Formosa Journal of Science and Technology (FJST)
Vol. 4, No. 8, 2025: 2593-2602

CCxLAB: A Classroom – Based Customized Experiential Lab in a Box for Retooling PCSHS Science Teachers

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A R T I C L E I N F O
Keywords: Classroom, Investigative Process Skills, Science Experiment

Received : 11, July
Revised : 25, July
Accepted: 27, August

A B S T R A C T
This study addresses persistent challenges in science education among PCSHS students in STEM, other academic tracks, and Junior High School within the K–12 program, particularly in light of the Philippines' at-risk performance in the 2018 and 2022 PISA assessments.The research implemented CCxLAB, an innovative classroom-based customized experiential laboratory box, in Research and Physical Science subjects. A total of 209 participants (149 STEM, 39 HUMSS, and 21 Junior High School students) engaged in laboratory activities. Data were collected through pre- and post-tests, the adapted Laboratory Performance Assessment Tool (Slater & Ryan, 1993), and teachers' reflective journals. Findings revealed significant mean differences in pre- and post-test scores across small and large groups. Students achieved performance levels ranging from meeting (2 points) to exceeding goals (3 points). Teachers reported CCxLAB's effectiveness in instructional and technical design, usability, and frequency. Statistical analysis confirmed the effectiveness of CCxLAB at the 5% significance level. The tool provides valuable insights for improving science instruction, enhancing literacy, and strengthening practical applications in the Philippine K–12 curriculum.

DOI prefix: https://doi.org/10.55927/fjst.v4i8.147
ISSN-E: 2964-6804
https://traformosapublisher.org/index.php/fjst

INTRODUCTION

In the Philippines, one of the strands under the Senior High School Curriculum is the Science, Technology, Engineering, and Mathematics (STEM). About 23.24% of the 2.8 million senior high school students were enrolled in the STEM strand based on the survey conducted by the Department of Education on the previous school year 2022 – 2023. High enrolment data was also reported by the DepEd last August 2023 revealing 21,029,531 students nationwide spreading across the public kindergartens, elementary and high schools. Moreover, these students are required to complete the prerequisites and academic requirements needed for the K-12 Science curriculum.

Identified challenges are anchored on the thousands of Filipino STEM graduates who are still considered insufficient leading to inadequate number of scientists with a ratio of 189 per million and is comparatively very low to the UNESCO recommendation of 380 per million (Anito, Morales & Palisoc, 2019). Another critical struggle is the distinction of low rankings among the global evaluations such as the 2018 and 2022 Programme for International Student Assessment (PISA), which evaluates the performance of 15-year-olds in reading, mathematics and science, with Philippines having the second-lowest spot in science and mathematics in 2018 and ranked 78 out of 81 countries in 2022. In the 2019 Trends in International Mathematics and Science Study (TIMSS), which evaluates the performance of Grade Four students in math and science proficiency ranks PH as the lowest among the 58 countries that were included in the study. With that being said, the 2019 Southeast Asia Primary Learning Metrics (SEA-PLM), which measures the capacity of Grade 5 students in reading, writing and mathematics having performed below the regional average in all three areas.

Thus, this calls to strengthen and improve the delivery of Science Instructions and STEM education in each classroom by recognizing that there is an urgent need to retool the teachers in the execution of the said curriculum.

In line with these, the Department of Science and Technology (DOST) in partnership with the Philippine Science Centrum conducted numerous teacher trainings on lessons and instructional kits based on interactive science exhibits popularized by the Philippine Foundation for Science and Technology (PFST). In addition, the DOST Science Education Institute also found a new way of customizing lab in box by engaging teachers to compete and create their own Innobox project.

To study the integration of lab in a box in classroom learning which were once solely focus as Basic chemistry and physics instructional materials, this action research aimed to assess the effectiveness of ***CCxLAB as an innovative classroom – based customized experiential laboratory box*** in two (2) learning key areas namely: Basic Research and Physical Science. Furthermore, it also aimed to seek the perceptions of the PCSHS science teacher who used the tool in terms of instructional design, technical design and usability in the classroom setting (Guidelines and Processes for LRMDS Assessment & Evaluation, 2009; Guidelines and Process for LRMDS Assessment and Evaluation of Locally Developed and Procured Materials, 2019).

THEORETICAL REVIEW

The aim of this study is to assess the effectiveness of CCxLAB as an innovative classroom – based customized experiential laboratory box in the performance of the students and teachers. Specifically, it sought answers to the following questions:

(1) Is there a significant mean difference based on the result of the pretest and post test after the implementation of CCxLAB?
(2) What is the achievement and performance level of the participants based on the *Laboratory performance assessment tool by Slater & Ryan* scored on a 3-point rating scale, in terms of:
   2.1 Methods of Research
   2.2 Appropriate Use of Equipment and Apparatus,
   2.3 Accuracy and Precision
   2.4 Comprehension
   2.5 Calculations
   2.6 Laboratory Report
(3) What are the perceptions of the participating teacher from the reflective journals, in terms of:
   3.1 instructional design
   3.2 technical design
   3.3 usability and frequency

METHODOLOGY

This study made use of pretest – posttest experimental research design to assess the effectiveness of CCxLAB based on the achievement and performance level before and after the implementation. The study was completed by utilizing the three-phase implementation strategy: 1. Identification of least mastered skills among the two (2) learning key areas of Research and Physical Science or needs assessment for the competencies which have used CCxLAB as experimentation manipulatives; 2. adapted standardized evaluation tool for the achievement level and 1 perception tool for the instructional and technical design, competency alignment, usability and frequency of the teacher implementer(s). 3. a reflective journal for the participating teacher, communication letters, validation tools and statistical computation instruments.

A compiled list of CCxLAB activities was used by the teacher implementer to assist in the utilization containing the materials needed, procedures and processing questions. A reflective journal was also implemented to check the perception of the participating teacher.

Participants and/or other Sources of Data and Information

A total of 209 students from the intact groups of SHS Grade 12 STEM students (149), one section from the SHS HUMSS students (39) and JHS Grade 9 (21) from Pasay City South High School were tagged as the sample in this study.

A written consent form duly signed by the respondents' parents/ guardian has been acquired prior to the implementation of the study.

The accomplished before, during and after implementation on the achievement and performance level of the learners and the researcher-made questionnaire as the perception tool for the instructional and technical design, competency alignment, usability and frequency were utilized as the pool of data in this study. Other remarks from the samples as been noted and synthesized qualitatively and quantitatively.

The researcher ensured that all the data gathered within the duration of this school year-based action research has been used for the sole purpose of this study.

Data Gathering Methods

Research Instruments

A total of 2 research instruments was used in this study. The objective scoring in the CCxLAB activity paper and a combined adapted Laboratory performance assessment tool by Slater & Ryan (1993) with three factor point standardized evaluation rating sheet based on the Guidelines and Processes for LRMDS Assessment & Evaluation, (2009); Guidelines and Process for LRMDS Assessment and Evaluation of Locally Developed and Procured Materials (2019) was used to assess the instructional design, technical design and usability and frequency of CCxLAB. These are the main instruments in tracing the learners' achievement and performance level in using the CCxLAB. Consequently, the tool was administered for one (1) semester equivalent to two (2) quarters to measure the significant differences. With each quarter having three (3) CCxLAB activities both used in the experimentation process of students enrolled in Research and Physical Science.

The learner's CCxLAB activities were content validated prior to the implementation to ensure the high validity and reliability of the assessment of learning.

A reflected journal was accomplished by the teacher implementer every after use of the CCxLAB. These were collected to note the perception of use and other remarkable details throughout the conduct of this study.

Data Gathering Procedures

The data gathering procedure composed of three phases. These phases are as follows:

1. identified the least mastered skills using Evaluation of Learning Outcomes and Results (ELOR) among the two (2) learning key areas namely: Basic Research and Physical Science.

2. adapted standardized evaluation tool for the achievement and performance level and 1 perception tool for the instructional and technical design, competency alignment, usability and frequency.

3. completed a reflective journal by the participating teacher, communication letters, validation tools and statistical computation instruments.

Data Analysis

The student's responses in the Slater & Ryan Laboratory Performance Assessment Achievement and Performance Level were individually scored based on the three levels and tabulated during the pretest and posttest. The mean and standard deviation of the overall scores has been determined. The pretest and posttest scores were compared, and its significant differences were analyzed.

The perceptions of the participating teacher have been assessed using the Perception Tool found in the Guidelines and Processes for LRMDS Assessment & Evaluation, 2009; Guidelines and Process for LRMDS Assessment and Evaluation of Locally Developed and Procured Materials, 2019.

Answers on the reflective journal of the teacher was thematically analyzed and coded based on similar themes. This was used for in – depth understanding of teachers' utilization of CCxLAB.

Statistical Analysis

Data gathered from the sample group has been subjected to statistical treatment and analysis. Frequency counts, percentages, means, and standard deviation were used for the descriptive statistics. The t-Test: Paired Two Sample for Means was used to determine if there is a significant difference at 0.05 level of significance between the pre-test and posttest after the implementation of the CCxLAB as a tool for the participating teacher.

RESULTS AND DISCUSSION

Using the Evaluation of Learning Outcomes and Results (ELOR), the top 3 least mastered skills for Research and Physical Science include: (1) apply scientific attitudes in designing simple science investigation (2) use of appropriate tools in measuring objects, (3) communicate the result of observations through different forms of science publications.

Findings were based on the adapted standardized evaluation tool for the achievement and performance level (Slater & Ryan, 1993) with six indicators namely Methods of Research, Appropriate Use of Equipment and Apparatus, Accuracy and Precision, Comprehension, Calculations, Laboratory Report scored on a 3-point rating scale, 149 STEM students acquired high scores across the five-piece CCxLAB activities with 85-98% objective scoring. The HUMSS students achieved a range from 85-95% based on 155-scored items. While the 17 JHS students who are composed mostly of Grade 9 students got a range of 88-93%. The means for the participants were identified to be 28.18 (STEM), 26.85 (HUMSS) and 23.95 (JHS).

Table 1. Mean Differences Among Groups

	Pre-Test (30)	**Post Test (30)**	**Mean Differences**	**Variance Post-Test**	**P(T<=t) one-tail**	**t-Critical one-tail**	**$T_{0.05}$**
STEM	16.18	28.18	12.00	2.06	5.68E-190	1.65	Reject H_o

HUMSS	23.84	26.84	3.00	2.97	2.25E-11	1.66	Reject H_o
JHS	20.95	23.95	3.00	18.24	0.01	1.68	Reject H_o

critical value 0.05 level

The table shows the mean differences between STEM, HUMSS and JHS. With STEM having the average gap from their pre-test. The HUMSS tied with the JHS for mean differences. Unequal variances were calculated using the EXCEL 2020 data analysis with the JHS being the highest may be associated with scores that are spread far from each other. Based on the computed t value, which is greater than the critical value, the null hypothesis is rejected which means that there is a significant effect of using CCxLAB as an instructional tool. This also implied that the Pre-Test mean is higher than the Post-Test mean.

Table No. 2 Laboratory Performance Assessment Tool by Slater & Ryan (1993) for Achievement and Performance Level

Average point	Methods of Research	Appropriate Use of Equipment and Apparatus	Accuracy and Precision	Comprehension	Calculations	Laboratory Report	Total (18)
STEM	3	2	3	3	3	3	17
HUMSS	3	2	2	3	3	2	15
JHS	3	2	2	1	2	2	12

Legend:
No Evidence (0 point)
Approaches Goal (1 point)
Meets Goal (2 points)
Exceeds Goal (3 points)

The table No.2 showed that the STEM students excelled based on the 3-point rating scale achieving the highest points among the six indicators followed by the HUMSS students and the JHS students. This is associated with the pre-requisites skills on the conduct of laboratory experiments.

The reflection journal of the participating teacher also showed significant impact on the delivery of lesson contents.

Table No. 3 Thematic Analysis of Reflection Journal

Adapted from Guidelines and Process for LRMDS Assessment and Evaluation of Locally Developed and Procured Materials (2019)	
Indicators instructional design	… the activity has refined procedures, clear and measurable learning objectives that align with the overall content standards.

	… the activity is logical from the nature of concepts to post discussion activities.
technical design	… interactive elements were incorporated. … the activity ensured that students determine the accuracy and precision based on the number of trials conducted.
	… the CCxLAB activities provide observation data which requires students to observe and infer.
	… conducted classroom-based laboratory activities that require to set and identify varying results with different conditions.
usability and frequency	… all students participated in the execution.
	… some students struggled with following advanced procedures but were guided with the teachers' intervention.
	…. the teacher simplified step by step process during the pre-instructions.
	…. students showed enjoyment and interaction during CCxLAB activities that were conducted every other week.

The table above showed that the participating teacher was able to document the experiences during the utilization of CCxLAB for classroom-based laboratory instructions.

The implication of this action research provided a valuable insight for science teachers and curriculum implementers in retooling and addressing the Philippine performance towards Scientific development, literacy, theoretical and practical applications.

CONCLUSION

Despite high overall performance scores across various grade levels and strands in science-based tasks, the study was only focused on the two-underlying discipline of science which is Basic Research and Physical Science. Thus, other least mastered integrated laboratory skills from Biology and Chemistry were not included in the study. The study was guided by the adapted standardized evaluation tool for achievement and performance levels developed by Slater and Ryan based on the six key indicators. Levels of discrepancy between overall academic performance and mastery of essential science process skills highlights a potential gap in instructional strategies, learning experiences, or assessment practices. Thus, there is a need to further examine the contributing factors

affecting students' development of these foundational skills and to identify targeted interventions that can enhance competency in these areas.

RECOMMENDATION

Based on the findings, the following recommendations are proposed:

1. The effectiveness of the CCxLAB has made an impact on the performance of the participating students and teachers. Other academic strands/clusters and grade levels may also utilize it in their classes.
2. The CCxLAB should be constantly reviewed and improved based on students' feedback and learning outcomes.
3. Teachers from other science disciplines may consider integrating the tool with interactive simulation elements to further enhance the students' practical and theoretical laboratory skills.
4. It is suggested that the CCxLAB should be integrated into performance and content standards aligned with the DepEd curriculum.
5. The school administrators can assist by allocating time and resources for educators to add more localized materials and equipment in the CCxLAB.

FURTHER STUDY

It is recommended to conduct further studies to assess the effectiveness of the CCxLAB on the advancement of the integrated science process skills like creating lab case reports and science investigatory projects as well as improvement of the critical thinking and foundational skills of the students towards laboratory tasks.

REFERENCES

Arboiz, K. M., & Malayao Jr., S. O. (2024). A simulation-based guided inquiry laboratory package in teaching mirrors and lenses for grade 10 learners. *International Journal of Research and Innovation in Social Science*, *VIII*(VI), 2558–2567. https://doi.org/10.47772/ijriss.2024.806195

Classroom Assessment Tools - Oregon State University. (n.d.-a). https://apa.oregonstate.edu/sites/apa.oregonstate.edu/files/Assessment/ClassroomAssessmentTools.pdf

Conceição, S. C., & Howles, L. L. (2023). *Creating meaningful learning activities through learning experience design. Designing the Online Learning Experience,* 84–101. https://doi.org/10.4324/9781003444121-5

DM No. 441, S. 2019 Guidelines and process for Lrmds assessment and evaluation of locally developed. Studocu. (n.d.). https://www.studocu.com/ph/document/universidad-de-zamboanga/secondary-education/dm-no-441-s-2019-guidelines-and-process-for-lrmds-assessment-and-evaluation-of-locally-developed-and-procured-materials/24968180

Framework for LRMDS (final draft) - DepEd LR portal. (March 2009). https://lrmds.deped.gov.ph/docs/LRMDSGuidelines.pdf

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Philippine struggle to make the grade in STEM education. UNESCO Bangkok. (2022, December 9). https://bangkok.unesco.org/content/philippine-struggle-make-grade-stem-education

Pursuing stem careers: Perspectives of senior high school students. (2020). https://www.researchgate.net/publication/342766109_Pursuing_STEM_Careers_Perspectives_of_Senior_High_School_Students

Sari, U., Ulusoy, A., & Pektaş, H. M. (2025c). Computational thinking in science laboratories based on the flipped classroom model: Computational thinking, laboratory entrepreneurial and attitude. *Journal of Science Education and Technology*. https://doi.org/10.1007/s10956-024-10192-y

Slater, T. F., & Ryan, J. M. (1993). Laboratory performance assessment. The Physics Teacher, 31(5): 306-309.

STEM education and competing in the 21st Century. Manila Bulletin. (2023). https://mb.com.ph/2023/6/12/stem-education-and-competing-in-the-21st-century

Tupas, F. P., & Matsuura, T. (2020). *Moving forward in STEM education, challenges and innovations in senior high school in the Philippines: The case of northern iloilo polytechnic state college*. Jurnal Pendidikan IPA Indonesia. https://journal .unnes.ac.id/nju/index.php/jpii/article/view/19707

Wejner, M., & Wilke, T. (2022). LabPi: A Digital Measuring Station for STEM education 4.0. *Journal of Chemical Education*, *99*(2), 819–827. https://doi.org/10.1021/acs.jchemed.1c01139

Why ph needs to strengthen delivery of STEM in the classroom. Manila Bulletin. (2022). https://mb.com.ph/2022/9/16/why-ph-needs-to-strengthen-delivery-of-stem-in-the-classroom

Win Gatchalian. (2023). *More STEM students needed to meet demand for civil engineers*. https://wingatchalian.com/news/more-stem-students-needed-to-meet-demand-for-civil-

engineers/#:~:text=For%20School%20Year%202022%2D2023,enrolled%20in%20the%20STEM%20strand.

u1. (n.d.). InnoBox. https://www.sei.dost.gov.ph/index.php/programs-and-projects/innovations/201-innobox

(2023, August 26). *Over 21 million students enrolled for school year 2023-2024, DepEd Reports*. Philstar.com. https://www.philstar.com/headlines/2023/08/26/2291568/over-21-million-students-enrolled-school-year-2023-2024-deped-reports