The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

CHEMISTRY TO BIODIVERSITY: THE CONUS OUTREACH PROJECT – A SCIENCE OUTREACH APPROACH FOR DYNAMIC SCIENCE LEARNING

SAGUIL, NOEL A.

Chief, CETR- Research Institute for Science and Technology, Polytechnic University of the Philippines, Sta Mesa, Manila. Corresponding Author Email: noels70@yahoo.com

SAGUIL, NOEL STEPHEN F.

Medical Technologist- Philippine Womens University, Taft Ave., Manila. Email: noelstephensaguil@yahoo.com

LIRIO, GARY ANTONIO C.

Chief, CNSRR, Research Institute for Science and Technology, Polytechnic University of the Philippines, Sta Mesa, Manila. Email: gaclirio@pup.edu.ph

CARIL, ALVIN N.

M.S Biology Student, Graduate School; Faculty, Department of Biology, College of Science, Polytechnic University of the Philippines, Philippines. Email: carilus.alvinii@gmail.com

BANTIGUE, PRINCESS CASEY

M.S Biology Student, Graduate School; Laboratory Assistant, Research Institute for Science and Technology, Polytechnic University of the Philippines, Philippines. Email: caseybantigue@gmail.com

SAGUIL, HORACIO A.

Pathologist, Ospital ng Maynila, City of Manila. Email: jrsaguil@yahoo.com

SAGUIL, HANNAH A.

English Supervisor, Philippine Pasay Chung Hua Academy, City of Pasay. Email: hannahsaguil@yahoo.com

Abstract

The Philippines, like many other countries, emphasizes the importance of science education and the importance of science outreach efforts. These activities are crucial for raising scientific literacy, fostering scientific passion, and developing a skilled workforce in the field of science and technology. In response to the ever-increasing demand for quality instruction in science education, this study presented the University of Utah's "*Chemistry to Biodiversity: The Conus Outreach Project,*" which engages Grade 8 students in exploratory and open-ended instructional modules guided by the principle that the earlier students do hands-on experimental science, the better their learning. The purpose of this study is to describe and assess the degree of implementation of the science outreach project and its impact on the academic performance of grade eight students from PCSHS and PCWHS–DOST during the 2014-2015 school year, a pre-pandemic academic year. Results show, in terms of implementation, the majority of students assessed the learning environment as "*very good,*" the learning materials as "*good,*" and the learning task as "*very good.*" Additionally, in terms of academic performance, grade eight students from both PCSHS and PCWHS–DOST presented average to above average achievement scores. Furthermore, the variables utilized in this study to measure the extent of outreach project implementation correlate significantly with student success in terms of achievement scores. Education officials and program organizers can get insights

DOI 10.17605/OSF.IO/HJCTQ

into the effectiveness of previous efforts by examining the outcomes of this study's science outreach data and implementing it into post pandemic planning. In the country's ever-changing approaches to scientific teaching, this data can be used to identify effective tactics, areas for progress, and specific student requirements. The findings of this study strongly urged the adaptation and incorporation of the science outreach program given in this study in order to boost Filipino students' science literacy and enable them to apply diverse scientific principles to real-world problems.

Keywords: Biodiversity, Chemistry, *Conus,* Dynamic Learning, Science Education, Science Outreach Project, Scientific Literacy,

1. INTRODUCTION

Science education in the Philippines faced significant challenges during the COVID-19 pandemic. Science instructors and institutions had to quickly adapt their teaching approaches to online platforms. Schools were forced to transition to remote learning, affecting the delivery of science education, such as restricted access to laboratory facilities, schools, and educational materials (Junsay & Madrigal, 2021; DepEd 2020). The Department of Education (DepEd) in the Philippines adopted online learning platforms and other methods of remote learning to continue instruction throughout the pandemic in order to address these challenges. Science subjects were taught through virtual classrooms, video tutorials, online modules, and instructional websites (DepEd, 2020). Teachers used video conferencing tools and online collaboration platforms to encourage conversations, run virtual experiments, and supply remote guidance to students (Landicho, 2021). In line with these, the Department of Education and other educational institutions in the Philippines collaborated to provide digital learning resources for science education. This transformation necessitated the creation of digital learning resources such as online modules, e-books, and open educational resources (OER) to provide free access to science materials for teachers and students (DepEd, 2020). Virtual experiments and simulations, as well as interactive online activities, are used to engage students in science education remotely (Ray & Srivastava, 2020). However, the challenges included ensuring equitable access to technology and internet connectivity and bridging the digital divide among pupils.

This "new normal" in education alters students' learning experiences and how education sectors supply these learnings. Teachers and students must rely on virtual simulations, television shows, and internet materials (Sahi, 2020; Landicho, 2021). In order to supplement practical experiences, blended learning involved students in self-paced learning utilizing printed modules at home, accessing internet resources, attending virtual classrooms, and watching educational programs on TV or listening to radio sessions (Galang, 2021; DepEd 2020), while educational apps, websites, and digital resources were used to obtain extra information, multimedia activities, and assessments (Junsay & Madrigal, 2021; DepEd, 2020). Additionally, to solve the restrictions of online access, instructional TV programs were used to offer science material to students. DepEd collaborated with television networks to broadcast science classes and educational shows to kids who did not have access to the internet (Toquero, 2020). However, despite these efforts to provide valuable science education, school closures and the shift to online learning limited students' access to laboratory equipment, specimens, and materials, resulting in limited hands-on experimentation, self-discovery, and practical learning

ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

in science courses.

Before the COVID-19 pandemic, science education in the Philippines included several critical components aimed to build scientific literacy and competency among learners. The country's education system followed a K-12 curriculum, which includes science education at various levels. The Department of Education (DepEd) introduced the K-12 Basic Education Curriculum, which incorporated scientific education as a core subject. Science was taught in elementary school (Grades 3–6), junior high school (Grades 7–10), and senior high school (Grades 11–12) (DepEd, 2017). The department developed science standards to guide science teaching and learning. These standards described the information, abilities, and competencies that students were required to achieve at each grade level (DepEd, 2016). Inquiry-based learning methodologies were promoted in science education, through hands-on activities, experiments, and problem-solving, and students were encouraged to explore and understand scientific principles (Kim *et al*., 2015; Aidoo *et al*., 2016; Constantinou *et al*., 2018). Science educators, like all educators, went through a dramatic paradigm shift when they switched from a teacher-centered to a learner-centered approach to teaching. Learners are becoming more driven to acquire and apply concepts and ideas that are pertinent to their desires and challenges. They can investigate ideas about themselves and their communities in order to assess their needs and set goals (Corpuz & Salandanan, 2007). These unending attempts have been made to raise the degree of scientific literacy among Filipino pupils. Forming the learners' thoughts and ideas about what they have learned in the four corners of their classroom in a way that meets the quality criteria of the globally competitive arena of education. The learners' attention is drawn to them as they progress through the educational center stage of the teaching-learning process. Therefore, science outreach programs can bridge the gap between theories and scientific practices.

The" Chemistry to Biodiversity: The Conus Outreach Project"

In response to the ever-growing demand for quality instruction in science education, the University of Utah, Salt Lake City has launched the *"Chemistry to Biodiversity: The Conus Outreach Project"*, which engages Grade 8 students (as well as 3rd and 4th Grade elementary students) in exploratory and open-ended instructional modules guided by the principle that the earlier students do hands-on experimental science, the better their learning. The project's primary manner of instruction was an activity-based strategy. Throughout the study process, students are also exposed to local biodiversity and cultural practices. This research was inspired by this context and the current problem situations in Science Education. It additionally incorporates the dynamic learning program approach, which promotes adaptability, flexibility, and continuous improvement (McLoughlin & Lee, 2010). It emphasizes encouraging students to actively engage with the subject, pursue their interests, and develop critical thinking and problem-solving abilities (Mahoney *et al.,* 2021). Moreover, dynamic learning programs can effectively engage and excite learners in scientific concepts and principles in science outreach activities. Plan engaging science displays and workshops in which participants can participate in hands-on activities and experiments. Involve people in citizen science programs, where they contribute to real scientific research, to improve understanding and interest in science

DOI 10.17605/OSF.IO/HJCTQ

(Wurdinger & Carlson, 2009; Metz *et al.,* 2018; Ashcroft *et al.,* 2020; Huvard *et al.,* 2020). Furthermore, citizen science initiatives encourage students to take an active role in data collecting, analysis, and problem resolution.

The Science Outreach Program focuses on an unusual species of marine organisms known as venomous cone snails. The Howard Hughes Medical Institute (HHMI) Professor project led to the development of a module primarily geared for second and third-graders to conduct experiments ranging from the physical sciences (particularly chemistry) to biodiversity. The biodiversity experimental work focuses on cone snails, and the module is meant to cover three class periods, during which college undergraduates are recruited to serve as mentors for second and third-graders as they conduct the experiments. Additionally, the *"From Chemistry to Biodiversity"* module has been widely used in a wide range of cultural settings, from fishing communities in rural Philippines to sophisticated Salt Lake City schools in the most affluent areas with highly educated parents, where, in most situations, minor modifications are required to make the modules functional. Higher grade level instructors who discover the experiments generally request that they be modified for their students, therefore the *"Chemistry to Biodiversity"* module is offered in both elementary and high school versions.

The University of Utah's Science Education Outreach Project with the *"Let's Do Science Module"* effectively took a four-decade project and presented it in a lesson that in itself awakens scientific curiosity in children. The project is composed of a module centered on the biodiversity of cone snails, including their taxonomy, anatomy, venom delivery system, and adaptations that allow them to thrive in their surroundings. Concerning the chemical aspects, the students are proposing hypotheses and collecting data on various chemical and physical processes involving cone snails. The HHMI has supported this experiment through the work of Dr. Baldomero M. Olivera, a renowned Filipino biologist, and neuroscientist. Moreover, hands-on experiments are given to students so that they can establish hypotheses, feel, manipulate laboratory equipment, follow laboratory safety standards, and draw appropriate conclusions based on their own observations, as this is what actual scientists do in the laboratory and what scientists do for a living. What makes it even more remarkable is that the experiments use commonly available materials such as water, vinegar, chalk, sugar, sand, and discarded clam and crab shells. Basic experimentation under controlled conditions, visual observations of reactions, and basic outcomes answered by yes or no are all procedures and methods used in an actual laboratory.

Purpose and relevance of the study in promoting science outreach programs in the post-pandemic science education system

Science education is an essential part of the Philippine educational system. The government and numerous educational institutions work hard to deliver quality science education to Filipino students (DepEd, 2017). In addition, science outreach plays an essential role in the Philippines' science education for increasing scientific awareness, knowledge, and involvement among the general people. It includes actions and programs aimed at making science more accessible and engaging to various communities (DOST, n.d.). As a result, the integration of these modules into the curriculum of schools in the Philippines is critical, as there has been a

The Seybold REPORT
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

government requirement to raise the number of years by two (to grade twelve), and science educators are looking for material to incorporate. These modules will essentially be disseminated through insertion into the normal K -12 curriculum in at least four significant provinces in the Philippines. However, testing with cultural minorities in the Philippines had only mixed results; the module as presented looked to be out of context, and additional work would be required to improve the efficacy of the presentations for truly isolated cultural minorities.

This study aims to describe and assess the extent of implementation of the University of Utah's *"Chemistry to Biodiversity: The Conus Outreach Project",* which is based on the *"Let's Do Science Module",* and its impact on the academic performance of grade eight students from Pasay City Science High School (PCSHS) and Pasay City West High School – DOST (PCWHS–DOST) during the 2014-2015 school year, a prepandemic academic year.

Considering the impacts of the COVID-19 pandemic on the science education system of the country, the results of this study may still be beneficial when directing future attempts. Even the arguments will be that post-pandemic science outreach initiatives may need to shift to virtual or hybrid models, employing online platforms and resources to continue engaging students in science learning (DepEd, 2021; DOST, 2021), hands-on experimentation, self-discovery, and practical learning are one of the best ways students acquire scientific knowledge. Furthermore, by analyzing the results of this study's science outreach data and incorporating it into post-pandemic planning, education officials and program organizers can obtain insights into the effectiveness of earlier endeavors. This data can be used to identify effective tactics, places for development, and individual student needs in the country's ever-changing approaches to science teaching.

2. METHODOLOGY

2.1 Research Design

This study was undertaken under the realms of descriptive and quasi-experimental research design which specifically made use of both descriptive evaluative and correlational methods and the posttest-only experimental group design respectively. According to Rahi (2017), descriptive studies are intended to describe and assess a certain phenomenon in variables in order to determine the relationship between variables.

The study made use of both research designs to meet the objectives of the present research, which are describing and evaluating the University of Utah's *"Chemistry to Biodiversity: The Conus Outreach Project"* after doing some experiments based on the learning modules involving the chemistry to the biochemistry of living things and non-living things.

Results of the experiments in the form of achievement scores after the posttest is then correlated with the extent of implementation of the above-mentioned project in terms of learning environment, learning materials, and learning tasks.

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

2.2 Sources of Data

Both primary and secondary were sourced for this study. Primary data originally consist of findings or results of two experiments undertaken by the subject-respondent Grade 8 students of two high schools in the City Schools Division of Pasay, Pasay City about the chemistry of living things and non-living things and their responses to the items contained in the questionnaire describing the extent of the implementation of the *"Chemistry and Biodiversity: The Conus Outreach Project"*. On the other hand, secondary data include articles, write-ups from both implement notes and documents about the project, literature review and studies (thesis), and then others taken from the internet.

2.3 Respondents of the Study

This study was conducted in two secondary schools that cater to specializations in the sciences, namely, the Pasay City Science High School (PCSHS) and Pasay City West High School – DOST (PCWHS– DOST). Respondents are fifty (50) grade eight students at each school. These respondents were purposively chosen in lieu of the major objective of the study.

2.4 Research Instruments Used

The research instruments of this study were composed of two significant materials, namely, a survey questionnaire for the implementation of the activity-based method that is categorized into three areas, the learning environment, learning materials, and learning tasks. Two experiments, contained in a module, namely "Experiment Number 1 – Biochemistry of Non-living Things" and "Experiment Number 2 – Biochemistry of Living Things" use 18-point items answerable by "yes" or "no" to determine the academic performance of grade 8 students in terms of their achievement scores.

The survey questionnaire is made with a five-point rating scale from the highest approval to the least approval that is interpreted with the corresponding extent of how this affects an individual's decision to interpret the significance of the outreach project. The designations are as follows:

a. A rating of 5 is numerically given to the column *"Strongly Agree"* which corresponds with the interpretation that the individual agrees to a *"Very Great Extent"* on the items described in learning materials, learning environment, and learning task;

b. A rating of 4 corresponds numerically to *"Agree"* which is interpreted as *"To a Great Extent";*

c. A rating of 3 means *"Partially Agree"* and interpreted *"To a Moderate Extent"* on how the respondent values the Project;

d. A rating of 2 expresses that the student *"Disagrees"* with the items which in turn is interpreted to a *"Lesser Extent";* and finally

e. A rating of 1 means that the student *"Strongly Disagrees"* with the items as set in the learning indicators, and thereby interpreted to *"To the Least Extent"*.

The Seybold REPORT

ISSN 1533-9211

DOI 10.17605/OSF.IO/HJCTQ

f. No answers in a column automatically are given a zero (0) and fall under this last category.

2.5 Validation of the Questionnaire

The survey questionnaire utilized in this study is a modified questionnaire. This survey questionnaire was earlier drafted, validate, and used unofficially by the CARAGA State University to gauge the effectiveness of this Outreach Program but was later scrapped. The original survey questionnaire made prior was answerable by yes and no, and not calibrated by a 5-step scale as presented. The previous unmodified survey questionnaire was validated by members of the faculty of education of the said university. The two experiments, *"Biochemistry of Non-living Things"* and *"Biochemistry of Living Things"* were formulated by a team of Research Scientists from the University of Utah. Both instruments were funded directly and indirectly by the Howard Hughes Medical Institute (HHMI) and the University of Utah.

2.6 Data Gathering Procedure

At the onset, the researcher requested permission from the City Schools Superintendent of Pasay to undertake the study. The survey questionnaire and two experiment activities were then given to the subject/respondents of the study to determine the extent of implementation of the *"Chemistry to Biodiversity: The Conus Outreach Project"* and its impact on the academic performance of the Grade 8 students, respectively.

2.7 Pre-Data Gathering Procedure

Prior to the actual implementation of the experimentations, students were first instructed to watch two videos entitled *"Surrounded by the Ocean: Philippine Maritime Culture, Biodiversity, and Research"*. This is a 12-minute video concerning what makes the Philippines unique in terms of our geographical location and our local traditional knowledge of marine life, then the second video entitled *"Cone Snails: Versatile Hunters"* is a 14-minute video that discusses what cone snails are, their anatomy, feeding behavior, and biology. Both videos are produced by the Howard Hughes Medical Institute (HHMI) in support of the outreach program.

After the video presentation, a Powerpoint Presentation entitled *"Doing Science"* is presented. This presentation is 30 minutes long and discusses the Biodiversity of Cone snails in the Philippines and what it stands for in Medical Research. Discussions on the biodiversity of cone snails; its body parts, structures and functions, taxonomy, and medical applications, in a chemical approach. Chemical concepts like atoms, molecules, chemical bonding, physical and chemical changes, and acids and bases are tackled. During the actual implementation of the experiments, students are instructed to read the instructions that are written on the module, formulate their own hypothesis, and each student is issued with the necessary materials to be able to perform the two experiments with minimal intervention. After a 20-minute break, students are invited back again to the room to answer a survey questionnaire that stands as an afteractivity evaluation. Results of the experiments and the respondent's responses to the questionnaire were tallied and statistically treated with the use of appropriate descriptive and inferential statistics.

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

2.8 Statistical Analysis

Data collected were statistically treated using the Weighted Mean, Pearson Product-Moment Correlation, and t-test for significant correlation.

The following formula was used in the conduct of this study:

$$\textbf{Weighted Mean} = (\sum xy)/ (\sum n)$$

Where: x = number of student respondents

y = scores

n = total number of students

$$\textbf{Percentage} = r/s \; X \; 100\%$$

Where: r = score obtained

s = perfect score

Pearson (r) =
$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}}$$

T-test (t)
$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{(N_1-1)S_1^2 + (N_2-1)S_2^2}{N_1+N_2-2}\right)\left(\frac{1}{N_1}+\frac{1}{N_2}\right)}}$$

2.8.1 Opinion Index

An opinion index is arbitrarily made based on the 5-point rating scale where;

a. 4.50 – 5.00 means to a very great extent
b. 3.50 – 4.49 means to a great extent
c. 2.50 – 3.49 means to a moderate extent
d. 1.50 – 2.49 means to a less extent
e. -1.49 means to a lowest extent or none at all

2.8.2 Interpretation of Correlation Value

To interpret the correlation value (Ꮁ) obtained, the following classifications are applied:

a. An Ꮁ and from 0.00 to +- 0.20 denotes *"negligible correlation"*
b. An Ꮁ and from +-0.21 to +- 0.40 denotes *"slight or low correlation"*
c. An Ꮁ and from +- 0.41 to +- 0.70 denotes *"marked moderate correlation"*
d. An Ꮁ and from +- 0.71 to +- 0.90 denotes *"high relationship"*
e. An Ꮁ and from +- 0.91 to +-0.99 denotes *"very high relationship"*

ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

f. An r and +- 1.00 denotes *"perfect correlation"*

3. RESULTS AND DISCUSSION

3.1 Chemistry to Biodiversity Conus Project's Level of the Implementation

Students in grade eight (8) at Pasay City Science High School (PCSHS) and Pasay City West High School – DOST (PCWHS-DOST) evaluated the extent of implementation of the Chemistry to Biodiversity Conus Outreach Program in terms of (1) learning environment; (2) learning material; and (3) learning task.

3.1.1 In Terms of the Learning Environment

As shown in the data in Table 3.1, based on the computation made in obtaining the weighted means of the items as indicated in the survey questionnaire, the respondent students generally rated the science outreach project to an average grand mean of 4.46, interpreted as *'to a great extent'* its impact on the students in terms of the learning environment. More specifically, the Grade 8 students at PCSHS achieved an average mean of 4.48, while the students at PCWHSDOST obtained an average mean of 4.44, both of which interpreted the impact of the said project on the students *'to a great extent'* in terms of the discussed variable. In addition, the results also reveal that PCSHS is highly interested in adopting the *"Let's Do Science Module"* Middle School Division approach. Frequently, 92% stated that the learning environment satisfied their desire to adapt to new ideas and strategies to comprehend Science through hands-on experience. Conversely, the learning environment for PCWHS-DOST students is still rated favorably high, with the lowest rating of 80% given on the indicator of the presence of lessons within the locality, which is understandable given that the PCWHS-DOST is located in the city and the majority of the students are city-bred. Nonetheless, the majority of the indicators were given high marks.

Table 3.1: Students' Perception of the Science Outreach Project in Terms of Learning Environment

VARIABLE	PCSHS		PCWHS-DOST			
	WM	Int	WM	Int	Composite Mean	Int
Learning Environment						
The lesson were presented in a 1.1. simple;	4.10	GE	4.00	GE	4.05	GE
1.2. interesting;	4.82	VGE	4.74	VGE	4.78	VGE
1.3. enriching;	4.70	VGE	4.62	VGE	4.66	VGE
1.4. interactive and;	4.56	VGE	4.38	GE	4.47	GE
1.5. student-friendly manner.	4.62	VGE	4.54	VGE	4.58	VGE
2. The examples used were delivered in a clear presentation	4.74	VGE	4.56	VGE	4.65	VGE
3. The illustration and examples cited in the lesson were present in our locality	4.06	GE	4.22	GE	4.14	GE
3.1. Can be observed in the environment.	4.14	GE	4.30	GE	4.22	GE
4. The significant connection between science and reallife was established during the discussion.	4.64	VGE	4.68	VGE	4.66	VGE
Average (Mean)	4.48	GE	4.44	GE		
				Grand Mean	4.46	GE

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

Legends: *WM = Weighted Mean; Int = Interpretation;* VGE = *very great extent; GE = great extent*

3.1.2 In Terms of Learning Materials

Table 3.2 shows that the grand mean of 4.51 computed from both schools was even higher, indicating *"to a very great extent"* where the students discovered and understood the science outreach project as being well-equipped in conducting and implementing this specific activity. Students at PCSHS had an average weighted mean of 4.53, while students at PCWHS-DOST had an average weighted mean of 4.52, both of which were evaluated as *"to a very great extent."*

Students from PCSHS scored high marks in the learning resources category, with several indicators gaining 100% approval for the materials used to conduct the experiments. Although the highest possible score or its equivalent was obtained in this category, a rating of 78% was also recorded in category 6.3; this is still acceptable as passing. Similarly, the learning materials performed similarly in PCWHS–DOST, with 80% being the lowest rating recorded in one of the indicators. However, in this section of indications, a perfect rating of 100% was received, and this was under the criteria pertaining to fresh ideas.

3.1.3 In Terms of Learning Task

As shown in Table 3.3, the respondents collectively have a computed grand mean of 4.56, which when interpreted to a *"very great extent"* means that the respondents believe that the outreach project delivered lessons with learning tasks whose objectives are relevant and meaningful, and laboratory experiments, procedures, and experiences that are generally scientific, innovative, and creative yet simple and easy to conduct to the point learning with fun. These assertions are supported by average weighted averages of 4.54 and 4.59 achieved by PCSHS and PCWHS–DOST students, respectively, both interpreted as *"very great extent."*

In addition, respondents from the PCSHS also provided high marks for accepting the learning task indicator. The lowest score that students rated on one of the indicators was 86%, which is still relatively high, and the highest was 96%. The same is true for the perceptual assessment of PCWHS–DOST Grade 8 students, where the vast majority assessed the learning task indicator as high.

Table 3.2: Students' Perception of the Science Outreach Project in Terms of Learning Materials

VARIABLE	PCSHS		PCWHS-DOST			
	WM	Int	WM	Int	Composite Mean	Int
Learning Material						
The topic contains 5.1. new ideas;	4.80	VGE	4.84	VGE	4.82	VGE
5.2. informative facts; and	4.74	VGE	4.64	VGE	4.69	VGE
5.3 practical applications.	4.58	VGE	4.34	GE	4.46	GE
The illustration and pictures were 6.1. creative;	4.76	VGE	4.46	GE	4.61	VGE
6.2. engaging; and	4.68	VGE	4.22	GE	4.45	GE

The Seybold REPORT

ISSN 1533-9211

DOI 10.17605/OSF.IO/HJCTQ

6.3. Enjoyable.	4.60	VGE	4.66	VGE	4.63	VGE
The illustration and pictures 7.1. stimulated the learners; and	4.48	GE	4.52	VGE	4.50	VGE
7.2. Engaged someone to learn more about science.	4.64	VGE	4.60	VGE	4.62	VGE
The lesson helped me in developing my skills in 8.1. formulating hypothesis; and	4.38	GE	4.42	GE	4.40	GE
8.2. Making scientific questions.	4.26	GE	4.22	GE	4.24	GE
9. The lesson emphasizes safety tips and precaution when conducting laboratory experiments.	4.20	GE	4.40	GE	4.30	GE
10. The lesson explained the wonder and importance of biodiversity especially among the species of conus shells.	4.78	VGE	4.86	VGE	4.82	VGE
11. The lesson provide me helpful concept that are useful in my daily life.	4.34	GE	4.44	GE	4.39	GE
12. The topic were 12.1. realistic in nature; and	4.70	VGE	4.84	VGE	4.77	VGE
12.2. Can be seen and experience on daily life.	3.88	GE	3.98	GE	3.93	GE
13. Science concept that was discussed was also consistent with our culture.	4.46	GE	4.44	GE	4.45	GE
14. The great impact of biodiversity to the local communities had been clearly discussed.	4.76	VGE	4.64	VGE	4.70	VGE
Average (Mean)	4.53	VGE	4.50	VGE		

Grand Mean 4.51 VGE

Legends: *WM = Weighted Mean; Int = Interpretation;* VGE = *very great extent; GE = great extent*

Table 3.3: Students' Perception of the Science Outreach Project in Terms of Learning Tasks.

VARIABLE	PCSHS		PCWHS-DOST			
	WM	Int	WM	Int	Composite Mean	Int
Learning Task						
15. The lesson help me in my developing skills in	4.42	GE	4.44	GE	4.43	GE
15.1. formulating hypothesis; and						
15.2. Making scientific questions.	4.26	GE	4.22	GE	4.24	GE
The laboratory experiments were 16.1. simple;	4.48	GE	4.24	GE	4.36	GE
16.2. easy to conduct; and	4.66	VGE	4.36	GE	4.51	VGE
16.3. Can be done repeatedly.	4.52	VGE	4.48	GE	4.5	VGE
The laboratory experiment exhibited 17.1. significance	4.44	GE	4.66	VGE	4.55	VGE
17.2. resourcefulness;	4.66	VGE	4.64	VGE	4.65	VGE

ISSN 1533-9211

DOI 10.17605/OSF.IO/HJCTQ

17.3. innovativeness	4.64	VGE	4.54	VGE	4.59	VGE
17.4. creativeness; and	4.66	VGE	4.76	VGE	4.71	VGE
17.5. utility/practicability.	4.66	VGE	4.54	VGE	4.6	VGE
18. The procedure in the laboratory experiments were 18.1. understandable;	4.72	VGE	4.66	VGE	4.69	VGE
18.2. easy to follow; and	4.72	VGE	4.8	VGE	4.76	VGE
18.3. fun-learning.	4.76	VGE	4.82	VGE	4.79	VGE
18.4. critical thinking; and	4.64	VGE	4.72	VGE	4.68	VGE
18.5. Creative thinking.	4.64	VGE	4.7	VGE	4.67	VGE
The laboratory exercise developed my skill in 19.1. formulating hypothesis;	4.42	GE	4.38	GE	4.4	GE
19.2. proper usage of laboratory equipment	4.44	GE	4.54	VGE	4.49	GE
19.3. using keen observation;	4.34	GE	4.6	GE	4.47	GE
19.4. interpreting data gathered;	4.52	VGE	4.6	VGE	4.56	VGE
19.5. scientific reasoning;	4.54	VGE	4.58	VGE	4.56	VGE
19.6. making generalization; and	4.36	GE	4.54	VGE	4.45	GE
19.7. Giving valid conclusions.	4.38	GE	4.62	VGE	4.5	VGE
The result of the laboratory exercise were 20.1. reliable (result are trustworthy)	4.58	VGE	4.78	VGE	4.68	VGE
20.2. accurate (close to exact result)	4.5	VGE	4.58	VGE	4.54	VGE
20.3. significant; and	4.48	GE	4.64	VGE	4.56	VGE
20.4. applicable to real-life situations.	4.48	GE	4.92	VGE	4.7	VGE
Average (Mean)	4.54	VGE	4.59	VGE		
				Grand Mean	4.56	VGE

Legends: *WM = Weighted Mean; Int = Interpretation;* VGE = *very great extent; GE = great extent*

3.2 Students' Academic Performance in Relation to Their Scores in Two Experiment Activities

Figures 3.1 and Figure 3.2 compares the achievement scores, in terms of percentage, of the two groups of Grade 8 students from the Division of Pasay City Schools, Pasay City, namely the Pasay City Science High School (PCSHS) and the Pasay City West High School – DOST (PCWHS-DOST), in two experiment activities, Experiment No.1 – Biochemistry of Non-Living Things and Experiment No.2 – Biochemistry of Living Things.

The results show (Figure 3.1A) that in Experiment 1 – Biochemistry of Non-Living Things, 54% of the fifty (50) PCSHS students obtained scores ranging from 13 – 15, followed by 32% of the students with scores ranging from 10 – 12. Following this group of pupils are the 12%, who achieved the highest scores ranging from 16 – 18. Further, only 2%, falls within the 7 – 9 range of category scores. On the other hand, students from PCWHS-DOST delivered different results in Experiment No.1 (Figure 3.1B), with 76% achieving scores ranging from 13 – 15, followed by 14% obtaining scores ranging from 10 – 12. The remaining percentages are made up of 6% who earned a score between 16 – 18, 2% who earned a score between 7 – 9, and another 2% who received no score. These results demonstrate that Grade 8 students from

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

PCSHS and PCWHS-DOST appear to have performed well in Experiment No. 1.

Figure 3.1: Results of Students' Academic Performance in Experiment 1 – Biochemistry of Non-Living Things. (A)

PCSHS and (B) PCWHS D

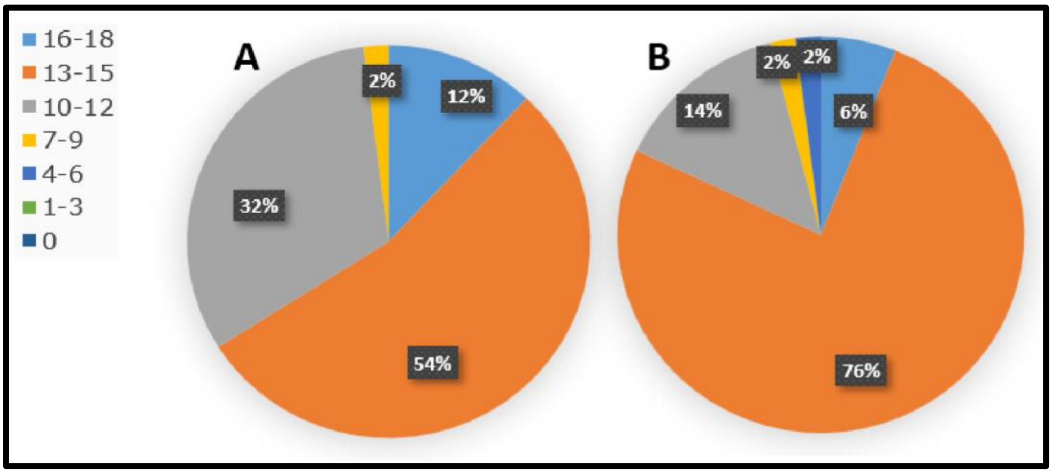
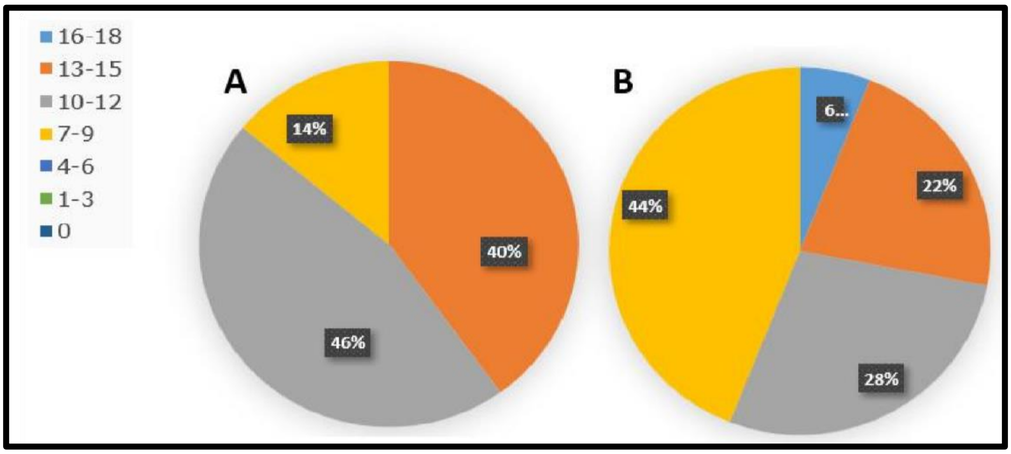


Figure 3.2 Results of Students' Academic Performance in Experiment 1 – Biochemistry of Living Things. (A) PCSHS

And (B) PCWHS D



In Experiment No.2 Biochemistry of Living Things, students from both schools did find difficulty in performing the activity. Figure 3.2A shows 46% of the fifty (50) PCSHS students achieved scores ranging from 10 – 12, while 40% earned scores ranging from 13 – 15. Following that are the 14% of students who received scores ranging from 7 – 9. PSCWHS–DOST results showed nearly identical difficulty (Figure 3.2B), with 44% of students obtaining scores ranging from 7 – 9, 28% earning scores ranging from 10 – 12, and 22% having scores

The Seybold REPORT
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

ranging from 13 – 15. However, 6% of the students from PSCWHS–DOST achieved a score between 16 – 18, but 0% of PCSHS students received a score in the same range. Undertaking Experiment No.2, students from both schools delivered some challenging performances, with the students collectively achieving a low percentage of the highest scores. However, respondents maintained aboveaverage results, with 46% of PCSHS students and 20% and 6% of PSCWHS-DOST students performing the experiment positively.

3.3 Correlation between the Overall Implementation of the *"Chemistry to Biodiversity: The Conus Outreach Project"* and the Academic Performance of Grade Eight Students

Table 3.4 shows the summarized results of the respondent's perception of the implementation of the *"Chemistry to Biodiversity: The Conus Outreach Project"* in terms of (1) learning environment; (2) learning materials; and (3) learning tasks, as they relate to the overall achievement test performance of Grade 8 students from PCSHS and PCWHS based on the two experiments they conducted during the study period.

The results show that students' perceptions of *the "Chemistry to Biochemistry: The Conus Outreach Project's"* implementation in terms of learning environment, learning materials, and learning tasks had a slight correlation with their achievement performance in the experiment. This assertion is supported by calculated values of 0.23 for the learning environment, 0.26 for learning materials, and 0.30 for the learning task. Thus, the average value was 0.23, which was regarded as a "slight correlation" between the two key variables: the *"Chemistry to Biodiversity: The Conus Outreach Project*" and students' performance in terms of accomplishment test scores in the experiment.

Table 3.4: Pearson (ᵲ) Degree of Correlation and T-values Between the Extent of Implementation of the Chemistry to Biochemistry Conus Outreach Project and Students Achievement Test Performance

Performance vis-a-vis the Chemistry to Biochemistry Conus Outreach Project Implementation	Computed Pearson (ᵲ)	Verbal Description	Computed T-value	Tabular Value of T	Verbal Interpretation	DECISION
1. Learning Environment	+/- 0.23	Slight Correlation	+-0.30	1.984	Significant	Reject H0
2. Learning materials	+/- 0.26	Slight Correlation	+-0.71	1.984	Significant	Reject H0
3. Learning Task	+/- 0.30	Slight Correlation	+-0.30	1.984	Significant	Reject H0
OVERALL	+/- 0.23	Slight Correlation	+-0.11	1.984	Significant	Reject H0

Alpha = 0.05 (*Significance*)

Furthermore, when the results are further analyzed for a significant relationship between each of the primary variables, the computed T-values are 0.30 for the learning environment, 0.71 for

ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

the learning materials, and 0.30 for the learning tasks. Considering these estimated t-values are less than the crucial value of T at 1.984, there appears to be a significant relationship between the variables mentioned above. Therefore, there is a significant relationship between respondents' perceptions of the extent of the "*Chemistry to Biodiversity: The Conus Outreach Project's*" implementation and students' achievement.

3.4 Implications of the Study's Findings for the Development of Science Outreach Programs in a PostPandemic Science Education Setting

In some ways, the outcomes of this study shed light on most teachers' utopian desire of creating relevant and impactful lectures. When this project was launched, there were several reservations: "*Will this strategy be well appreciated by the students?," "Will this work?," "Will it transform classroom instruction?"* A number of trials and errors were made, but with the dynamic method in executing the scientific education outreach approach, the better or best elements are kept so that it can fulfill the requirements of the students.

Lessons were created by utilizing indigenous resources that were readily available at the local wet market and even groceries. Considering hydrochloric or even hazardous sulfuric acid was not included in the experiment design, household vinegar was the only liquid solvent examined throughout the planning phase. This also implies that it is not necessary to use expensive and inaccessible materials to create meaningful and effective lessons. Moreover, when the experiments were being written, the most important consideration was to write them in such simple language that even a third-grade student could understand them. This resulted in an exercise that a reader could readily read and comprehend.

The survey questionnaire's results are conclusive. It can be viewed as follows under the learning environment: The outreach initiative as a whole is simple, interesting, enriching, interactive, and student friendly. The examples and illustrations that exist within the locality were presented clearly, and they provided a clear distinction between actual life and the world of science. The majority of respondents thought it to be more relevant to them and to the learning environment. Moreover, the learning materials also performed excellently in terms of interpreting the student responders' remarks. In summary, respondents thought the project contained teachings that were innovative, instructive, useful, creative, engaging, interesting, stimulating, realistic, and culturally appropriate. Students also stated that they learned about biosafety, biodiversity, and its importance in daily life. This, in turn, encouraged students to become more involved in Science as a subject and aided them in making decisions when presented with issues. Take notice that, overall, in this category, the students assessed the experience that they had in conducting the outreach as having a very high relevance. Lastly, under the learning task category, the students appreciated it as the experiments allowed them to make hypotheses and conclusions in an easy and simple manner. They thought the concept was novel, inventive, resourceful, clear, and simple to implement. They also noticed that it improved their ability to maintain proper laboratory material usage and develop their keen interest in observation so that in the end they independently interpreted their own data, applied their scientific reasoning, and made them make good scientific generalizations that are valid, accurate, and applicable to everyday life. Also in this category, students provided a high rating, which is interpreted to a

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

high extent.

Based on this research, it was determined that in order for science education outreach programs to work, simple, engaging, stimulating courses that are task-based, innovative, and easily accessible by students must be used. The materials to be utilized must also be visible in the local environment and accessible to the majority. Forming hypotheses and establishing appropriate generalizations are only possible if students understand what is presented to them. It is important to note that lessons should be given from a progressivist perspective in order to have a meaningful and effective learning experience. Teachers should use tri-media in lesson development, especially now that pupils have greater access to information. When creating lessons for science-related subjects, hand-mind coordination should constantly be considered. Science lessons should not be limited to making students memorize terminologies; rather, they should be taught to understand them, and if that terminology can be demonstrated and replicated, time should be allotted to have the students experience it.

Furthermore, as the country transitions back to a hybrid form of learning, combining traditional face-to-face instruction with online or digital learning methods, the reintroduction or reutilization of science outreach programs is essential. The Philippines, like many other countries, recognizes the value of science education and the need for science outreach programs. These initiatives are critical in increasing scientific literacy (Montgomery & Fernandez-Cardenas, 2018; Bush *et al*, 2020), promoting scientific enthusiasm (Fernandez-Cezar, 2020; Drazan, 2020), and generating a professional workforce in the field of science and technology (Constan & Spicer, 2015; Doerschuk *et al*., 2016; Tillinghast, 2020; Appel *et al*., 2021). A study by Macabalang *et al*. (2019) showed the positive influence of science outreach initiatives in bridging the gap between theory and practice in the Philippine education system. Science outreach programs serve as a link between formal education and society, connecting classroom learning to realworld applications. These programs involve students in community-based initiatives, stimulate collaboration with experts, and allow them to apply scientific knowledge to address local concerns. At the same time, these programs frequently incorporate laboratory experiments, field trips, and interactive demonstrations, allowing students to apply what they learn in the classroom to real-life circumstances (Wang & Braman, 2009; Leighton & Crompton, 2017; Burns & Chopra, 2017; Loveys & Riggs, 2019). As a result, science outreach programs ensure that education is relevant, meaningful, and responsive to social demands by embedding science into the fabric of society, where science outreach programs connect students to practical and real-world applications of scientific concepts.

Finally, the study's integration of dynamic learning and science outreach activities can effectively engage and inspire learners. Organize science festivals and exhibitions that feature a variety of interactive exhibits, demonstrations, and speeches as these events allow attendees to explore diverse scientific subjects in a dynamic and engaging manner (Gorman, 2020; Friesner *et al.,* 2021). The use of online science platforms and virtual labs that provide interactive simulations, virtual experiments, and multimedia resources. These dynamic online tools provide learners with accessible and immersive science learning experiences (Haleem *et*

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

al., 2022*)*. Moreover, the engagement of scientists, educators, and science communicators in dynamic science communication and outreach activities where these programs can use novel tactics, such as storytelling, demonstrations, and interactive presentations, to make science accessible and interesting to a wide range of people (Laursen *et al.,* 2007; Varner, 2014; Akhter *et al.,* 2021). Lastly, science outreach programs can develop and implement dynamic learning programs in collaboration with science institutions, museums, research organizations, and universities (NRC, 2009; Friesner *et al.,* 2021). These collaborations can increase the effectiveness and reach of science outreach efforts by providing access to expertise, resources, and facilities (Komoroske *et al.,* 2015; Monteiro *et al.,* 2016). With all these requirements, it is highly encouraged to adapt and incorporate science outreach programs like the *"Chemistry to Biodiversity: The Conus Outreach Project"* presented in this study in order to increase the science literacy of Filipino students and enable them to apply various scientific concepts to real-world problems.

4. CONCLUSIONS AND RECOMMENDATIONS

Results of this study conclude that in general, the *"Chemistry to Biodiversity: The Conus Outreach Project"* was implemented to a large extent in two Pasay City School Divisions, namely the Pasay City Science High School (PCSHS) and the Pasay City West High School – DOST (PCWHS-DOST). Specifically, the majority of students rated the learning environment as *"very good,"* the learning materials as *"good,"* and the learning task as *"very good"* in terms of implementation. In terms of academic performance, grade eight students from both PCSHS and PCWHS-DOST demonstrated an average to above-average performance in terms of achievement scores. Moreover, the variables utilized in this study to determine the extent of implementation of the outreach project correlate considerably with students' academic success in terms of achievement scores. Finally, the study's findings have significant implications for the development and enhancement of Science Education and related projects.

To advance the results of this study and have a better view of applying it to the post-pandemic setup of science education in the country, the researchers recommend that the Chemistry to Biodiversity Conus Outreach Project improve and develop more learning areas: learning environment, learning materials, and learning task to collect a high perception among the respondents. Additionally, proponents should look for or construct alternative teachings that can be easily adapted in similar settings and used in the existing school system. Furthermore, interventions such as implementing the *"Chemistry to Biodiversity: The Conus Outreach Project"* on the planned time frame should be carried out on a longer time frame aligned with the academic calendar of the school year as issues concerning the lesson helped in developing skills in formulating a hypothesis and making scientific questions and results of the laboratory exercises were significant and applicable to real-life situations aroused since the students were given insufficient. Finally, further studies should be conducted to demonstrate the validity of the trend of association between achievement scores in the two experiments and the level of implementation among students as the time interval increases.

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

References

1) Aidoo, B., Boateng, S. K., Kissi, P. S., & Ofori, I. (2016). Effect of Problem-Based Learning on Students' Achievement in Chemistry. *Journal of Education and Practice*, 7(33), 103-108.

2) Akhter, N., Ali, M. S., Siddique, M., & Akram, M. S. (2021). The Role and Importance of Communicating Science for Building up Understanding of Science Applications. *Multicultural Education*, 7(10), 274281.

3) Appel, D., Tillinghast, R. C., & Mansouri, M. (2021, March). Identifying positive catalysts in the STEM career pipeline. In 2021 IEEE Integrated STEM Education Conference (ISEC) (pp. 132-139). *IEEE.*

4) Ashcroft, J., Blatti, J., & Jaramillo, V. (2020). Early career undergraduate research as a meaningful academic experience in which students develop professional workforce skills: A community college perspective. In integrating professional skills into undergraduate chemistry curricula (pp. 281-299). *American Chemical Society.*

5) Burns, C., & Chopra, S. (2017). A meta-analysis of the effect of industry engagement on student learning in undergraduate programs. *The Journal of Technology, Management, and Applied*

6) *Engineering*, 33(1).

7) Bush, S. B., Cook, K. L., Edelen, D., & Cox Jr, R. (2020). Elementary students' STEAM perceptions: extending frames of reference through transformative learning experiences. *The Elementary School Journal*, 120(4), 692-714.

8) Constan, Z., & Spicer, J. J. (2015). Maximizing Future Potential in Physics and STEM: Evaluating a Summer Program through a Partnership between Science Outreach and Education Research. *Journal of Higher Education Outreach and Engagement*, 19(2), 117-136.

9) Constantinou, C. P., Tsivitanidou, O. E., & Rybska, E. (2018). What is inquiry-based science teaching and learning?. Professional development for inquiry-based science teaching and learning, 1-23.

10) Corpuz, B.B., & Salandanan, G.G (2007). Principles of Teaching 1. Quezon City: *Lorimar Publishing.*

11) Department of Education (DepEd) Philippines. (2016). Most Essential Learning Competencies (MELCs) in Science. Retrieved from https://www.deped.gov.ph/wp-content/uploads/2016/06/Most-EssentialLearning-Competencies-Science.pdf.

12) Department of Education (DepEd) Philippines. (2017). K to 12 Basic Education Curriculum: Science. Retrieved from https://www.deped.gov.ph/wp-content/uploads/2017/10/S2_7_SCIENCE.pdf

13) Department of Education (DepEd) Philippines. (2020). Basic Education Learning Continuity Plan. Retrieved from https://www.deped.gov.ph/wp-content/uploads/2020/06/Basic-Education-LearningContinuity-Plan-06042020-2.pdf

14) Department of Education (DepEd) Philippines. (2020). DepEd Commons. Retrieved from https://commons.deped.gov.ph/

15) Department of Education (DepEd) Philippines. (2021). Enhanced Basic Education Curriculum Guide-Science. Retrieved from https://www.deped.gov.ph/wp-content/uploads/2021/06/Enhanced-BECScience.pdf

16) Department of Science and Technology (DOST) Philippines. (n.d.). Science Education Institute. Retrieved from https://sei.dost.gov.ph/

17) Department of Science and Technology (DOST) Philippines. (2021). Science and Technology Information

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

Institute. Retrieved from http://www.stii.dost.gov.ph/

18) Doerschuk, P., Bahrim, C., Daniel, J., Kruger, J., Mann, J., & Martin, C. (2016). Closing the gaps and filling the STEM pipeline: A multidisciplinary approach. *Journal of Science Education and Technology*, 25, 682-695.

19) Drazan, J. F. (2020). Biomechanists can revolutionize the STEM pipeline by engaging youth athletes in sports-science based STEM outreach. *Journal of Biomechanics*, 99, 109511.

20) Fernández-Cézar, R., Garrido, D., & Solano-Pinto, N. (2020). Do science, technology, engineering and mathematics (STEM) experimentation outreach programs affect attitudes towards mathematics and science? A quasi-experiment in primary education. *Mathematics*, 8(9), 1490.

21) Friesner, J., Colón-Carmona, A., Schnoes, A. M., Stepanova, A., Mason, G. A., Macintosh, G. C., ... & Dinneny, J. R. (2021). Broadening the impact of plant science through innovative, integrative, and inclusive outreach. *Plant Direct*, 5(4), e00316.

22) Galang, A. D. (2021). Teachers' critical reflections on the new normal Philippine education issues: Inputs on curriculum and instruction development. *International Journal of Social Learning (IJSL),* 1(3), 236-249.

23) Gorman, M. J. (2020). Idea colliders: the future of science museums. *MIT Press.*

24) Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3, 275-285.

25) Huvard, H., Talbot, R. M., Mason, H., Thompson, A. N., Ferrara, M., & Wee, B. (2020). Science identity and metacognitive development in undergraduate mentor-teachers. *International Journal of STEM Education*, 7, 1-17.

26) Junsay Jr, F. B., & Madrigal, D. V. (2021). Challenges and benefits of facilitating online learning in time of Covid-19 pandemic: Insights and experiences of social science teachers. *Technium Soc. Sci. J.,* 20, 233.

27) Kim, P., Suh, E., & Song, D. (2015). Development of a design-based learning curriculum through designbased research for a technology-enabled science classroom. *Educational Technology Research and Development*, 63, 575-602.

28) Komoroske, L. M., Hameed, S. O., Szoboszlai, A. I., Newsom, A. J., & Williams, S. L. (2015). A scientist's guide to achieving broader impacts through K–12 STEM collaboration. *BioScience*, 65(3), 313-322.

29) Landicho, C. J. B. (2021). Changes, challenges, and opportunities in teaching senior high school earth science amidst the COVID-19 pandemic. *Journal of Learning and Teaching in Digital Age*, 6(1), 5557.

30) Laursen, S., Liston, C., Thiry, H., & Graf, J. (2007). What good is a scientist in the classroom? Participant outcomes and program design features for a short-duration science outreach intervention in K–12 classrooms. *CBE—Life Sciences Education*, 6(1), 49-64.

31) Leighton, L. J., & Crompton, H. (2017). Augmented reality in K-12 education. In Mobile technologies and augmented reality in open education (pp. 281-290). *IGI Global.*

32) Loveys, B. R., & Riggs, K. M. (2019). Flipping the laboratory: improving student engagement and learning outcomes in second year science courses. *International Journal of Science Education*, 41(1), 64-79.

33) Macabalang, A. A., Velasquez, R. T., & Abanto, J. B. (2019). Science outreach program: Its impact on students' performance and perception in selected public schools in the Philippines. *Asia Pacific Journal of Education, Arts and Sciences*, 6(3), 21-30.

34) Mahoney, J. L., Weissberg, R. P., Greenberg, M. T., Dusenbury, L., Jagers, R. J., Niemi, K., ... & Yoder, N. (2021). Systemic social and emotional learning: Promoting educational success for all preschool to high school students. *American Psychologist*, 76(7), 1128.

ISSN 1533-9211
DOI 10.17605/OSF.IO/HJCTQ

35) McLoughlin, C., & Lee, M. J. (2010). Personalised and self-regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. *Australasian Journal of Educational Technology*, 26(1).

36) Metz, C. J., Downes, S., & Metz, M. J. (2018). The in's and outs of science outreach: assessment of an engaging new program. *Advances in Physiology Education*, 42(3), 487-492.

37) Monteiro, B. A. P., Martins, I., de Souza Janerine, A., & de Carvalho, F. C. (2016). The issue of the arrangement of new environments for science education through collaborative actions between schools, museums and science centres in the Brazilian context of teacher training. *Cultural Studies of Science Education*, 11, 419-437.

38) Montgomery, C., & Fernández-Cárdenas, J. M. (2018). Teaching STEM education through dialogue and transformative learning: global significance and local interactions in Mexico and the UK. *Journal of Education for Teaching*, 44(1), 2-13.

39) National Research Council. (2009). learning science in informal environments: People, places, and pursuits. *National Academies Press.*

40) Rahi, S. (2017). Research design and methods: A systematic review of research paradigms, sampling issues and instruments development. *International Journal of Economics & Management Sciences*, 6(2), 1-5.

41) Ray, S., & Srivastava, S. (2020). Virtualization of science education: a lesson from the COVID-19 pandemic. *Journal of proteins and proteomics*, 11, 77-80.

42) Sahi, P. K., Mishra, D., & Singh, T. (2020). Medical education amid the COVID-19 pandemic. *Indian Pediatrics*, 57, 652-657.

43) Tillinghast, R. C., Appel, D. C., Winsor, C., & Mansouri, M. (2020, August). STEM outreach: A literature review and definition. In 2020 IEEE Integrated STEM Education Conference (ISEC) (pp. 1-20). *IEEE.*

44) Toquero, C. M. (2020). Challenges and opportunities for higher education amid the COVID-19 pandemic: The Philippine context. *Pedagogical Research*, 5(4).

45) Varner, J. (2014). Scientific outreach: toward effective public engagement with biological science. *BioScience*, 64(4), 333-340.

46) Wang, Y., & Braman, J. (2009). Extending the classroom through Second Life. *Journal of Information Systems Education*, 20(2), 235.

47) Wurdinger, S. D., & Carlson, J. A. (2009). Teaching for experiential learning: Five approaches that work. *R&L Education.*