GOTTA CATCH' EM ALL: UTILIZATION OF IMPROVISED INSECT TRAPS AS HOME-BASED BIOLOGY EXPERIMENT FOR INSECT TAXONOMY

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ABSTRACT

Classifying, naming, and identifying insects have been complicated topics among science teachers and students. This problem is due to the highly technical collection protocols, safekeeping procedures, the unavailability of appropriate learning resources, and the closure of school laboratories and facilities due to the COVID-19 pandemic. Using the remote learning setup, this study utilized Improvised Insect Traps (IITs) to provide an authentic learning experience in teaching and learning insect taxonomy at home. The study aimed to determine the effects of using IITs on students' self-efficacy beliefs and perceived levels of engagement. In this quasi-experimental study, 42 students designed and developed their improvised insect traps. Insect collection and classification were accomplished within four weeks. A 20-item validated survey questionnaire on self-efficacy and engagement levels was administered via Google Forms. Students' feedback was gathered using virtual focus group discussions and open-ended questions. Results revealed that IITs effectively improved students' self-efficacy beliefs (Z=0.033, p-value=0.022, g=0.68), while no improvement was noted in students' perceived levels of engagement (Z=0.143, p-value=0.188, g=0.07) in teaching and learning insect taxonomy. Moreover, students' feedback and responses were classified as Affordances or Constraints. Subthemes such as motivation, satisfaction, authentic learning, safety, and parental involvement were generated in the thematic analysis. Overall, this study found that the IITs activity is relevant in teaching insect taxonomy and delivering practical learning experiences among students in a distance learning modality.

Keywords: Improvised insect trap, home-based experiment, distance education, insect taxonomy, self-efficacy, engagements.

INTRODUCTION

Insects are diverse organisms, with over one million species described to date. Insects play an essential role in many ecosystems and facets of human existence, including agriculture, medicine, and pest management (Kjer, 2011; Zhang & Weirauch, 2017). These connections can make insects more enticing to students and aid in connecting science to real-world situations (Dewey & Lu, 2002). Many insects can be collected, observed, and analyzed in the classroom, giving students hands-on learning and discovery possibilities (Casey et al., 2019). This approach can help students get more involved in learning and gain a better knowledge of scientific ideas. Insects can be used in science classes ranging from primary school to advanced university degrees (Klein et al., 2017). They can also be used to teach biology, ecology, and entomology, among other subjects (Gopnik, 2012).

Insect taxonomy refers to identifying, naming, classifying, and placing insects in different taxonomical categories that correspond to varying degrees of precision (Briggs, 2007). Teaching insect taxonomy has been a major challenge for science educators due to the topic's complexity and a lack of learning and teaching resources (Ingram et al., 2012; Gopnik, 2012; Cajaiba, 2014). Teachers may have limited resources to employ in the classroom, such as textbooks, interactive tools, or educational software. These resources may be outdated or lack the detail needed to teach insect taxonomy effectively (Cajaiba, 2014). Initiatives to change the approaches to teaching insect-related topics have advocated inquiry-based teaching and learning methods in science classrooms (Ebach et al., 2011). Inquiry-based scientific education encourages student participation in the vast array of methods used to examine, model, and explain the world (Sotiriou et al., (2020). Due to their tiny size, fast reproduction rate, and ease of handling, insects can be utilized to promote inquiry-based techniques through experiments (Boero, 2001).

As the COVID-19 pandemic disrupted the world's educational system, science teachers devised multiple strategies and ways to address the different issues and conflicts. One of these strategies is the use of Home-based Biology Experiments (HBEs) that provide authentic learning experiences at home. HBEs are activities that utilize household materials adapted for the remote learning environment and are aligned with standard learning competencies (Robledo, 2021). Insect traps are portable or fixed devices that lure insects with baits such as nectar and UV light (Ford et al., 2020). Although most traps may catch a few insects without insect bait, using insect bait can dramatically increase the number of catches (Boero, 2001). Most of the bait consists of simple sugars and yeast in the form of fermented fruit, sugar water, corn syrup, or alcohol. Many insects are attracted to overripe fruit, fermented foods (such as bread soaked in beer), peanut butter, and sugar (Boero, 2001). Because these materials are affordable, safe to use, easy to acquire, and readily available at home, this study emphasized developing, implementing, and evaluating improvised insect traps (IITs) as home-based biology experiments in teaching insect taxonomy.

THEORETICAL UNDERPINNINGS

The use of IITs as instructional material for insect taxonomy was primarily anchored to the Theory of Engagements, Self-Efficacy theory, and the Cartoon-based teaching model, as demonstrated in Figure 1. The Theory of Engagement emphasized that students learn more effectively and are able to transfer their knowledge to other contexts when they find the lesson meaningful and have a high level of interest in the tasks (Meese et al., 2018). Additionally, the Self-efficacy Theory defines "self-efficacy" as an individual's confidence in their ability to plan and execute the necessary actions to handle anticipated challenges (Maddux, 2013). Various studies have established a correlation between students' self-efficacy and their perceived level of engagement. Hayat et al. (2020) observed that self-efficacy impacts students' learning-related emotions and metacognitive learning strategies, which, in turn, affect their academic performance and engagement. Azila-Gebettor et al. (2021) further noted that self-efficacy enhances students' intellectual engagement when engaging in student-centered activities. As home-based biology experiments, Improvised Insect Traps (IITs) are considered student-centered since they allow students to design, implement, and evaluate their homemade insect traps. The Cartoon-based teaching model suggests that using cartoons in instruction can increase student participation, interest, and engagement, as they find discussing and studying cartoons more enjoyable, and the combination of words and familiar images resonates with them (Balim et al., 2016). Therefore, students' perceived levels of self-efficacy and engagement were assessed as indicators of the effectiveness of IITs as a learning activity.

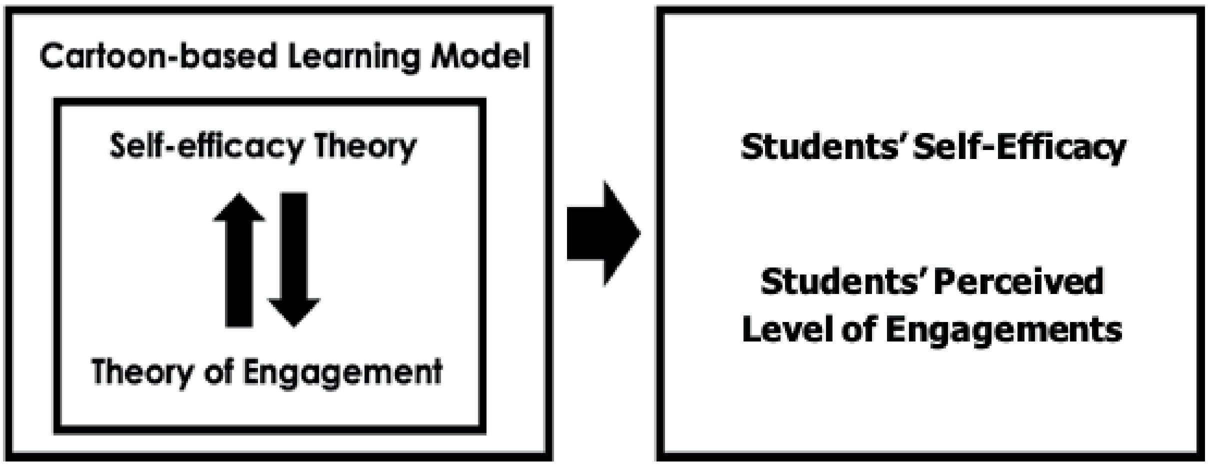

Figure 1. Theoretical underpinnings of the development, implementation, and evaluation of Improvised Insect Traps (IITs) as Home-based Experiment

In this study, the Japanese cartoon series "Pokemon" was used as the theme to increase students' motivation, as some characters are insect-type Pokemon which may be relevant to the activity, as presented in Figure 2. Pokemon is a creature-collecting game simulation for urban youth with the famous tagline, "Gotta Catch' Em All" (Clark, 2016). The use of Pokemon as a theme in teaching and learning has been a major topic among researchers and educators. Daley (2016) mentioned that Pokemon Go could captivate students' attention and intention to participate in class activities. This claim was confirmed by Emily (2016), who found that Pokemon-related activities significantly enhanced students' literacy and academic achievement in science subjects. In the context of this activity, the students received "badges" based on the number of collected species of insects. The idea of using "pokemon badges" in this study was adapted from the cartoon series, where characters received badges to recognize how much they interacted with the game (Clark, 2016).

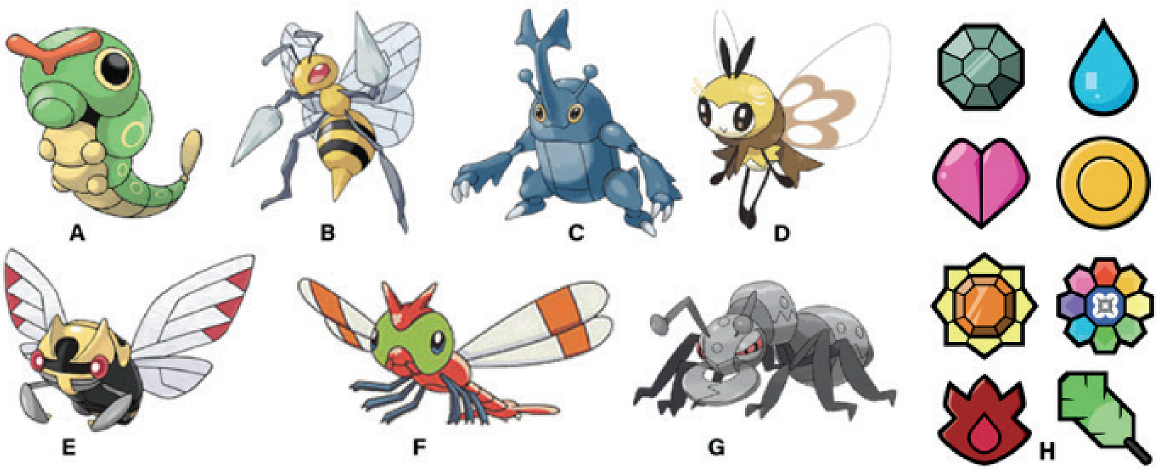

Figure 2. Examples of insect-type Pokemon used as "theme" for the improvised insect traps (IITs). (A- Caterpie (Caterpillar); B- Beedrill (Bumblebee); C-Heracross (Rhinoceros beetle); D-Ribombee (Bee fly); E- Ninjask (Cicada); F- Yanma –(Dragonfly); G- Durant (Ant); H – Samples of badges

Image source: Clark (2016)

PURPOSE OF THE STUDY

Due to the complexity and abundance of insects, students' appreciation of insect taxonomy and other invertebrates remain limited (Ingram & Golick, 2018). To mitigate this lack of knowledge and appreciation for insects, science education efforts have centered on identifying necessary learning competencies and learning resources to deliver authentic experiences in learning despite the disruption brought by the COVID-19 pandemic (Chu et al., 2022; Lapada et al., 2020; Robledo et al., 2021). To the researchers' knowledge, no studies have been conducted to assess the effectiveness of home-based experiments in learning insect taxonomy. Thus, this study aimed to investigate the effects of the improvised insect traps (IITs) activity on students' self-efficacy and perceived level of engagement in insect taxonomy. Specifically, this study sought to answer the following research questions.

1. To what extent does the improvised insect traps (IIT) activity affect students' level of self-efficacy in learning insect taxonomy?
2. To what extent does the improvised insect traps (IIT) activity affect students' perceived level of engagement?
3. What are the affordances and constraints experienced by the students during the development, implementation, and evaluation of improvised insect traps?

METHOD

The study employed the educational action research design (Brydon-Miller et al., 2017) using a quasi-experimental mixed-method approach. The principal purpose of educational action research is to improve the student's learning outcomes. Findings of educational action research can help teachers meet the needs of their students and help them attain their full potential by reviewing and changing their teaching approaches (Kidd & Kral, 2005; Arcidiacono et al., 2016). Moreover, a pre/post-test design was used to determine the effects of the IITs on students' perceived level of engagement and self-efficacy.

Participants

The IITs activity was performed by 42 Grade 11 students who agreed to participate in the study (42 out of 63) from a private school in Manila City, Philippines. The participants were selected using the convenience sampling method, which primarily depends on their availability and willingness to participate in the study (Galloway, 2005). After which, a virtual orientation with the parents was conducted to discuss the objectives of the activity, hazards and risks mitigation strategies, and the roles of the parents as home-based supervisors. Table 1 presents the characteristics of the involved participants. As shown below, all participants were aware and knowledgeable of Pokemon, implying that the IIT activity's theme might be relevant to them.

Table 1. Characteristics of the Research Participants (N=42)

Characteristics	n	Percentage (%)
Gender		
Male	30	71.4
Female	12	28.6
Familiarity to Pokemon		
Yes	42	100
No	0	0

Development and Validation of the Improvised Insect Traps (IITs) Activity

The IITs worksheet was developed based on the prescribed and standard procedures emphasized in the studies by Heath et al. (1995) and Snyder et al. (2022). Before implementation, IITs activity was pilot-tested and validated by groups of science teachers and insect experts following the validation protocol of Stephenson (2020). During the first validation stage, two insect scientists evaluated the accuracy and relevance of the proposed IITs worksheet. Terminologies and instructions were improved based on their comments and suggestions. Instruments used in the validation of IIT (by scientists and experts) were appended in Appendix C-B. During the second stage, three science teachers performed the activity based on the procedures indicated in the worksheet, using different baits (honey, light, candy). For comparison of ctivities, a commercially available insect trap (Safer©) was used as the control. The traps were placed in an area known to have a diverse insect population (e.g, garden, under the tree) and left for 24 hours. After the exposure period, the traps were emptied, and baits were refilled for the next cycle of collection for three consecutive days. The average number of collected insects may indicate the efficiency of the IITs design in attracting and collecting insects vs. the control.

The insects caught in the traps were gathered and initially identified using the Picture Insect© mobile software – an open-source software developed by Next Vision Limited (2022) that utilizes artificial intelligence for insect identification. Initial identification was verified using a standard insect taxonomy protocol (Example: Insect Identification Guide, University of Georgia, 2012). This activity may require reference materials such as field guides or other online resources. Validation was accomplished by comparing the total number of gathered insects in each trap vs. the control and the evaluation ratings and comments from the experts. Science teachers' comments and perceptions were also collected to determine the strengths, weaknesses, and risks associated with the activity, as presented in Table 2.

Table 2. Results of the Validation of Improvised Insect Traps (IITs) Activity

Traps	Average No. of Insects per Day	Efficiency % (vs. control)	Experts' Comments	Teachers' Comments
Trap 1 (honey)	35	85.37	*This trap was effective in gathering flying insects such as beetles.*	*The activity was fun. For sure, students will enjoy this.*
Trap 2 (light)	36	87.80	*A little bit expensive but effective in collecting insects.*	*The procedure is easy to follow.*
Trap 3 (candy)	33	80.49	*Candy may attract other invertebrates. It is recommended to use different kinds of bait*	*This activity is innovative and appropriate for remote learning.*
Safer Insect Trap (Control)	41	100	Not evaluated	Not evaluated

Overall, the validators (science teachers and experts) gave positive feedback about the efficiency of IITs and their experiences performing the activity. Several suggestions from the validators were noted and considered, such as safety issues in handling scissors and sharp objects, some expensive materials, and hazards in working with insects that are a vector of diseases. To address these concerns, the validated IITs worksheet has sections for pre-cautionary measures and waste disposal (Appendix A).

Data Collection and Analysis

A formal letter was initially sent to the Office of the School Principal to ask for permission and ethics approval to conduct the study. After approval, a virtual orientation with the parents and students was conducted to discuss the objectives of the study, the risk associated with the activity, and the roles of the parents as supervisors during the implementation stage. Sarnikova (2022) noted that parents, as educational stakeholders, should assume the role of supervisor at home in remote learning programs. To ensure research ethics and data privacy, online consent and data privacy forms were sent to the parents and students after the orientation. This study was conducted for four weeks. Before constructing IITs, a 20-item pretest questionnaire was sent to the students via google forms to determine their initial level of self-efficacy and perceived level of engagement. The first week was allotted to design and prepare the materials necessary to construct their improvised insect traps. Using the IIT Activity Sheet (Appendix 1), students built their improvised insect traps (IIT) during the second week using the recyclable materials readily found at home, as shown in Figure 3. Some students used different baits such as sugar solution, light blub, honey, corn starch, and many more. Students' designs and outputs were presented via Zoom in one synchronous virtual class.

As summarized in Figure 4, students deployed their insect traps in their preferred or designated locations in the third week, such as under a tree, near the window, garage, garden, etc. The insect traps were continuously and closely monitored for one week. At the end of the third week, captured insects were carefully collected, preserved, and photographed using smartphones for identification. Proper handling of insects was observed, as indicated in the worksheet. Insect photographs were uploaded to a Google Drive for data storage and sharing. The identification of insects was made collaboratively using Google Sheets in synchronous sessions via Zoom. Students performed the identification in groups (4 members) to attain consensus and to have interrater identifications. Insects were initially grouped and classified according to their Orders (Coleoptera, Hymenoptera, Lepidoptera, Diptera, etc.) and identified using the Picture Insect© software and were confirmed using the standard Insect Identification Guide (University of Georgia, 2012). During the fourth week, students presented their findings and outputs in a virtual synchronous session. Groups with the highest number of collected species or genera received Pokemon badges as tokens of recognition. Moreover, they accomplished the post-test questionnaire via Google Forms and participated in a focus group discussion to share their insights and experiences in performing IITs activity.

Descriptive statistics such as mean, frequency, and normalized gains were used to analyze the pre/post-test scores. All quantitative data were analyzed using SPSS v.26. Students' feedback and perceptions from the virtual focus group discussion were reviewed and coded twice. Thematic analysis was used to describe and interpret the qualitative data (Braun and Clarke, 2006). More details about the protocol used in the thematic analysis are presented in Appendix B.

Figure 3. Samples of Improvised Insect Traps (IITs) made using recyclable materials.

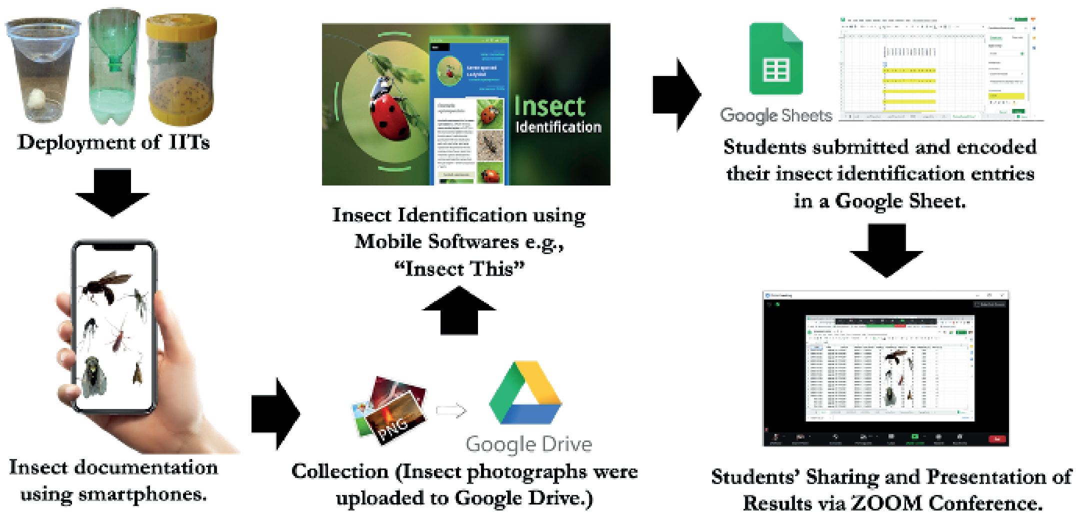

Figure 4. Procedures in the Implementation of IITs and Presentation of Results

Pre/Post-Test Questionnaires on Self-Efficacy and Perceived Level of Engagements

The parallel 20-item pre/post-test questionnaire for self-efficacy and perceived levels of engagement was adopted from the studies of Axboe et al. (2016) and Boulton et al. (2019). Some items from the instrument were removed and paraphrased for contextualization. To assess its face validity, the science coordinator and two science teachers evaluated the questionnaire to gauge the suitability of the items for measuring the variables of interest. Questions such as "Are the instrument's components related to what's being measured? "Is the measurement method appropriate for measuring the variable? and "Is the measure appearing to be suitable for capturing the variable?" were asked during the evaluation. Overall, the validators gave positive feedback regarding the face validity of instruments such as "Clearly relevant for what it's measuring", "Appropriate for the participants," and "Adequate for its purpose.". To assess the reliability of the pre/post-test questionnaire, the instrument was pilot tested on a group of Grade 12 science students (N=22) who performed a similar home-based activity. Cronbach alpha values were calculated to measure the internal consistency of each instrument's dimension. Results showed that the dimensions of the instruments had good and excellent levels of reliability, as shown in Table 3. Table 4 shows the 4-point Likert scale used to interpret the results, which was adopted from the paper of Pimentel (2019). The validated pre/post-test questionnaire is available in Appendix C.

Table 3. Cronbach alpha values for each dimension of the pre/post-test questionnaire

Dimensions	No. of items	Cronbach Alpha	Reliability
Self-efficacy	10	0.89	Good
Perceived Level of Engagement	10	0.91	Excellent
Overall	20	0.90	Excellent

Table 4. Likert Scale Range and Descriptions

Scale	Interval	Range Difference	Description
1	1.00-1.75	0.75	Strongly Disagree (SD)
2	1.76-2.51	0.75	Disagree (D)
3	2.52-3.27	0.75	Agree (A)
4	3.28-4.00	0.72	Strongly Agree (SA)

Virtual Focus Group Discussion

To better understand the students' perceptions and experiences with the IITs activity, a virtual focus group discussion (FGD) was conducted via Zoom using the protocol of Wong (2008). FGD is a qualitative research technique used to learn about participants' perspectives, attitudes, and experiences (O.Nyumba et al., 2018). Initially, a total number of 39 participants were recruited from the original group of participants. Participants were invited based on their availability and willingness to participate. Using Google Jam Board, prompts and questions such as "What were your thoughts and expectations before participating in the activity?", "What was your experience building and using the improvised insect trap?" "What are your perceptions about the theme of the activity – Pokemon?" were posted on the screen during the discussion. Students responded by posting "sticky notes" on the collaborative board, as shown in Figure 5. Follow-up questions were given to further expound the responses of students' regarding their perceptions and experiences. After the FGD, the video recording of the session and sticky note responses was extracted and transcribed. Coding was done twice for thematic analysis, as described in Appendix C.

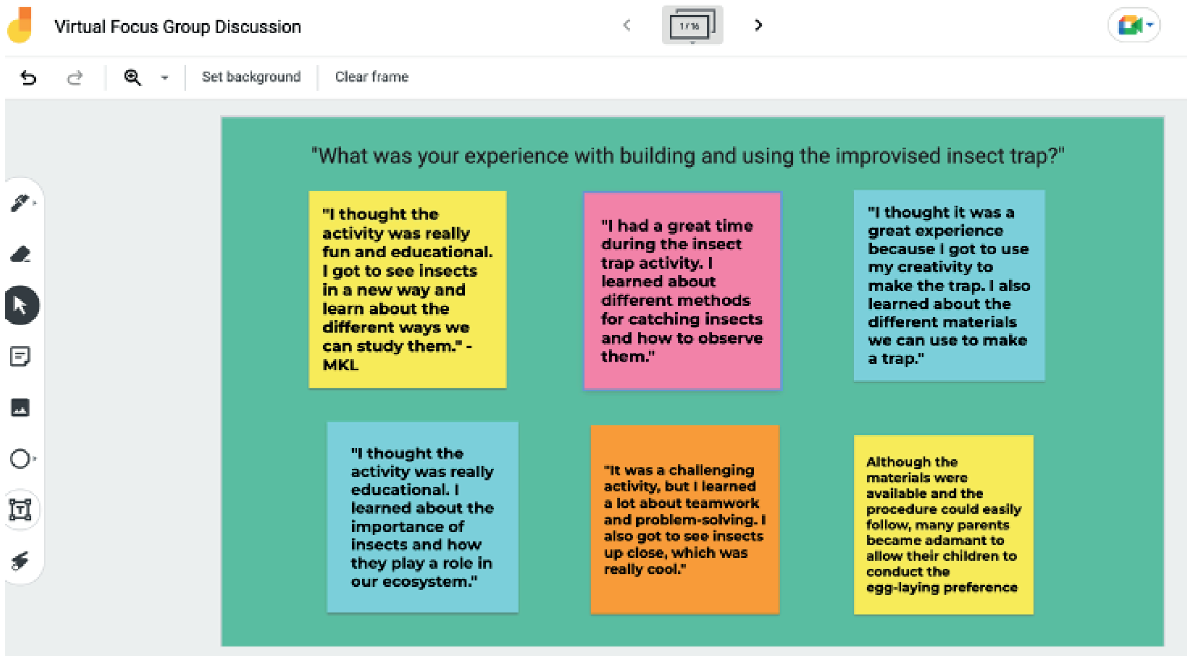

Figure 5. Sample of Google Jam Board used during the virtual focus group discussion

RESULTS

Results of the Normality Test

Given the limited sample size of this study, identifying the distribution of the variables was critical for selecting a practical statistical approach. Shapiro Wilk test was used to compare the sample data to the normal distribution to determine whether the sample data deviates significantly from normality (Shapiro & Wilk, 1965). Table 5 shows that the distribution of self-efficacy and perceived levels of engagement ratings departed significantly from normality (W=0.922, p=0.121; W=0.843, p=0.166, respectively). Based on these results, non-parametric tests and the median were used to analyze the variables.

Table 5. Results of Shapiro Wilk Tests

Variables	Shapiro Wilk Test		
	Statistics *(W)*	*df*	Sig.
Self-Efficacy	0.922	41	0.121
Perceived Engagements	0.843	41	0.166

*significant at p<0.05

Students' Self-efficacy in Performing IITs Activity

Students' self-efficacy is an essential variable in evaluating students' experiences in performing activities in science class. Hu et al. (2020) noted that students' self-efficacy might reflect their enthusiasm, participation, and interest in class activities. In this study, students' self-efficacy was assessed before and after performing the IITs activity. Table 6 shows the frequency and percentage distribution of the students' responses regarding the self-efficacy indicators. Looking at the pretest results, most students disagreed about confidence and comfortability in using materials to create functional insect traps (47.4% and 47.6%, respectively). It was also noted from the initial assessment that most of the students (52.4%) doubted their success in doing the IITs activity. These findings imply that before the conduct of the activity, most of the students had relatively low to mid-level confidence and positive belief regarding their performance. These claims were confirmed in some of the students' responses during the virtual FGD, as shown below.

"Insects are not my thing. I feel gross and disgusted whenever I see insects."
"I thought this activity would be very complicated. Can't imagine catching insects and identifying them."
"I love Pokemon, but I am not sure about real insects. Some of them are not cute at all. Scary!"

Table 6. Frequency Distribution of Students' Responses on the Indicators of Self-Efficacy

Items	Pretest (%)				Mdn	Post-test (%)				Mdn
	SA	A	D	SD		SA	A	D	SD	
1. I am confident in my ability to create an effective improvised insect trap.	2 (4.8)	15 (38.5)	5 (11.9)	0 (0.0)	3	39 (92.9)	3 (7.1)	0 (0.0)	0 (0.0)	4
2. I am capable of using the materials available to create a functional insect trap.	1 (2.4)	16 (38.1)	20 (47.6)	5 (11.9)	2.5	40 (95.2)	2 (7.8)	0 (0.0)	0 (0.0)	4
3. I believe I have the skills necessary to successfully complete this activity.	4 (9.5)	12 (28.6)	22 (52.4)	4 (9.5)	2.5	30 (71.4)	12 (28.6)	2 (4.8)	0 (0.0)	4
4. I am capable of using my creativity to design an improvised insect trap.	3 (7.1)	21 (50.0)	10 (23.8)	8 (19.0)	3	12 (28.6)	30 (71.4)	0 (0.0)	0 (0.0)	4
5. I feel comfortable taking risks and trying new things in this activity.	2 (4.8)	12 (28.6)	20 (47.6)	8 (19.0)	2.5	32 (76.2)	10 (23.8)	0 (0.0)	0 (0.0)	4
6. I am confident in my ability to think critically and problem-solve while creating an insect trap.	3 (7.1)	22 (52.4)	15 (35.7)	2 (4.8)	3	26 (69.1)	16 (38.1)	1 (2.4)	0 (0.0)	4
7. I believe that I can successfully complete the improvised insect trap activity without assistance.	2 (4.8)	23 (54.8)	13 (31.0)	4 (9.5)	3	40 (95.2)	0 (0)	2 (4.8)	0 (0.0)	4
8. I am capable of using my prior knowledge and experience to inform my insect trap design.	3 (7.1)	12 (28.6)	20 (47.6)	7 (16.7)	2.5	23 (54.8)	19 (45.2)	0 (0.0)	0 (0.0)	4
9. I am comfortable working independently in this activity.	2 (4.8)	18 (42.9)	20 (47.6)	2 (4.8)	2.5	13 (31.0)	29 (69.0)	2 (4.8)	0 (0.0)	4
10. I believe that I will be successful in completing the improvised insect trap activity.	3 (7.1)	16 (38.1)	20 (47.6)	3 (7.1)	2.5	41 (97.6)	1 (2.4)	0 (0.0)	0 (0.0)	4

Regarding the post-test results, it was evident that most students (>90%) strongly agreed or agreed on the indicators of their confidence, certainty, beliefs, and satisfaction after performing the activity. Forty (95.2%) noted that they could finish the IIT activity successfully without assistance. Thirty-nine students (92.9%) showed that they were confident with their skills in making improvised insect traps in the future. Almost all of them (97.6%) expressed that they could complete the activity successfully in the future. These findings denote those students had a positive level of self-efficacy after doing the IITs activity. To compare the difference between the responses from the pretest and post-test, Wilcoxon Signed Rank Test and Haike's Gain were used, as shown in Table 7. Findings revealed that the median post-test rank was statistically higher than the median pretest rank regarding the students' self-efficacy in performing IITs activity ($Z=0.033$, $p=0.022$), with a g-value of 0.68, indicating a medium increase.

Table 7. Results of Wilcoxon Signed Ranked Test on Students' Self-Efficacy (N=42)

Variable	Tests	Mdn	Z value	p-value	Haike's Gain (g)	Verbal Interpretation
Self-efficacy	Pretest	2.5	0.033	0.022*	0.68	Medium
	Post-test	4.0				

Results demonstrate that authentic learning activities such as the IITs might improve students' confidence, resiliency, and self-efficacy by allowing them to work independently under minimal supervision of the teacher. Evidence of improvements in their self-efficacy was reflected in students' responses, such as follows

> *"Designing and constructing our insect traps are remarkable experiences because I felt like I am an engineer/scientist crafting a prototype for my experiments. Surely, I am confident and satisfied with the design that I have made."*

> *"Since this activity was performed at home, I had more freedom to work independently and test things out of curiosity. During the orientation activity, I thought it would be challenging. But I noticed that it is easy to build, and the collection and identification are fun! I believe I can do more of this next time!"*

Students' Perceived Levels of Engagement

By understanding students' level of engagement, educators can personalize their instruction to meet the individual needs of their students. Thus, this study assessed the perceived levels of engagement of the students before and after doing the IITs activity. As presented in Table 8, the pretest results show that students agreed on the items regarding the indicators of perceived levels of engagement. Most students had positive confirmation regarding the impact of IITs activity on their learning. Before the activity, they noted that they felt excited (52.4%), motivated to participate in the activity (54.8%), excited about the Pokemon theme (69.9%), and believed that their learnings would be used in real-life (59.5). Moreover, they also thought that the IIT activity would help them understand the lesson better, and they will be showing their creativity and imagination in designing improvised traps (52.4 and 69.9, respectively). However, most students disagreed regarding their interest in participating in future activities like the IIT activity (47.6%). These results imply that students had positive perceptions and motivation to participate before the conduct of the IITs activity but were hesitant at the same time to perform more similar activities. These claims were reflected in their responses during the virtual focus group discussion, as presented below.

> *"During the orientation, I was excited to learn that we would use Pokemon terms and rules to perform the activity. Making our improvised trap design sounds exciting that time!"*

> *"Catching insects sounds cool, so I felt motivated to perform the activity."*

> *"Before doing the activity, I felt confident that it would help me understand the complex topic of insect taxonomy."*

Table 8. Frequency Distribution of Students' Responses on the Indicators of Engagement

Items	Pretest (%)				Mdn	Post-test (%)				Mdn
	SA	A	D	SD		SA	A	D	SD	
1. I believe that the IIT activity was valuable and helped me to understand insect taxonomy.	21 (50.0)	21 (50.0)	0 (0.0)	0 (0.0)	3.5	38 (90.5)	4 (9.5)	0 (0.0)	0 (0.0)	4
2. I found the IIT activity interesting and enjoyable.	19 (45.2)	22 (52.4)	1 (2.4)	0 (0.0)	3.5	36 (85.7)	6 (14.3)	0 (0.0)	0 (0.0)	4
3. I was motivated to participate in the IITs activity.	23 (54.8)	15 (35.7)	4 (9.5)	0 (0.0)	3.5	35 (83.3)	5 (11.9)	2 (4.8)	0 (0.0)	4
4. The Pokemon theme held my attention, and I was focused throughout the activity.	26 (69.9)	16 (38.1)	0 (0.0)	0 (0.0)	3.5	40 (95.2)	2 (4.8)	0 (0.0)	0 (0.0)	4
5. I was able to understand the purpose of the activity and why it is important.	26 (69.9)	14 (33.3)	2 (4.8)	0 (0.0)	3.5	32 (76.2)	10 (23.8)	0 (0.0)	0 (0.0)	4
6. I was able to apply what I learned from the IITs activity to real-life situations.	25 (59.5)	17 (40.5)	0 (0.0)	0 (0.0)	3.5	26 (61.9)	15 (35.7)	1 (2.4)	0 (0.0)	4
7. I felt challenged by the IIT activity, and I was able to solve the problems effectively.	10 (23.8)	32 (76.2)	0 (0.0)	0 (0.0)	3	37 (88.1)	3 (7.1)	2 (4.8)	0 (0.0)	4
8. The IITs activity helped me develop new knowledge and skills.	20 (47.6)	22 (52.4)	0 (0.0)	0 (0.0)	3.5	40 (95.2)	1 (2.4)	1 (2.4)	0 (0.0)	4
9. I was able to use my creativity and imagination during the IITs activity.	14 (33.3)	26 (61.9)	2 (47.6)	0 (0.0)	3	38 (31.0)	4 (69.0)	0 (4.8)	0 (0.0)	4
10. I would like to participate in similar activities in the future.	7 (16.7)	15 (35.7)	20 (47.6)	0 (0.0)	2.5	38 (31.0)	4 (69.0)	0 (4.8)	0 (0.0)	4

Table 9. Results of Wilcoxon Signed Ranked Test on Students' Perceived Level of Engagement (N=42)

Variable	Tests	Mdn	Z value	p-value	Haike's Gain (g)	Verbal Interpretation
Perceived Level of Engagement	Pretest	3.5	0.143	0.188	0.07	Negligible
	Post-test	4.0				

On a different page, post-test results show that most students strongly agreed on all the indicators of their engagement in doing the IITs activity. Thirty-eight students noted that the IITs activity helped them understand the concept of insect taxonomy (90.5%). Most of them enjoyed the activity (85.7%) and were motivated to finish it (83.3%). The students perceived using Pokemon as a theme in the IITs activity as helpful in keeping their focus consistent and motivated (95.2%). Interestingly, there was an evident positive shift regarding students' perceptions of their interest in participating in future similar activities (69.0%). Although a significant change was observed on the last indicator, Table 9 displayed no significant difference between the overall median pre/post-test ranks (Z=0.143, p=0.188), which was confirmed by Haike's gain value of 0.07, indicating a negligible change. These results convey that students' positive perceptions of their level of engagement were maintained and consistent throughout the activity. These reports were apparent in some of their responses, as presented below.

"The improvisation aspect of the activity made it unique and challenging. I enjoyed the process of coming up with creative solutions to trap insects. It was a great experience in learning insect taxonomy."

"My excitement level before and after the activity was skyrocketing. I never thought we could do experiments like this at home. I look forward to doing more of this in the future."

"The activity was so much fun and educational at the same time. I learned about the different classifications of insects and how to make an improvised trap. I was amazed by the variety of insects we caught."

"Even though the activity was performed remotely, I was really impressed by the level of engagement I had during the insect trap activity. Everyone was eager to learn and participate, making the experience more enjoyable."

"The activity was well-organized, and the instructions were clear. I felt confident in my ability to create a successful trap, and I was thrilled when we caught so many insects."

Affordances and Constraints of Using the IITs Activity

By assessing the affordances and constraints in performing the IITs activity, this study aimed to identify the strengths of the activity and the areas for improvement. Using the recordings and responses of the students during the virtual focus group discussion, thematic analysis was performed to generate the themes and subthemes. Responses were classified into two themes (Affordances and Constraints). For the affordances, three subthemes emerged – motivation, satisfaction, and authentic learning. The use of Pokemon as a theme in the activity was found appealing among the students. They mentioned that Pokemon badges made the activity more exciting and fun. Most of the students gave positive feedback regarding the effects of the Pokemon theme on their motivation, as demonstrated below.

"I was motivated to participate in the IIT activity because of the Pokemon concept. It made the activity feel like a fun and interactive game, which kept me engaged and interested in learning about insects."

"The Pokemon aspect of the activity made it unique and exciting. I felt like I was on a real-life adventure, searching for different types of insects. It was a great way to bring the learning to life."

"The Pokemon theme made the IIT activity more engaging and entertaining. I was motivated to participate because I felt like I was part of a real-life Pokemon adventure, searching for new and exciting insects."

Regarding the satisfaction level of the students, it was evident during the virtual FGD that most students had good learning experiences while doing the IITs activity. They expressed their satisfaction with the quality of the trap design, the number of caught insects, the accuracy of their insect identification, and their overall experience. These claims were apparent in their responses as follows.

"I was delighted with the IIT activity. I felt like I learned a lot about insects and their taxonomy and had a lot of fun in the process."

"The IIT activity was a great learning experience. I was satisfied with the level of engagement and interaction, and I felt like I gained a deeper understanding of insect taxonomy."

"I was thrilled with the IIT activity. I felt like I could apply what I learned in class and had a lot of fun in the process."

In this study, IITs activity was used as a home-based experiment to deliver authentic home learning for insect taxonomy. Some students mentioned that they found the IITs activity helpful as they learned new first-hand experiences. Other students emphasized that they preferred doing hands-on activities at home rather than performing virtual simulations and activities. Hereunder are some of the excerpts from students' responses.

> *"The IIT activity was a fantastic example of hands-on, real-world learning. I felt like I could apply what I learned in class, and it was a lot more interesting than just identifying insects."*

> *"I thought the IIT activity was a great representation of authentic learning. It allowed us to see insects in their natural habitats and was much more engaging than just doing virtual simulations."*

On the different side of the coin, the negative comments from students regarding the IITs activity were classified as "Constraints". Under this theme, two subthemes were generated – safety and parental involvement. Students raised some issues regarding the implementation of the activity. Some of them were concerned regarding the kind of insects that they were dealing with. They were worried about mosquitos and other beetles that may carry diseases. They also mentioned the unsatisfactory level of supervision that some of the parents implemented during the activity. Although it was emphasized during the orientation program that students should wear protective clothing during the deployment of traps, close and strict supervision of the parents were necessary to monitor these guidelines.

Some of the quotations from students' feedback are presented below.

> *"I was concerned about the safety of doing the IIT activity. I felt there wasn't enough adult supervision, and I was worried about getting stung or bitten by insects."*

> *"The risk of getting bitten by mosquitoes during the IIT activity was a major concern for me. I felt there wasn't enough protection and worried about my safety."*

> *"I was worried about the risk of disease transmission from the mosquitoes, and it made me feel unsafe."*

> *"The instructions for safely handling the mosquitoes were not clear, and it made me feel unsure about what I was doing, afraid of being bitten by the mosquitoes, and I didn't feel confident in my ability to protect myself."*

DISCUSSIONS

Learning insect taxonomy has been challenging for students due to the lack of appropriate learning activities. This concern was further aggravated by the school closure brought about by the COVID-19 pandemic. Students' self-efficacy has been an essential variable in determining the effectiveness of IITs as a learning activity for insect taxonomy. Findings revealed that students had a low level of confidence and self-efficacy before the implementation of the IITs activity. This might be due to their fear of insects and initial impression regarding the complexity of the activity. Lane et al. (2021) mentioned that students' first impressions of the activity played a significant role in their succeeding performance in class. Moreover, Ernst et al. (2012) noted that using insects in education might be an excellent approach to enhance the learning experience but may pose significant drawbacks and challenges, such as these invertebrates might induce panic or anxiety among students. On a positive note, considerable improvement was observed in their self-efficacy after doing the IITs activity. These findings indicate that as a home-based experiment, the IITs activity enhanced the students' confidence in making improvised traps and learning insect taxonomy. This claim supports the studies by Ainscough et al. (2016) and Robledo & Prudente (2022), which emphasized that academic self-efficacy encompasses judgments regarding one's ability to perform academic tasks and is greatly influenced by doing hands-on activities independently.

According to Bandura's self-efficacy hypothesis, individuals who engage in hands-on tasks and successfully finish them are more likely to develop a sense of self-efficacy (Bandura, 1977). Students can see the direct outcomes of their activities by making and using IITs, which can boost their confidence in their abilities to solve issues and carry out tasks effectively. Furthermore, the ability to design, build, and test their IITs can promote a sense of ownership and responsibility, increasing self-efficacy (Schunk, 1991). Gowda and Mohamed (2020) discovered that hands-on science activities might boost students' self-efficacy and confidence in their abilities. Similarly, Robledo et al. (2021) and Villanueva and Enright (2020) found that hands-on learning experiences can improve students' problem-solving skills, leading to self-efficacy improvement.

The perceived levels of engagement of the students indicate their satisfaction, learning experience, and motivation in doing a learning task. Pretest results revealed that students had positive perceptions and expectations of their engagements and participation in the IITs activity. This perceived level of engagement was consistent and maintained throughout the activity, as confirmed in the post-test results. No significant improvement in students' engagement was found after the activity, maybe because they initially had a relatively high level of perceived engagement. These findings were controversial as they contradict the previous study by Qua et al. (2021), which explained that using hands-on activity might significantly improve the engagement levels of the students in science classes. Salgueira et al. (2012) added that students' degree of engagement and involvement was influenced by their characteristics and demographics, which was not considered in this study due to the small number of participants.

Other possible reasons for the conservation of the students' perceived engagement levels are the following: the activity is highly relevant and engaging, the virtual classroom environment is positive, and the use of a personalized learning approach. Mebert et al. (2020) discovered that pupils are more likely to be engaged when the learning material is relevant and engaging. If students perceive the IIT to be exciting and relevant, they are more likely to be involved before and after the activity. Qui (2022) and Chu et al. (2021) explained that a conducive, friendly, and supportive classroom environment could boost student participation and engagement. Moreover, a study by Grijpma et al. (2022) noted that active learning strategies could increase student engagement. Students may be more engaged and retain learning if they participate in hands-on activities such as the IIT.

Several affordances and constraints transpired during the virtual focus group discussion. Students believed that using "Pokemon" as the theme of the activity enhanced their motivation to participate. They also mentioned that they were highly satisfied with the activity as they we able to apply their learning in real life and got the chance to perform authentic learning activities at home. These findings support the study of Marquet et al. (2017), wherein they found that by incorporating Pokemon Go in teaching strategies, teachers can create a fun and engaging Pokemon-themed activity that will enhance student learning motivation but also reinforce essential skills and concepts in a meaningful and memorable way. Kong (2021) added that authentic learning experiences could improve student satisfaction, engagement, and motivation. Teachers may help students recognize the value of their education and encourage a lifelong love of learning by providing them with relevant, empowering, collaborative, and individualized learning experiences. On the other hand, students raised concerns regarding safety regarding the presence of mosquitos and the low-level parental involvement during the activity. Knopik et al. (2021) discussed that some parents might be unaware of the significance of educational activity or the role they can play in their child's education. Parents' understanding and participation can be increased by providing precise and straightforward information about the activity and the necessity of parental involvement. These constraints mentioned by students are expected based on the nature of the activity. Thus, building stronger connections and constant communication with parents is necessary to ensure that the guidelines and protocol are implemented accordingly.

CONCLUSION

Engaging in the activity of using improvised insect traps (IITs) proved to be instrumental in increasing students' interest and active involvement in the field of insect taxonomy. Students' feedback and responses indicated that their knowledge and proficiency in insect identification significantly advanced as a result of collecting insects using these traps and learning to distinguish between species based on observable traits like size, shape, color, and markings. Furthermore, the incorporation of insect traps in the learning process provided students with an opportunity to delve into the principles of classification and gain a deeper understanding of the hierarchical structure utilized in taxonomy for categorizing organisms. Moreover, the utilization of improvised insect traps not only served as an educational tool but also played a vital role in fostering environmental consciousness and promoting the conservation of insect diversity, thereby highlighting their ecological importance within ecosystems.

Limitations and Recommendations

There are several limitations to consider when evaluating the effectiveness of improvised insect traps (IITs) as a home-based activity. Firstly, the study's sample size may be limited, which could impact the generalizability of the findings. Secondly, the study may not have accounted for all relevant variables, such as socioeconomic status or prior knowledge of insects, which have the potential to influence the results. Additionally, reliance on self-reported data in the study introduces the possibility of biases or inaccuracies. To address these limitations, future research should aim to employ larger and more diverse samples, control for important variables, and utilize data collection methods beyond self-reports, such as observations and output evaluations. Furthermore, conducting an analysis of the long-term effects of the activity, including changes in knowledge, attitudes, or behaviors related to insects and the environment, would provide valuable insights. By implementing these recommended procedures, future studies can offer a more comprehensive understanding of the outcomes associated with homemade insect traps as a home-based activity.

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