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Home-Based Sci-Lab Experiments in Developing Scientific Skills in General Biology 2

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ABSTRACT

This action research examined the use of home-based science laboratory experiments in developing the scientific skills of Grade 11 Science, Technology, Engineering, and Mathematics (STEM) students in General Biology 2 at Tanay Senior High School during School Year 2021-2022. The intervention was designed to provide hands-on learning opportunities during distance-learning conditions. Twenty-eight Grade 11 STEM students from Section Neptune participated and were grouped according to the proximity of their residences. Three teacher-developed laboratory activity sheets were implemented: Developing Maggots, DNA Extraction, and Frog Dissection. Before and after the intervention, the students completed a 15-item confidence checklist using a five-point scale. Performance rubrics were also used to evaluate the outputs of the three groups. The reported overall confidence mean increased from 3.28 before exposure, interpreted as Somewhat Confident, to 4.81 after exposure, interpreted as Completely Confident. The source manuscript reported a statistically significant difference based on the paired comparison of the 15 item means, $t(14) = -12.25$, $p < .001$. Group performance was Outstanding across all activities. The overall group mean was 4.75 for Developing Maggots, 4.83 for DNA Extraction, and 4.92 for Frog Dissection. The findings indicate that carefully guided home-based experiments can support scientific-skill confidence and practical engagement when face-to-face laboratory access is limited. The intervention may be adapted for blended and emergency distance-learning contexts, provided that safety protocols, guardian supervision, and appropriate materials are ensured.

Keywords: *action research, General Biology 2, hands-on learning, home-based laboratory, scientific skills, STEM students*

INTRODUCTION

Laboratory activities are essential in science education because they enable learners to connect concepts with observation, manipulation, evidence gathering, and scientific explanation. In senior high school STEM subjects, practical experiences are particularly important because students are expected to develop the scientific skills required for more advanced academic work and future science-related courses.

During pandemic-related disruptions, conventional face-to-face laboratory sessions became difficult to conduct. This situation created a need for alternative strategies that could preserve hands-on learning while observing health and safety measures. Home-based laboratory activities offered a practical response when they were supported by clear procedures, appropriate materials, teacher guidance, and family supervision.

The Department of Education has emphasized the observance of safety measures in science laboratories and the importance of informing students about hazards and the proper handling of tools, equipment, and chemicals (Department of Education, 2006). These principles remain relevant even when experiments are conducted outside the school laboratory. Safety reminders, careful selection of activities, and guided implementation are necessary.

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Hands-on experience can stimulate learner interest and strengthen meaningful learning. Bergin (2001) discussed situational factors that influence interest, while Rutherford (2003) described hands-on learning as an experience in which learners handle scientific instruments and manipulate objects. These principles guided the development of teacher-made home-based laboratory activity sheets for General Biology 2.

This action research assessed the confidence of Grade 11 STEM students before and after exposure to home-based science-laboratory experiments and described their performance in three General Biology 2 activities: Developing Maggots, DNA Extraction, and Frog Dissection.

Literature Review

Hands-On Learning in Science Education

Hands-on activities provide opportunities for learners to observe, investigate, test ideas, and connect theory with practice. Rutherford (2003) emphasized that learners develop understanding when they handle scientific instruments and manipulate the objects being studied. Practical activities can also encourage interest and motivation because learners experience scientific processes directly rather than through explanation alone (Bergin, 2001).

Instructional Materials and Scientific-Skill Development

Teacher-developed materials can guide learners through structured activities and promote meaningful practice. Tambongco (2021) reported that enhancement activities can support the physical, mental, and social dimensions of learning. Resita and Ertikanto (2018) likewise developed an electronic module designed to strengthen students' representational skills. These studies highlight the value of materials that target identified learning gaps and provide clear directions for active participation.

Laboratory Work During Flexible Learning Conditions

Laboratory work can be adapted to flexible-learning environments when the selected activities are suitable for home implementation and when safety remains a priority. Asadovna (2020) emphasized the importance of combining instruction, problem-solving, and laboratory activities in science teaching. In the present intervention, the teacher provided activity sheets, laboratory apparatus, online orientation, safety reminders, and post-activity discussion.

Safety and Supervision

Home-based laboratory work requires careful risk management. Activities should be selected according to the students' developmental level and the availability of safe materials. Students should receive explicit safety instructions, and parent or guardian participation should be encouraged when practical tasks involve tools, specimens, or laboratory apparatus.

METHODS

Research Design

The study used an action-research approach with a one-group pre-intervention and post-intervention confidence assessment. The source manuscript describes the procedure as a one-shot experimental design, but the reported implementation included both before-exposure and after-exposure confidence checklists. Performance was also assessed after the implementation of the three laboratory activities.

Research Locale and Participants

The study was conducted at Tanay Senior High School, District of Tanay I-A, Division of Rizal, during the second semester of School Year 2021-2022. The participants were 28 Grade 11 STEM students from Section Neptune handled by the teacher-researcher. Purposive sampling was used.

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Intervention

The intervention consisted of three teacher-developed home-based science-laboratory activities aligned with General Biology 2 learning competencies: Developing Maggots, DNA Extraction, and Frog Dissection. The students were organized into three groups based on the proximity of their residences. Group leaders received soft copies of the activity sheets and the required laboratory apparatus in advance so that the learners could prepare additional localized materials.

Before the activities, the teacher-researcher conducted an online orientation to explain the procedures, guide questions, safety precautions, and assigned tasks. During implementation, the students documented the activities and were encouraged to include parents or guardians in the evidence-gathering process. Follow-up discussions, presentations, and reporting of results were conducted online.

Research Instruments

A 15-item questionnaire-checklist assessed the students' confidence in scientific skills before and after the intervention. The scale was interpreted as follows: 4.20-5.00, Completely Confident; 3.40-4.19, Fairly Confident; 2.60-3.39, Somewhat Confident; 1.80-2.59, Slightly Confident; and 1.00-1.79, Not Confident at All.

Performance rubrics assessed the outputs of the three groups in each laboratory activity. The interpretation scale was as follows: 4.20-5.00, Outstanding; 3.40-4.19, Very Satisfactory; 2.60-3.39, Satisfactory; 1.80-2.59, Unsatisfactory; and 1.00-1.79, Poor. The source manuscript states that the questionnaire and rubrics were checked and evaluated by science teachers from Tanay-Sampaloc National High School.

Data Analysis

Mean was used to summarize the level of confidence before and after the intervention and the students' group performance in the three laboratory activities. The source manuscript reported a paired t-test based on the 15 before-and-after item means to examine the difference in confidence.

Ethical and Safety Consideration

The teacher-researcher provided safety instructions before implementation and emphasized the proper handling of laboratory apparatus. The students were encouraged to document guardian or parent involvement during the home-based activities. The source manuscript does not report a formal ethics-clearance reference number; this detail should be confirmed before journal submission.

RESULTS AND DISCUSSION

Confidence Before and After Exposure to Home-Based Sci-Lab Experiments

Table 1. *Summary of Confidence Before and After the Intervention*

Selected Scientific Skill	Before Mean	Before Interpretation	After Mean	After Interpretation
Understanding the objectives of the experiment	2.96	Somewhat Confident	4.61	Completely Confident
Gathering data from the experiment	3.25	Somewhat Confident	4.46	Completely Confident
Following scientific procedures	3.46	Fairly Confident	4.68	Completely Confident
Explaining the result of the experiment	3.14	Somewhat Confident	4.96	Completely Confident
Working with laboratory apparatus	2.71	Somewhat Confident	4.86	Completely Confident
Using and manipulating the microscope properly	2.64	Somewhat Confident	4.82	Completely Confident
Dissecting frogs and labeling their parts correctly	2.32	Slightly Confident	4.86	Completely Confident

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Performing experiments scientifically	3.00	Somewhat Confident	4.75	Completely Confident
Accepting comments and suggestions from group members	4.00	Fairly Confident	5.00	Completely Confident
Overall mean	3.28	Somewhat Confident	4.81	Completely Confident

The overall confidence mean increased from 3.28 before exposure to 4.81 after exposure. Before the intervention, the students were least confident in frog dissection and labeling (M = 2.32), microscope manipulation (M = 2.64), and working with laboratory apparatus (M = 2.71). After the intervention, all reported confidence indicators were interpreted as Completely Confident.

The strongest after-exposure rating was accepting comments and suggestions from group members (M = 5.00), followed by explaining results and following instructions and assigning tasks (M = 4.96 each). These findings suggest that the intervention supported not only practical laboratory confidence but also collaboration, communication, and scientific explanation.

Reported Difference in Confidence

Table 2. *Reported Paired t-Test Based on the 15 Confidence-Indicator Means*

Statistic	Reported Value
Before intervention mean	3.276
After intervention mean	4.810
Number of paired indicators	15
Degrees of freedom	14
t statistic	-12.251
Two-tailed p-value	< .001
Decision	Reject the null hypothesis

The source manuscript reported a statistically significant difference between the before-exposure and after-exposure confidence ratings, $t(14) = -12.25$, $p < .001$. The reported analysis used the 15 confidence indicators as paired observations. The substantial increase in the overall mean provides descriptive evidence that the students felt more confident after completing the home-based laboratory activities.

For journal publication, the inferential analysis should be reviewed carefully. A stronger analysis would use the individual students' paired pre-intervention and post-intervention confidence scores rather than the aggregated item means. This would align the unit of analysis with the 28 participating students.

Performance in the Three Home-Based Laboratory Activities

Table 3. *Group Performance in Home-Based Sci-Lab Experiments*

Laboratory Activity	Group	Mean	Interpretation
Developing Maggots	Group 1	4.75	Outstanding
	Group 2	4.75	Outstanding
	Group 3	4.75	Outstanding
	Overall group mean	4.75	Outstanding
DNA Extraction	Group 1	4.75	Outstanding
	Group 2	4.75	Outstanding
	Group 3	5.00	Outstanding
	Overall group mean	4.83	Outstanding
Frog Dissection	Group 1	5.00	Outstanding
	Group 2	4.75	Outstanding
	Group 3	5.00	Outstanding
	Overall group mean	4.92	Outstanding

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All groups obtained Outstanding performance ratings across the three laboratory activities. Developing Maggots obtained an overall group mean of 4.75. DNA Extraction obtained 4.83, and Frog Dissection obtained the highest overall group mean of 4.92. These results indicate that the students were able to complete the assigned activities and demonstrate the required performance criteria under guided home-based conditions.

Implications for Science Instruction

The findings support the use of home-based laboratory activities as a supplementary strategy when school-laboratory access is limited. The intervention provided opportunities to manipulate apparatus, follow procedures, collect data, explain results, collaborate with peers, and complete performance tasks. The results are consistent with the view that enrichment and enhancement materials can facilitate active and meaningful learning (Tambongco, 2021).

Home-based experimentation should not replace school-based laboratory work when safe and appropriate facilities are available. Rather, it can serve as a flexible supplementary approach for blended-learning schedules, emergency closures, remediation programs, and selected activities that can be conducted safely outside the laboratory.

Proposed Utilization and Enhancement Plan

Table 4. *Proposed Plan for the Continued Use of Home-Based Sci-Lab Experiments*

Priority Area	Recommended Action	Persons Involved	Expected Output
Activity-sheet enhancement	Revise the three activity sheets for blended, full face-to-face, and emergency distance-learning contexts.	Science teachers and department coordinators	Updated and context-appropriate laboratory guides
Safety protocol strengthening	Develop activity-specific safety checklists, guardian-orientation notes, and equipment-accountability forms.	Science teachers, school administrators, parents or guardians	Safer implementation and clearer supervision
Teacher capability building	Conduct learning-action-cell sessions on designing safe home-based and blended science experiments.	Science teachers and school leaders	Expanded teacher capacity for flexible laboratory instruction
Pilot expansion	Adapt suitable activities for other science subjects and grade levels.	Science department and selected classes	Broader use of carefully selected hands-on activities
Monitoring and evaluation	Use student-level pretests, posttests, confidence measures, performance rubrics, and reflection forms.	Teacher-researchers and coordinators	Stronger evidence for continuous improvement

CONCLUSION

Home-based sci-lab experiments provided Grade 11 STEM students with structured opportunities to develop scientific skills in General Biology 2 during distance-learning conditions. The students' reported confidence increased from Somewhat Confident before the intervention to Completely Confident after the intervention. Their group outputs in Developing Maggots, DNA Extraction, and Frog Dissection were all rated Outstanding. The intervention appears useful as a supplementary strategy for flexible-learning contexts, provided that activities are appropriate for home implementation and supported by teacher guidance, safety protocols, guardian supervision, and careful monitoring.

Recommendations

1. Science teachers may adapt suitable home-based laboratory activities for blended-learning schedules, emergency school closures, remediation, and enrichment programs.
2. The activity sheets may be revised to include clearer procedures, guide questions, safety checklists, guardian-orientation notes, and equipment-accountability forms.

3. School leaders may support learning-action-cell sessions on designing safe and curriculum-aligned laboratory activities for flexible-learning contexts.
4. Home-based activities involving specimens, laboratory tools, or potentially hazardous materials should be implemented only when risks are manageable and adult supervision is available.
5. Future action research may use student-level paired confidence scores, objective pretests and posttests, comparison groups, learner reflections, and larger samples to strengthen the evidence.
6. The three laboratory activities may be reviewed carefully to confirm their alignment with the intended Most Essential Learning Competencies and current safety requirements.

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