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Reintroduction of Composting in a Tech-Driven Generation through 3D Manipulation Model

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Abstract: ***Environmental education plays an essential role in helping learners develop awareness of sustainable practices such as composting and proper waste management. However, many elementary learners find it difficult to understand natural processes like composting when these are presented only through traditional classroom instruction. This study aimed to reintroduce composting practices to a tech-driven generation through the use of a 3D manipulation model that visually demonstrates the composting process. Specifically, the study assessed the level of awareness and knowledge of Grade 4 and Grade 5 learners regarding composting, evaluated the effectiveness of the 3D manipulation model as an instructional tool, and determined the level of student engagement and motivation during the activity. A quantitative descriptive research design was employed involving twenty learners from Bulan North Central School-B who participated in pre-demonstration and post-demonstration learning activities using a structured Likert-scale questionnaire. The results revealed that Grade 4 learners obtained a pre-demonstration composite mean of 2.86 interpreted as Moderately Aware, which increased to 3.86 interpreted as Aware after the intervention. Similarly, Grade 5 learners improved from 3.19 Moderately Aware to 3.92 Aware following the demonstration. The effectiveness of the 3D manipulation model was rated Effective, with composite means of 4.12 for Grade 4 and 4.48 for Grade 5. Student engagement was also high, with mean scores of 3.90 and 4.20, both interpreted as Engaging. The findings indicate that the 3D manipulation model effectively enhanced learners' understanding of composting concepts while promoting active participation in environmental learning. It is therefore recommended that teachers integrate interactive instructional materials and experiential activities when teaching environmental concepts. Schools may further strengthen environmental education by incorporating composting demonstrations, waste segregation practices, and hands-on sustainability activities within the science curriculum.***

Keywords: Composting education, 3D manipulation model, environmental education, elementary science learning, student engagement

1. Introduction

Environmental education continues to evolve as schools search for effective ways to address waste management challenges and strengthen learners' ecological awareness. With today's learners growing up in a technology-driven environment, traditional methods of teaching composting are no longer as engaging or effective as before. This study recognizes the need to merge environmental education with innovative, interactive instructional tools to meet the learning needs of the modern generation.

Composting Practices

Composting is widely recognized as an effective method for managing biodegradable waste while simultaneously enhancing soil quality. It transforms organic materials, such as food scraps and garden waste, into nutrient-rich compost that can improve soil fertility and structure (Haug, 2018). Studies demonstrate that composting not only reduces the volume of waste sent to landfills but also lowers methane emissions, contributing to climate mitigation efforts (Ayilara et al., 2020). These environmental benefits position composting as a sustainable practice for households, communities, and institutions.

Recent research highlights the ongoing innovation in composting methods, such as improved aeration techniques, biochar amendments, and optimized moisture management, which increase decomposition efficiency and compost quality (Sánchez et al., 2024). Such advancements indicate that composting is not a static practice but one that continuously evolves in response to scientific insights and practical needs (Abubakar et al., 2022).

In the Philippines, composting is strongly supported by policy and legislation. The Ecological Solid Waste Management Act (RA 9003) mandates segregation at source and encourages composting as part of community-based solid waste management (Republic Act No. 9003, 2000). RA 9512, or the National Environmental Awareness and Education Act, integrates environmental education, including composting, into school curricula (Republic Act No. 9512, 2008). Furthermore, the Department of Education has institutionalized environmental programs through initiatives such as the Youth for Environment in Schools Organization (YES-O), which engages students in hands-on sustainability practices (Department of Education, 2003). Collectively, these legal and institutional frameworks establish composting as both a practical and mandated educational activity.

Composting in Modern Classrooms

Schools are ideal settings for implementing composting because they generate consistent organic waste and serve as structured learning environments. Classroom-based composting initiatives help students develop environmental awareness while providing practical experience with natural processes. Studies indicate that school composting programs improve waste management practices, reduce operational costs, and enhance students' understanding of ecological concepts such as decomposition and nutrient cycling (Consuelo, 2020; Wisudo et al., 2023).

DepEd policies reinforce the integration of composting in schools. DO 5, s. 2014 directs schools to incorporate Gulayan sa Paaralan, solid waste management, and tree planting under the National Greening Program (Department of Education, 2014). DO 6, s. 2016 strengthens these programs by encouraging schools to utilize compost produced on-site for

gardens and other environmental activities (Department of Education, 2016). Additionally, YES-O provides structured opportunities for students to take leadership roles in environmental stewardship activities (Department of Education, 2003).

Pedagogically, composting in classrooms promotes experiential learning. Students actively engage with the stages of decomposition, collaborate on maintaining compost systems, and relate theoretical knowledge to real-life environmental practices. Empirical studies support that such hands-on experiences enhance student engagement, foster environmental responsibility, and reinforce learning outcomes aligned with science curricula (Ramírez & Bernal, 2024). Moreover, these programs contribute to Sustainable Development Goals, particularly SDG 12 on responsible consumption and production.

3D Models as Learning Tools

Three-dimensional (3D) models and simulations are effective tools for teaching abstract scientific processes. In science education, 3D models improve students' conceptual understanding, spatial reasoning, and engagement by allowing them to visualize structures and dynamic processes that are otherwise difficult to observe (Robles-Moral et al., 2023). Composting, which involves microbial activity, heat generation, and layered decomposition, is particularly suited to this approach.

Studies show that learners exposed to 3D models demonstrate higher motivation, better comprehension, and improved performance compared to those taught through conventional methods (Teplá et al., 2022). Physical 3D models support hands-on, tactile learning, while digital 3D simulations allow students to observe time-based changes such as temperature variations and decomposition progression (Fernández-Díaz et al., 2023). Integrating 3D modeling into composting instruction thus facilitates a deeper understanding of complex biological processes and enhances students' ability to translate conceptual knowledge into practice.

The application of 3D models aligns with contemporary educational goals that emphasize technology-enhanced learning. Combining composting activities with 3D manipulation tools supports DepEd's initiatives on digital and innovative instruction while promoting environmental literacy. This approach offers a dual benefit: it strengthens students' comprehension of sustainability concepts and cultivates technological competence relevant to a modern learning environment.

The Present Study

The reviewed literature indicates that composting is an effective method for managing organic waste and improving soil quality. Studies consistently show that composting reduces landfill waste, lowers greenhouse gas emissions, and produces nutrient-rich materials that support plant growth. Research on school-based composting demonstrates that engaging students in hands-on composting activities enhances environmental awareness, promotes responsible waste management, and strengthens understanding of ecological concepts. Similarly, studies on 3D models and simulations indicate that these tools improve students' conceptual understanding, engagement, and motivation, particularly when learning abstract or complex processes.

The related studies share a common goal of promoting environmental literacy and sustainability practices among learners. Most of the research emphasizes hands-on or experiential learning approaches, either through direct composting activities or through physical models that help learners visualize processes. However, while school composting studies focus on waste reduction and ecological awareness, they often do not incorporate advanced technology tools that cater to the learning preferences of today's tech-driven generation. Conversely, studies on 3D models show the benefits of visualization for learning complex processes but rarely integrate them into practical environmental education such as composting.

While the related studies share a common goal of promoting environmental education and active learning, they differ in approach and focus. School composting studies primarily concentrate on operational benefits and environmental literacy, often using traditional instructional methods to guide learners. On the other hand, research on 3D physical models emphasizes visualization and experiential learning but rarely integrates these tools into real-world environmental practices such as composting. These differences reveal that although both approaches improve learning, neither fully combines hands-on environmental education with tangible models that make abstract biological processes observable and engaging.

Previous studies highlight the benefits of school composting programs and 3D learning tools separately, very few integrate the two approaches. Most composting studies focus on operational waste management and ecological awareness without incorporating tangible, interactive models. Similarly, research on 3D physical models emphasizes visual and tactile learning but rarely applies them to practical environmental education like composting. The present study addresses this gap by developing and testing a 3D manipulation model tailored for elementary students in today's technology-driven generation. Its aim is to combine modeling-based instruction with environmental education through hands-on, low-tech, and making the learning process both practical and visually accessible. This approach is different because it introduces a concrete, interactive way for learners to observe and understand composting while fostering engagement and ecological responsibility.

Objectives of the study

The main objective of this study is to reintroduce composting practices to a tech-driven generation through a physical 3D manipulation model. Specifically, it aims to: a) Assess the current level of awareness & knowledge of elementary learners regarding composting, b) Develop a physical 30 manipulation model that visually demonstrates the composting process, c) Determine the level of student engagement of motivation, and d) Evaluate the effectiveness of 3D manipulation models in enhancing students' understanding of composting concepts.

This study is conducted in a Bulan North Central School-B, involving Grade 4 and 5 students. It excludes private schools, out-of-school youth, and learners with no prior exposure to

basic science concepts. The study is limited to the development of a physical 3D manipulation model, the assessment of students' knowledge and engagement, and the evaluation of the model's effectiveness. It does not cover long-term composting cycles, large-scale waste management systems, or full implementation beyond the school setting.

2. Methodology

This section presents the methods used to develop, validate, and evaluate the 3D manipulation model for reintroducing composting to elementary learners. It described the research design, sources of data, and instruments employed to obtain accurate and reliable findings. All procedures were carried out in a systematic manner to meet the objectives of the study.

Research Design

This study used a descriptive–developmental research design to examine the use of a 3D manipulation model in reintroducing composting practices to elementary learners. The design allowed the researchers to assess the learners' initial awareness of composting, develop an instructional model that demonstrates the composting process, and evaluate its effectiveness in improving students' understanding and engagement. To determine the learners' initial awareness and knowledge about composting, a pre-demonstration Likert scale survey was administered to the participants. The survey consisted of ten statements measuring the students' familiarity with composting concepts, including its meaning, process, environmental importance, and materials involved. The researchers then developed and personally demonstrated the 3D manipulation model, which presented the composting process. The development of the model was guided by environmental education references, science learning competencies, and instructional materials related to composting to ensure that the content was accurate and appropriate for elementary learners. After the demonstration, a post-demonstration Likert scale survey was conducted to measure the outcomes of the intervention. This instrument assessed three areas: students' knowledge and awareness after the activity, the effectiveness of the 3D manipulation model, and the level of student engagement and motivation during the demonstration. The pre- and post-demonstration activities were conducted on February 16, 2026 as part of the implementation of the study.

Sources of Data

The primary sources of data for this study were 20 elementary students from Bulan North Central School B, consisting of 10 Grade 4 students and 10 Grade 5 students. All participants came from the first section of their respective grade levels and were selected through random sampling. Data were collected using a Likert scale questionnaire administered before and after the demonstration of the 3D manipulation model. The pre-demonstration survey measured the learners' initial awareness and knowledge about composting. Meanwhile, the post-demonstration survey gathered data on the learners' understanding after the intervention, the effectiveness of the 3D manipulation model, and the level of student engagement and motivation during the activity. Additional information used in developing the 3D manipulation model was obtained from environmental education references, science learning competencies, and instructional materials related to composting, ensuring that the content presented in the model was accurate and appropriate for the learners.

Research Ethics

This study was conducted in accordance with ethical standards in educational research, particularly because the participants were elementary learners. Prior to the conduct of the study, permission was first secured from the administration of Bulan North Central School B to allow the researchers to carry out the instructional demonstration and data gathering activities. Since the respondents were minors, parental consent was obtained a day before the instructional session. The parents or guardians of the selected students were provided with a consent form explaining the purpose of the study, the nature of the activity, and the participation of their children. On the day of the data gathering, the students were also asked to sign an informed consent sheet before answering the survey questionnaire. The purpose of the study and the instructions for the activity were explained to them in a clear and simple manner to ensure that they understood their participation.

Participation in the study was voluntary, and the students were informed that they could choose not to answer the questionnaire or withdraw from the activity at any time without any negative consequences. The researchers ensured that the activity was conducted in a respectful and supportive learning environment during the demonstration of the 3D manipulation model.

Confidentiality and anonymity were also strictly observed throughout the research process. The questionnaire did not require the respondents to provide their names, allowing them to answer freely and honestly. All data collected were used solely for academic purposes and were presented in summarized form to ensure that no individual participant could be identified.

Research Instrument

The primary research instrument used in this study was a Likert scale questionnaire designed to gather data on the learners' awareness, understanding, engagement, and perception of the effectiveness of the 3D manipulation model in learning about composting. The questionnaire served as both the pre-demonstration and post-demonstration survey administered to the participants.

The instrument consisted of two main parts. The first part was the pre-demonstration survey, which included ten statements that measured the learners' initial level of awareness and knowledge about composting. These statements focused on basic concepts such as the meaning of composting, the importance of composting for the environment, the types of materials used in composting, and the basic steps involved in the process. The second part was the post-demonstration survey, which was administered after the researchers demonstrated the 3D manipulation model. This section was composed of three subparts. The first subpart measured the learners' knowledge and awareness after the intervention, the second assessed the effectiveness of the 3D manipulation model as a learning tool, and the third evaluated the learners' engagement and motivation during the activity.

Each item in the questionnaire used a five-point Likert scale. For the awareness sections, the responses ranged from 5 – Fully Aware, 4 – Aware, 3 – Moderately Aware, 2 – Less Aware, and 1 – Not Aware. For the sections measuring effectiveness and engagement, the responses ranged from 5 – Very Effective/Very Engaging to 1 – Not Effective/Not Engaging. The responses gathered from the instrument were then analyzed using the Weighted Mean to determine the overall interpretation of the learners' responses. The questionnaire was administered to the participants before and after the demonstration of the 3D composting manipulation model to assess the learners' awareness prior to the activity and to evaluate the impact of the instructional intervention.

Data Collection

The data collection for this study was conducted at Bulan North Central School B with selected Grade 4 and Grade 5 students as participants. Prior to the conduct of the study, the researchers first sought permission from the school administration to carry out the instructional demonstration and data gathering activities. Before the implementation of the study, parental consent forms were distributed to the parents or guardians of the selected students to inform them about the purpose and procedures of the research. On the day of the activity, the participating students were also asked to sign an informed consent sheet to confirm their willingness to take part in the study. The data collection was carried out on February 16. The participants were first asked to answer the pre-demonstration Likert scale questionnaire to assess their initial awareness and knowledge about composting. After completing the survey, the researchers conducted the demonstration of the 3D composting manipulation model, explaining the composting process and allowing the students to observe and interact with the model. Following the demonstration, the participants were asked to answer the post-demonstration questionnaire, which measured their level of understanding after the activity, the perceived effectiveness of the 3D manipulation model, and their level of engagement and motivation during the demonstration. The responses from both the pre-demonstration and post-demonstration questionnaires were then collected, organized, and prepared for analysis using the appropriate statistical treatment.

Data Analysis

The data gathered from the pre-demonstration and post-demonstration Likert scale questionnaires were carefully organized, tallied, and analyzed to address the objectives of the study. The responses of the 20 participants from Grade 4 and Grade 5 were first collected and grouped according to the indicators in each section of the questionnaire. To interpret the responses, the Weighted Mean was computed for each indicator in the survey. The results from the pre-demonstration questionnaire were analyzed to determine the learners' initial level of awareness and knowledge regarding composting. Meanwhile, the responses from the post-demonstration questionnaire were analyzed to measure the learners' level of knowledge and awareness after the intervention, the perceived effectiveness of the 3D manipulation model, and the level of student engagement and motivation during the activity. The computed weighted means were then interpreted using the corresponding descriptive interpretations of the Likert scale. Through this process, the researchers were able to identify patterns in the learners' responses and determine whether the 3D manipulation model contributed to improving their understanding of composting concepts and their engagement in the learning activity.

3. Results

Grade 4

A. Pre- demonstration

Indicators	WM	Interpretation
I know what composting means	2.40	Less Aware
I am aware that food waste can be used to make compost	3.40	Moderately Aware
I know the difference between biodegradable-and non-biodegradable waste.	1.60	Less Aware
I am aware of the steps involved in the composting process.	1.90	Less Aware
I know why composting is important to the 1 environment.	2.90	Moderately Aware
I am aware that composting can reduce garbage-at home or school	4.20	Aware
I know what materials should not be included in composting.	1.90	Less Aware
I am aware that compost can be used to help plants grow.	3.80	Aware
I am aware that composting takes time before it becomes useful for plants.	3.70	Aware
I know that composting needs proper care such as mixing and watering.	2.80	Moderately Aware
Composite Mean	2.860	Moderately Aware

Pre-demonstration data refers to the learners' awareness of composting concepts before being introduced to the 3D manipulation model. A composite mean of 2.860 was computed, which falls under the Moderately Aware category.

From the results, the learners showed awareness in the fundamental aspects of composting. Learners were particularly aware that composting can reduce garbage at home or school, that compost can help the plants grow, and that composting takes time before being useful for the plants. However, several indicators, specifically knowledge on the difference between biodegradable and non-biodegradable waste, awareness of the steps involved in composting, and identification of materials that should not be included in composting received lower weighted means.

Pre-demonstration data revealed that learners have moderate awareness of composting concepts but lack deeper understanding of its processes and correct practices. This highlights the need for an interactive and visual teaching approach, such as the 3D manipulation model, to strengthen their knowledge and improve their practical understanding of composting.

B. Post-Demonstration

B1. Knowledge and Awareness After the Intervention

Indicators	WM	I
1. I understand the composting process better after using the 3D model.	4	Aware
2. I am now more aware of the steps in composting.	4.10	Aware
3. I can identify the materials needed for composting.	3.80	Aware
4. I understand how composting helps the environment.	4.30	Aware
5. I am more aware of proper waste segregation after the demonstration.	3.10	Moderately Aware
Composite Mean	3.860	Aware

Post-demonstration data refers to learners' knowledge and awareness of composting concepts after being introduced to the 3D manipulation model. A composite mean of 3.860 was computed, which falls to Aware. The results indicate an obvious improvement in learners' understanding of composting after the intervention. Learners reported that they understand better the composting process after using the 3D manipulation model and are now more aware of the process that involved in composting. They are also able to recognize the materials that needed for composting and have a stronger understanding of how composting helps the environment. These findings show that the demonstration effectively enhanced both conceptual and procedural knowledge.

Post-demonstration results reveal that the 3D manipulation model was effective in increasing learners' knowledge and awareness of composting. The increase from a Moderately Aware level in the Pre-demonstration to an Aware level after the intervention demonstrates the positive impact of the interactive and visual teaching strategy on learners' comprehension and understanding of composting concepts.

B2. Effectiveness of the 3D Manipulation Model

Indicators	WM	I
1. The 3D manipulation model helped me understand composting easily.	4.10	Effective
2. The model clearly showed how composting works.	3.90	Effective
3. The materials used in the model were helpful for learning.	4.30	Effective
4. The model made the lesson easier to remember.	4.40	Effective
5. The 3D manipulation model helped me see the-real process of composting clearly.	3.90	Effective
Composite Mean	4.120	Effective

The effectiveness of the 3D manipulation model was rated as having a composite mean of 4.120 which falls under the Effective category. The results show that learners positively recognize the 3D manipulation model as helpful in understanding composting concepts. The learners agreed that the 3D model helped them understand composting easily and clearly showed the composting process and how it works. Learners also found the materials used in the model helpful for learning, and they indicated that the model made the lesson easier to remember. They also agreed that the 3D manipulation model helped them see the real process of composting clearly. The highly effective findings suggest that the 3D manipulation model not only improved learners' knowledge and awareness but also enhanced their engagement, understanding, and retention of the lesson.

The results confirm that the interactive and visual features of the 3D manipulation model served as an effective teaching strategy in promoting meaningful learning and deeper comprehension of composting concepts.

B3. Student Engagement and Motivation

Indicators	WM	Interpretation
I enjoyed learning composting using the 3D manipulation model.	4.30	Engaging
I was interested and focused during the activity.	4	Engaging
The model made me want to learn more about composting	4	Engaging
I am motivated to try composting after the activity	3.40	Moderately Engaging
I actively participated in the activity using the 3D composting model.	3.80	Engaging
Composite Mean	3.90	Engaging

The category of student engagement and motivation resulted in a composite mean of 3.90 which translates to Engaging. This shows that the learners enjoyed using the 3D model, were interested and engaged during the entire process, and were motivated to practice their knowledge of composting. The findings show that learners enjoyed and motivated in learning composting using the 3D manipulation model. This suggests that the instructional material made the lesson enjoyable and attractive to the learners. Learners are being interested and focused during the activity and expressed that the model made them want to learn more about composting. However, motivation to try composting after the activity was categorized as Moderately Engaging, suggesting that while learners were actively involved during the session, their willingness to independently apply composting practices may still require further encouragement.

Overall, the results demonstrate that the 3D manipulation model effectively promoted student engagement and motivation. The interactive and visual features of the model contributed to an enjoyable, participatory, and meaningful learning experience, encouraging learners to become more involved and interested in composting concepts.

Grade 5

A. Pre-demonstration

Indicators	WM	Interpretation
1. I know what composting means.	2.40	Less Aware
2. I am aware that food waste can be used to make compost.	3.20	Moderately Aware
3. I know the difference between biodegradable and non-biodegradable waste.	4.30	Aware
4. I am aware of the steps involved in the composting process.	2.40	Less Aware
5. I know why composting is important to the environment.	3.60	Aware
6. I am aware that composting can reduce garbage at home or school.	4	Aware

7. I know what materials should not be included in composting.	2.60	Moderately Aware
8. I am aware that compost can be used to help plants grow.	4.10	Aware
9. I am aware that composting takes time before it becomes useful for plants.	3.70	Aware
10. I know that composting needs proper care such as mixing and watering.	3.40	Moderately Aware
Composite Mean	**3.190**	**Moderately Aware**

Pre-demonstration data refers to learners' awareness of composting concepts before being introduced to the 3D manipulation model. A composite mean of 3.19 was calculated, which falls under the Moderately Aware category.

From the results, it is evident that learners are familiar with basic concepts of composting, which include its definition, importance of composting to the environment, and its role in reducing garbage. However, aspects of procedural knowledge, which include steps involved in composting, proper care of the compost, and identification of items that should be avoided during composting, received lower ratings under the moderate category.

Pre-demonstration data revealed that although learners were familiar with the concept of composting, it had not been fully internalized by them with regard to its process and application. This is because today's youth belong to a technology-driven generation, and environmental practices like composting may not be commonly experienced by them. Thus, it is evident that although they were moderately aware of composting, it is still necessary to introduce them to an interactive and visual teaching strategy so that they may be able to grasp the concept of composting more deeply and may be encouraged to adopt it as an environmental practice.

B. Post-demonstration

B1. Knowledge and Awareness After the Intervention

Indicators	WM	Interpretation
1. I understand the composting process better after using the 3D model.	3.90	Aware
2. I am now more aware of the steps in composting.	3.70	Aware
3. I can identify the materials needed for composting.	4.10	Aware
4. I understand how composting helps the environment.	4.20	Aware
5. I am more aware of proper waste segregation after the demonstration.	3.70	Aware
Composite Mean	**3.920**	**Aware**

It was noted that after the implementation of the 3D manipulation model, the learners' post-demonstration results revealed a combined mean of 3.92, which equated to Aware. The indicators revealed a significant improvement in learners' comprehension of the composting process, the materials required for composting, environmental benefits, and waste segregation. The learners exhibited better comprehension of the steps involved in composting and demonstrated a better clarity of understanding of the composting process in real-life situations.

The rise in the mean values of learners' awareness and comprehension of composting and its benefits, as depicted in the learners' results before the demonstration (3.19) and after the demonstration (3.92), revealed a positive impact of the intervention on learners' awareness and comprehension.

The substantial rise in learners' awareness after the demonstration of the 3D manipulation model revealed the effectiveness of employing interactive and experiential learning tools. The learners' improvement in awareness revealed that the 3D manipulation model was effective in addressing the learners' knowledge gaps and enhancing their comprehension of composting. The improvement in learners' awareness revealed that the abstract environmental process of composting was better presented in a concrete manner.

B2. Effectiveness of the 3d Manipulation Model

Indicators	WM	Interpretation
1. The 3D manipulation model helped me understand composting easily.	4.30	Effective
2. The model clearly showed how composting works.	4.30	Effective
3. The materials used in the model were helpful for learning.	4.50	Effective
4. The model made the lesson easier to remember.	4.70	Very Effective
5. The 3D manipulation model helped me see the real process of composting clearly.	4.60	Very Effective
Composite Mean	**4.480**	**Effective**

The effectiveness of the 3D manipulation model was rated as having a composite mean of 4.48, which falls under the category of Effective. The indicators show that the model was able to enable learners to easily understand composting. The model was able to clearly show learners how the composting process works. The model was able to make the lesson easier for learners to remember. The learners agreed that the materials presented in the model were able to help learners. The learners were able to visualize the composting process through the demonstration of the model. The high effectiveness of the model indicates that the 3D manipulation model is a highly effective model in environmental learning. The model was able to translate theoretical concepts into a learning experience. This was a major factor in helping learners understand the concepts better. The effectiveness of the model shows that it aligns well with the learning preferences of a technology-oriented generation. The model was able to enable learners to better understand and visualize the concepts through a visual representation.

B3. Student Engagement and Motivation

Indicators	WM	Interpretation
1. I enjoyed learning composting using the 3D manipulation model.	4.40	Engaging
2. I was interested and focused during the activity.	4.30	Engaging
3. The model made me want to learn more about composting.	4.30	Engaging
4. I am motivated to try composting after the activity.	4.10	Engaging
5. I actively participated in the activity using the 3D composting model.	3.90	Engaging
Composite Mean	**4.20**	**Engaging**

The category of student engagement and motivation resulted in a composite mean of 4.20, which translates to Engaging. This shows that the learners enjoyed using the 3D model, were interested and engaged during the entire process, and were motivated to practice their knowledge of composting. Moreover, the data show that the learners were actively engaged in the process and were curious about the subject matter.

The high-rating of student engagement levels confirms that the use of a 3D manipulation model not only enhances the knowledge of the learners but also their interest and motivation. Student engagement plays a vital role in the retention of knowledge and behavioral intentions, especially when dealing with environmental education.

From the findings of the study, it is safe to conclude that the Reintroduction of Composting in a Tech-Driven Generation through a 3D Manipulation Model was successful in increasing the learners' awareness and knowledge of the subject matter and their engagement levels. Therefore, the findings emphasize the need to use innovative approaches in the introduction of environmental education to the younger generation.

4. Conclusion and Recommendations

4.1 Conclusion

This study examined the use of a 3D manipulation model as an instructional tool for reintroducing composting concepts to elementary learners who belong to a technology driven generation. The pre demonstration findings revealed that both Grade 4 and Grade 5 learners only had a moderate level of awareness about composting. Although some students were familiar with its environmental importance and its role in reducing waste, many lacked a clear understanding of the composting process, proper materials, and correct practices involved. These results suggest that while environmental topics are introduced in school, learners may still require more concrete and visual forms of instruction to fully grasp these concepts.

After the implementation of the 3D manipulation model, the results showed an improvement in learners' knowledge and awareness of composting. Both Grade 4 and Grade 5 learners reached the level of Aware after the demonstration, indicating that the instructional intervention helped clarify the composting process and strengthened learners' understanding of its environmental benefits. The model was also rated effective by the learners, as it helped them visualize how composting works and made the lesson easier to understand and remember. In addition, the activity promoted active participation and interest among the learners, showing that interactive and visual learning materials can increase both understanding and engagement in environmental education.

A comparison between the two grade levels indicates that the 3D manipulation model was slightly more suitable for Grade 5 learners. Grade 5 students obtained higher composite means in knowledge and awareness after the intervention, perceived effectiveness of the model, and engagement during the activity. This suggests that the 3D manipulation model may be more suitable for learners at the Grade 5 level, who demonstrated higher levels of understanding and engagement during the activity. However, the improvement observed in both groups confirms that the 3D manipulation model is an effective instructional approach for teaching composting concepts to elementary learners.

Overall, the findings highlight the value of using interactive and tangible learning tools in environmental education. By presenting composting in a visual and participatory manner, the 3D manipulation model helped translate an abstract environmental process into a more concrete learning experience. This supports the broader goals of environmental education and aligns with national policies that promote proper waste management and ecological awareness among students.

4.2 Recommendations

Based on the findings of the study, it is recommended that teachers integrate interactive and visual instructional strategies when teaching environmental concepts such as composting. The results showed that the use of the 3D manipulation model helped learners better understand the composting process and increased their engagement during the learning activity. Teachers may therefore consider using physical models, demonstrations, and other hands-on materials to make environmental lessons clearer and more meaningful for elementary learners.

Schools may also strengthen environmental education programs by connecting classroom instruction with practical environmental activities. Since the study demonstrated an increase in learners' awareness and interest in composting, schools may introduce simple composting projects, waste segregation activities, or school gardening programs. These initiatives may help learners apply the knowledge they gained from the lesson and develop responsible environmental habits that support proper waste management practices.

Educational institutions may also consider strengthening the integration of environmental education within the science curriculum. Lessons related to composting, waste segregation, and sustainable practices may be incorporated more consistently in classroom instruction. Providing learners with opportunities to understand the environmental impact of waste and the importance of responsible practices can help build stronger ecological awareness among students.

Curriculum developers and educators may further explore the use of instructional models and visual learning materials in teaching scientific processes. As discussed in the related literature, three dimensional models can help learners visualize processes that are difficult to observe directly. The use of physical models, simulations, and other interactive instructional tools may therefore support students' conceptual understanding and make science lessons more engaging and accessible.

Future researchers are encouraged to expand this study by including a larger number of participants and additional grade levels to further examine the effectiveness of the 3D manipulation model in environmental education. Similar

studies may also investigate the long term impact of interactive learning interventions on students' environmental awareness and their willingness to practice composting in their homes or communities.

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