the remaining students were distributed across average and passing levels. Overall, the distribution shows that the respondents had generally satisfactory academic performance in Genetics. The result in **Table 1** provides a useful basis for examining how YouTube video tutorials may support Genetics learning. Genetics is often difficult for students because it involves abstract processes, technical vocabulary, and concepts such as DNA replication, translation, mitosis, meiosis, Mendelian inheritance, non-Mendelian inheritance, and genetic disorders. Previous studies have similarly reported that students experience difficulty in learning biology when topics involve complex terminology and limited instructional support [2]. However, because this study used a descriptive-correlational design, the grade distribution should not be interpreted as direct evidence that YouTube video tutorials caused students' academic performance.

Other factors, such as classroom instruction, study habits, prior knowledge, teacher support, assessment methods, and peer learning, may also have contributed to the results.

**Table 1.** Academic performance of science students in genetics (n = 84).

ACADEMIC PERFORMANCE	PERCENT EQUIVALENT	FREQUENCY	PERCENT	INTERPRETATION
1.50	93-95	9	10.7	Very Good
1.75	90-92	27	32.1	Above Average
2.00	87-89	31	36.9	Above Average
2.25	84-86	12	14.3	Average
2.50	81-83	4	4.8	Average
2.75	78-80	1	1.2	Passing
<b>Total</b>		<b>84</b>	<b>100.0</b>	

Students' perceptions toward YouTube video tutorials in learning Genetics are presented in **Table 2**. The overall mean was 3.41, interpreted as Very Effective. This indicates that students generally viewed YouTube video tutorials as helpful supplementary tools for learning Genetics. The highest-rated item was the ability to pause, rewind, and rewatch specific parts of the video tutorials, with a mean of 3.65. This suggests that students valued the control and flexibility offered by video-based learning.

**Table 2.** Students' perceptions toward the genetics subject (n = 84).

INDICATOR	MEAN	SD	INTERPRETATION
I find YouTube video tutorials to be a helpful supplement to my classroom learning of Genetics.	3.60	0.54	Very Effective
I appreciate the flexibility and accessibility of YouTube video tutorials, allowing me to learn at my own pace and convenience on the subject.	3.49	0.57	Very Effective
I find that YouTube video tutorials are more engaging than traditional lectures or textbooks.	3.11	0.66	Effective
I see YouTube videos as a valuable supplement to my learning but not a sole source of information. Textbooks and other resources remain important.	3.38	0.62	Very Effective
I appreciate the ability to pause, rewind, and rewatch specific parts of the video tutorials, allowing me to learn at my own pace.	3.65	0.53	Very Effective
Using YouTube video tutorials fosters self-directed learning, allowing me to focus on topics I find most challenging or interesting.	3.43	0.59	Very Effective
YouTube videos can provide me with foundational understanding of key genetic concepts.	3.36	0.59	Very Effective
The use of animations and visuals can improve my grasp of complex biological processes such as protein synthesis.	3.52	0.57	Very Effective
I enjoy learning Genetics with the use of YouTube video tutorials.	3.29	0.61	Very Effective
I am motivated to learn Genetics with the help of YouTube video tutorials.	3.26	0.58	Very Effective
<b>Overall Mean on Student Perceptions</b>	<b>3.41</b>	<b>0.39</b>	<b>Very Effective</b>

The findings in **Table 2** show that students appreciated YouTube video tutorials because they allowed self-paced learning, repeated viewing, and easier review of difficult topics. These features are important in Genetics because students often need to revisit processes and sequences before they fully understand them. YouTube can extend learning beyond formal classroom settings by giving students flexible access to educational materials [1]. However, students also recognized that YouTube should not be the only source of information. The item stating that YouTube videos are valuable supplements but not sole learning sources received a high mean of 3.38. This suggests that students viewed YouTube as useful when combined with textbooks, teacher explanation, classroom discussion, and other academic resources.

Students' concepts of knowledge and understanding in Genetics with the aid of YouTube video tutorials are shown in **Table 3**. The overall mean was 3.33, interpreted as Very Effective. The highest-rated item was the ability to differentiate the stages of meiosis and mitosis, with a mean of 3.48. This result suggests that video tutorials were especially helpful for topics involving visual comparison, movement, and sequential biological processes.

**Table 3.** Students' concepts of knowledge and understanding (n = 84).

INDICATOR	MEAN	SD	INTERPRETATION
I can easily remember the concepts of DNA replication and translation with the help of YouTube video tutorials.	3.32	0.52	Very Effective
I can easily comprehend the process of protein synthesis with the help of YouTube video tutorials.	3.29	0.55	Very Effective
I can easily state the parts and function of the cell with the help of YouTube video tutorials.	3.37	0.51	Very Effective
I can differentiate the stages of meiosis and mitosis in Genetics with the help of YouTube video tutorials.	3.48	0.50	Very Effective
I can easily understand the disorders involved in cell division, such as Trisomy 21, with the help of YouTube video tutorials.	3.23	0.52	Effective
I can easily recall the DNA base triplets, codons, and anticodons with the help of a YouTube video tutorial.	3.12	0.50	Effective
I can easily identify the difference between a DNA and RNA sequence with the help of YouTube video tutorials.	3.39	0.52	Very Effective
I can easily describe the difference between Mendelian and non-Mendelian Genetics with the help of YouTube video tutorials.	3.29	0.57	Very Effective
I can differentiate the concept of heredity and variation with the help of YouTube video tutorials.	3.37	0.51	Very Effective
I can easily understand the Punnett square method with the help of YouTube video tutorials.	3.42	0.56	Very Effective
<b>Overall Mean on Concepts of Knowledge and Understanding</b>	<b>3.33</b>	<b>0.37</b>	<b>Very Effective</b>

The results in **Table 3** indicate that YouTube video tutorials helped students understand Genetics concepts that require visualization, such as DNA and RNA sequences, Punnett square methods, mitosis, meiosis, and heredity. Visual explanations can make abstract biological processes more concrete and easier to follow. Technology-supported biology instruction can strengthen understanding when it provides visual representations of concepts that are difficult to observe directly [3]. However, the lower-rated items, such as recalling DNA base triplets, codons, and anticodons, show that video tutorials may be less sufficient for concepts requiring precise recall and deeper molecular understanding. These topics may still require guided practice, teacher explanation, and structured classroom activities.

Students' application of knowledge and understanding is presented in **Table 4**. The overall mean was 3.26, also interpreted as Very Effective. The highest-rated item was the ability to illustrate the stages of meiosis and mitosis, with a mean of 3.44. This finding is consistent with **Table 3**, where meiosis and mitosis also received the highest rating in terms of knowledge and understanding.

**Table 4.** Students' application of knowledge and understanding (n = 84).

INDICATOR	MEAN	SD	INTERPRETATION
I can easily discuss the concepts of DNA replication and translation with the help of YouTube video tutorials.	3.35	0.53	Very Effective
I can easily explain the stages of protein synthesis and its importance with the help of YouTube video tutorials.	3.17	0.58	Effective
I can easily draw and label the parts and functions of the cell with the help of YouTube video tutorials.	3.33	0.61	Very Effective
I can easily illustrate the stages of meiosis and mitosis with the help of YouTube video tutorials.	3.44	0.55	Very Effective
I can easily write the behavior and characteristics of a person who has Trisomy 21 with the help of YouTube video tutorials.	3.12	0.55	Effective
I can easily construct my own DNA base triplets with the help of YouTube video tutorials.	3.04	0.63	Effective
I can draw the structure of DNA and RNA with the help of YouTube video tutorials.	3.29	0.53	Very Effective
I can draw a graphical representation to differentiate Mendelian from non-Mendelian Genetics with the help of YouTube video tutorials.	3.21	0.60	Effective
I can easily deliver a report about the concept of heredity and variation with the help of YouTube video tutorials.	3.33	0.61	Very Effective
I can easily share my understanding of how to use Punnett square with the help of YouTube video tutorials.	3.36	0.55	Very Effective
<b>Overall Mean on Application of Knowledge and Understanding</b>	<b>3.26</b>	<b>0.42</b>	<b>Very Effective</b>

The findings in **Table 4** suggest that YouTube video tutorials supported students not only in understanding Genetics concepts but also in applying them through explanation, illustration, discussion, and representation. Students reported that the tutorials helped them illustrate meiosis and mitosis, share their understanding of Punnett square methods, draw DNA and RNA structures, and discuss DNA replication and translation. These results confirm that video tutorials are most useful when topics involve visual stages, diagrams, and step-by-step procedures. However, the construction of DNA base triplets received the lowest mean of 3.04, showing that molecular-level tasks remained more challenging. Thus, YouTube video tutorials are useful learning supports, but they should be strengthened through exercises, concept checks, and teacher-led feedback.

The regression results are presented in **Table 5**. The model result was statistically significant,  $F(3,80) = 3.673$ ,  $p = 0.016$ , indicating that the three contextual-effect variables were related to academic performance when considered together. However, the R square value was 0.121, which indicates low explanatory power. This means that the contextual effects of YouTube video tutorials explained only a small portion of the variation in students' academic performance.

**Table 5.** Students' level of contextual effects of YouTube video tutorials in learning Genetics and academic performance of science students (n = 84).

PREDICTOR VARIABLES	UNSTANDARDIZED COEFFICIENT	P-VALUE	INTERPRETATION
Students' perceptions toward Genetics	1.465	0.158	Not significant
Students' concepts of knowledge and understanding	1.022	0.445	Not significant
Students' application of knowledge and understanding	0.209	0.857	Not significant
<b>Model Result</b>	<b>F(3,80) = 3.673</b>	<b>0.016</b>	Significant model
<b>R Square</b>	<b>0.121</b>		Low explanatory power

Although the overall model was significant, the individual predictors were not statistically significant. Students' perceptions toward Genetics had a p-value of 0.158, concepts of knowledge and understanding had a p-value of 0.445, and application of knowledge and understanding had a p-value of 0.857. These results show that none of the three contextual-effect dimensions individually predicted academic performance in a statistically significant way. Therefore, while students perceived YouTube video tutorials as very effective, this perception did not directly translate into significantly higher Genetics grades.

This finding highlights the difference between perceived learning support and measurable academic performance. Students may find YouTube video tutorials helpful for motivation, review, visualization, and self-paced learning, but grades are influenced by broader factors. These may include classroom teaching, assessment design, learning habits, prior knowledge, attendance, teacher feedback, and students' preparation for examinations. Previous research on video tutorials also emphasizes that videos are most effective when integrated properly into instruction rather than used as independent substitutes for teaching [4].

The results also support the idea that YouTube video tutorials are more effective for some Genetics topics than others. Students rated video tutorials highly for understanding and illustrating meiosis and mitosis, using Punnett square methods, identifying DNA and RNA differences, and reviewing DNA replication and translation. However, topics such as DNA base triplets, codons, anticodons, and genetic disorders received relatively lower ratings. This suggests that YouTube tutorials are especially useful for visual and procedural concepts, while more complex molecular topics still require guided explanation and practice.

The prospect of applying Genetics learning to food biotechnology should be understood as an implication of the study rather than as a directly measured variable. The Genetics topics examined in this study, including DNA replication, protein synthesis, heredity, variation, DNA and RNA sequences, and Punnett square methods, are foundational concepts for understanding food-related biotechnology applications such as crop improvement, genetic modification, food production, nutritional quality, and community health. Since YouTube video tutorials were perceived as helpful in visualizing and explaining these Genetics concepts, they may also support students' readiness to connect classroom Genetics with applied food biotechnology contexts. However, this study did not measure students' actual competence in food biotechnology or specific food-related learning outcomes. Therefore, the expected impact should be interpreted cautiously.

This finding is consistent with recent studies showing that biology education can be strengthened through animation, visualization tools, artificial intelligence-supported learning, technological pedagogical content knowledge, inquiry-based approaches, and genetics-related applications [5-10]. In this context, YouTube video tutorials may serve as accessible learning tools that support students' conceptual understanding and prepare them to relate Genetics to broader scientific and food biotechnology applications.

Students perceived YouTube video tutorials as very effective for learning Genetics, particularly in terms of perception, understanding, and application. However, the regression results indicate that these contextual effects did not individually predict academic performance. Thus, YouTube video tutorials should be used as supplementary resources that support, but do not replace, structured classroom instruction. Their effectiveness depends on the quality of selected videos, alignment with course objectives, teacher guidance, learning activities, and integration with formal assessment.

#### 4. CONCLUSION

This study concludes that YouTube video tutorials are useful supplementary tools for learning Genetics among science students. Students perceived these tutorials as very effective because they supported flexible, self-paced learning and helped them review difficult concepts through visual explanations, animations, and repeated viewing. These features were especially helpful for Genetics topics involving stages, diagrams, and processes, such as mitosis, meiosis, DNA replication, and Punnett square methods. The findings also show that YouTube video tutorials supported students' knowledge, understanding, and application of Genetics concepts. However, molecular-level topics such as DNA base triplets, codons, and anticodons remained more difficult and may require additional teacher guidance, practice activities, and classroom discussion. Although students viewed YouTube video tutorials positively, the contextual effects did not significantly predict academic performance when examined individually. This indicates that academic performance in Genetics is influenced by multiple factors beyond video tutorial use, including classroom instruction, study habits, prior knowledge, assessment methods, and teacher support. The prospect of food biotechnology application should therefore be interpreted as an implication of Genetics learning, not as a directly measured outcome. Teachers may select YouTube video tutorials that connect Genetics concepts with food biotechnology applications, such as heredity, genetic variation, crop improvement, food production, nutrition, and community health, to make learning more meaningful and relevant. Future studies may examine the effectiveness of selected YouTube tutorials through experimental designs, controlled classroom implementation, or comparisons between teacher-guided and independent video-based learning, particularly in relation to students' food biotechnology knowledge and application.

#### 5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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