

# ANALYSIS OF PHILIPPINE STEM JOURNALS AND IMPLICATIONS FOR HIGH SCHOOL RESEARCH DURING REMOTE LEARNING

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## ABSTRACT

While secondary research teachers must simplify student research projects during a completely remote learning scheme, the projects must still pursue a quality comparable to published scientific literature. This paper reviewed 102 research articles published in *Kimika*, the *Philippine Journal of Science*, and *Science Diliman* to discover trends in studies that could be adapted by high school students during a scheme where they are not allowed to leave their households. Articles were reviewed and coded based on discipline and adaptability. Only 26 studies were coded as adaptable. In general, experimental disciplines had low adaptability (physics: 0% adaptable studies, chemistry: 14%, biology: 18%, vs health: 75%, chemistry education: 100%). Based on the analysis, experimental research could be adapted by exploring simple response variables such as length or count, relying on the services of external laboratories, and involving heavily proxies such as the research teacher or a parent. Some simpler mathematical methods and *in silico* experiments could also be adaptable with heavy guidance of the research teacher. Non-experimental research such as surveys were highly adaptable. This paper could be useful for Filipino secondary or even tertiary research teachers in assisting students on what STEM projects to pursue during a remote learning scheme.

**KEYWORDS:** STEM research; high school; remote learning

## I. INTRODUCTION

Due to the new normal brought about by COVID-19, many science research projects (e.g. investigatory projects, laboratory research work etc.) could not be reasonably implemented by high school students as these activities entailed outdoor exposure. The development of science research skill remains to be a challenge given that projects are normally implemented in school facilities such as chemistry laboratories. The general lack of literature on high school science research makes it difficult to address this matter. There are no studies that could be immediately cited for direct reference. Hence, this project sought to examine published Filipino work that could be adaptable for home implementation by high school students. The goal of this project was to determine studies that could be explored in the current situation (or in similar situations in the future), as well as provide recommendations to teachers and management on how to best implement science research curricula under remote learning circumstances.

While this area has not been explored, literature review studies in general are abundant. Flaherty (2020) reviewed published chemistry education papers that are focused on the affective domain of students to synthesize generalizable findings. To accomplish this goal, the author performed a manual search of relevant articles from five predetermined journals from the year 2000 onwards. Once the studies ( $n = 91$ ) were obtained, Flaherty performed an inductive qualitative analysis. Each study was assessed for (i) the measured affect construct, (ii) the research approach, (iii) the instrument for data collection, and (iv) the general research findings. Papers that were categorizable were grouped and presented with descriptive statistics. Major research themes were provided and summarized. Fenwick (2008) reviewed journals for articles about individual and collective learning processes. A total of 1780 articles across nine journals in the years 1999-2004 were identified, and of these, 208 were deemed relevant to the review. To determine relevance, each study was examined by reading the title and abstract. Articles were assessed in terms of (i) research questions, (ii) overall purpose, (iii) theoretical concepts, (iv) methods, and (v) findings. Similar to Flaherty (2020), descriptive statistics were provided and common themes across articles were presented.

## II. METHODOLOGY

Journal issues containing the thirty (30) latest journal full articles (excluding editorials, comments and corrections as well as papers in the humanities or social sciences) from *KIMIKA*, the *Philippine*

Journal of Science, and Science Diliman were collected on September 2020. A spreadsheet was prepared where information about the journal articles were encoded.

Each article was processed by reading the title and abstract and then the methodology. After reading the vital parts of the paper, the following items were assessed and coded:

- The major content domain/discipline (e.g. chemistry, physics, etc.)
- The feasibility for adaptation (i.e. "Completely feasible," "Workable," "Completely non-feasible")
- The difficulties encountered in the study
- Notes/recommendations for possible implementation

An article was coded as "Completely feasible (A)" unless a difficulty was established where it became "Workable (B)", or "Completely non-feasible (X)". Adaptable studies included A and B articles. A brief reason for categorization of X were provided in the notes. After completion, all coded entries were double-checked by revisiting the original paper.

### III. RESULT

**Table 1.** Summary of articles reviewed per discipline per journal

	Biology (n = 34)	Chemistry (n = 36)	Chemistry Education (n = 8)	Design and Technology (n = 3)	Health (n = 4)	Mathematics (n = 12)	Physics (n = 5)
KIMIKA (n = 33) Philippine Journal of Science (n = 35) Science Diliman (n = 34)	3 14 17	22 8 6	8 - -	- 1 2	- 4 -	- 7 5	- 1 4
Adaptable studies per discipline	6 (18%)	5 (14%)	8 (100%)	1 (33%)	3 (75%)	3 (25%)	0 (0%)
Most common difficulty for direct adaptation	Unsafe materials/ methods (n = 27)	Use of measurement equipment (n = 34)	-	Use of specialized apparatuses (n = 2)	Fieldwork (n = 4)	Specialized knowledge* (n = 11)	Specialized knowledge* (n = 3)

\*Difficulty of concepts is beyond what is expected from the high school level.

**Table 2.** Top five themes generated across adaptable studies

Theme	n	Examples
Alternative methods Studies use non-experimental non-traditional hard science methodologies.	10 (38%)	Usage of survey instruments Usage of content analysis
Purchase of equipment Students can purchase equipment to conduct hard science methodologies at home.	7 (27%)	Purchase of a microscope for home data gathering Purchase of a top-loading balance
Involvement of teacher/adviser Teacher/Adviser can guide or perform methods in the study.	7 (27%)	Adviser can do sample preparation on behalf of students Adviser guides how to perform a GIS study
Simple response Study studies a response variable that is easily measured.	5 (19%)	Measurement of weight and length of fish Measurement of animal activity by counting
External laboratories Students can pay for laboratories to analyze samples.	5 (19%)	Samples can be sent to a laboratory for chemical analysis

#### IV. DISCUSSION

Table 1 summarizes the reviewed literature. Biology and chemistry papers were well represented with at least 30 papers each compared to other disciplines. The present work may be extended in the future to have richer insights on these other disciplines. Despite not being traditional STEM disciplines, chemistry education and health were included due to their comparable frequency to physics and design/tech in the reviewed literature.

Out of 102 research articles reviewed, only 26 (25%) were coded as adaptable (completely feasible or workable). In general, experimental research was less likely for adaption for remote learning. The top themes found across the 26 adaptable studies were summarized in Table 2.

Biology and chemistry were difficult to adapt because of their dependence on specialized apparatuses and measurement equipment. For the matter of safety, chemistry studies may have involved dangerous conditions such as usage of hazardous chemicals or high temperatures, while biology studies also had these features as well as the use of dangerous microorganisms. Of these studies across both disciplines, purchase of equipment for home adaptation could be viable, such as microscopes (e.g. exploration of phytoplankton in port water in Austero & Ananza, 2018) or top-loading balances (e.g. measurement of fish mass in Denura *et al.*, 2020). Moreover, the teacher or adviser must be highly involved and closely supervise these types of studies as students attempt to do at home methodologies they may not have been traditionally trained in, such as morphotaxonomy (Arguelles, 2020) or overall handling of chemicals. If the school allows handling of chemicals, the teacher/adviser may necessarily be the one to prepare dilutions/preparations for safe processing at home. Sampling can also be done by proxy such as through a parent. In terms of the experimental variables being studied in these disciplines, adaptability can improve if simpler response variables would be pursued instead (e.g. measurement of leaf size in Cabarrubias *et al.*, 2017). Other parameters that need specialized measurement equipment may be sent to external laboratories for analysis.

Studies in design/tech, mathematics and physics had less usage of experiments and more dependence on calculations. However, the reviewed studies in this discipline generally were too complicated to be expected to be fulfilled by students at home and thus had low adaptability. For example, we normally do not expect high school students to come up with mathematical theorems and their proofs on their own. *In silico* and other computational studies can be implemented with the heavy involvement of the adviser (e.g. guidance on how to do modeling using government data as in Evengalio *et al.*, 2020). Small-scale design projects (such as Arduino gadgets) may also be pursued.

While health and chemistry education research studies are not normally thought of during science projects, these studies had high adaptability due to their usage of alternative methodologies such as surveys that do away with safety or technical concerns. As such, depending on the direction of the school with their STEM research curricula, research projects like these may be interesting for schools or teachers that have limited access to laboratories and materials.

#### V. CONCLUSIONS

High School STEM research implemented under remote schemes can still exhibit sufficient rigor to reflect published academic work basing on a review of 102 Filipino journal articles. Of the generated themes, a simpler approach is to implement survey-based methodologies such as in health or chemistry education research, or other non-traditional methodologies. Mathematical or computational studies may be done with heavy involvement of the research adviser to eliminate problems with difficulty. A more traditional alternative is to proceed with experimental methods but instead to study simpler response variables, purchase equipment for home data gathering, and/or recruit the services of external laboratories. The findings of this study may be useful for STEM research teachers both in the secondary and tertiary levels as they guide students or design research curricula.

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