www.arisejournal.com
ISSN: 2626-9902

**COMMUNICATION**

# Furthering Students' Conceptual Change on Grade 9 Electricity and Magnetism Topics and Physics Corridor Demonstrations

**Mariane Grace Cabiles** Ateneo de Manila University, Philippines
**Ivan Culaba** Ateneo de Manila University, Philippines
**Cornelia Soto** Ateneo de Manila University, Philippines

Learners often take part in science instruction bringing with them different perceptions of concepts and skills or those that are inconsistent with the target knowledge. True understanding of information is attained when students are provided opportunities to make meaning from data and evidences. Hence, corridor demonstrations were developed in this study. Corridor demonstrations are ready-to-use experimental setups installed along a corridor, which may be manipulated by students with or without teachers' supervision. This pioneering study discusses students' conceptual change in grade 9 electricity and magnetism topics after using corridor demonstrations as learning materials. Corridor demonstrations on electromagnetic induction, AC generator, DC generator, transformer, solar energy and wind energy, were developed by the researcher and validated by experts. Students' conceptual understanding were evaluated using a researcher-made and expert-validated test questionnaire. Using paired samples t-test, the results showed that students' post-test average conceptual understanding (49%) is significantly higher than their pre-test result (29.3%), with p=.002. This difference may be attributed to the students' experiences using the corridor demonstrations, that helped them understand the relationship of variables, apply the concepts that they learned, acquire a deeper understanding of how things work. Qualitative data including quotations from the focus group discussions and written responses in test items provide an in-depth look at the influence of using corridor demonstrations in the students' conceptual understanding in physics. Further research on the learning materials and its pedagogical practicality are recommended.

**Keywords:** Physics education, Inquiry-based learning, Corridor demonstrations, Conceptual change, Electricity, Magnetism

• Received 21 June 2022 • Revised 21 February 2024 • Accepted 04 December 2024

## Introduction

From preschool through college, learners attend instruction with different perceptions but erroneous interpretations of science concepts and skills or those that are inconsistent with the target knowledge (Taber, 2011; Singer, Nielsen & Schweingruber, 2012). The teachers' role is to further conceptual change among students (Tsui & Treagust, 2004; Domović, Vasta & Bouilliet, 2017); so that, for example, students will no longer just see when things move from one place to another but will investigate how and search for causes why (Taber, 2011). It is affirmed that true understanding is attained when students are provided opportunities (Duit & Treagust, 1998) to make meaning from data and evidences like relating information to other phenomena, constructing generalizations, and comprehending prior experiences.

Philippines' recent educational efforts focused on placing inquiry, among others, at the heart of the science curriculum for high school (Republic Act 10533, 2013). Employing inquiry-oriented science classes calls for several requirements which include, but are not limited to, laboratory facilities and equipment. A rationale for this are the results of various publications and studies that pointed out the significant contribution of laboratory activities and experiences in the enhancement of learning (American Chemical Society, 2018; National Association for Research in Science Teaching, 1990; Said, Friesen & Hiba, 2014; Wang et al., 2011; Shamsudin. Abdullah, & Yaamat, 2012).

Implementing an inquiry-based instruction, which demands hands-on and direct experiences, would not be successful if good and functioning laboratory facilities are not available—a problem that is common among Philippine schools (International Bureau of Education – The Chinese National Commission for UNESCO. 2000). This issue has been evident even before the implementation of the K to 12 curriculum, which also advocates for hands-on, minds-on and hearts-on activities for students (Department of Education, 2016). Effective practical science cannot be delivered efficiently because of insufficient resources (Said et al., 2014). Hence, more students lose the opportunity of experiencing laboratory activities and experiments.

Initiatives from science educators have tried to resolve this issue by introducing low-cost experiments. In the Philippines, this is very common because of the common issue of laboratory resources insufficiency. Several studies in the international setting looked into teaching physics topics through experiments using low-cost materials highlighting that physics experiments can actually be taken outside of classrooms or laboratories with little financial requirements (Bouquet, Dauphin, Bernard, & Bobroff., 2019; Josey, Alvi, Kattayat, & Asha, 2018). Although these research studies have delved into inexpensive laboratory experiments, there are limited studies conducted specifically to try resolve the common problem of public secondary schools with inferior or even no laboratory facilities and resources.

This paper presents the development of an alternative laboratory material called corridor demonstrations (CD) as an answer to the dilemma of deficient laboratory facilities. Furthermore, this paper discusses the effect of the use of corridor demonstrations on students' conceptual understanding of concepts in electricity and magnetism. A conceived relationship of laboratory facilities to students' conceptual understanding is depicted in **Figure 1**.


https://doi.org/10.51724/arise.51
* Corresponding author

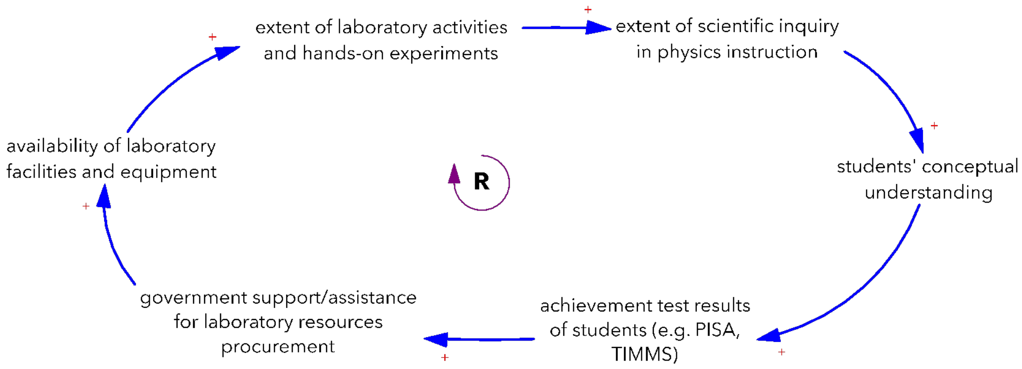



**Figure 1.** Relationship of laboratory facilities to students' conceptual understanding and other relevant factors: a causal loop diagram

**Figure 2.** Actual physics corridor demonstrations

Corridor demonstrations (see **Figure 2**) are portable setups installed along corridors, consisting of experiments that may be manipulated with or without a teacher's direct supervision (Cabiles, 2019). A study conducted by Panti (1997) in the Philippines yielded positive results regarding the contribution of wall-fixed corridor demonstrations to the quality of Philippine schools science. After the said study, this paper is another pioneering work and a new source of information about the use of corridor demonstrations in encouraging inquiry in the classroom and hence, advancing learners' conceptual understanding in physics topics; that is, electricity and magnetism.

## Methodology

One-group pre-test-posttest design was employed to determine the effect of utilizing corridor demonstrations in the improvement of students' conceptual understanding in electricity and magnetism.

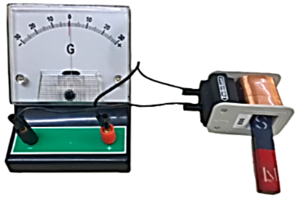
In a government secondary school, 40 students in the Grade 9 level participated in the physics classes which utilized corridor demonstrations as laboratory activity and learning materials. Grade 9-level corridor demonstrations on electromagnetic induction, AC generator, DC generator, transformer, solar energy and wind energy, were developed by the researcher and validated by experts.

The procedure followed in using the corridor demonstrations involve the following steps: (a) dividing the students into six (6) groups with either six (6) or seven (7) members each, (b) conducting a pre-activity orientation discussing the how to use the six (6) corridor demonstrations and the accompanying activity sheet, (c) proceeding to the corridors to do the activities simultaneously, transferring from one corridor demonstration to another, (d) accomplishing the activity sheet and answering the guide questions, (e) conducting post-activity class discussions, and if applicable, (f) assisting students in using the corridor demonstrations during breaks or after their last class periods for the day.

Students' conceptual understanding were evaluated using an expert-validated and research-constructed pre-test and a post-test questionnaire called the Electricity and Magnetism Test for Grade Nine (EMT-G9). The test was constructed and designed to measure specifically conceptual understanding in electricity and magnetism possessed by the learners. In line with the Philippine K to 12 science curriculum, the researcher constructed the test covering and extending the topics in electricity and magnetism enumerated in the curriculum guide and learner's manual. The items are three-tier test questions, which require three responses: (1) answer to the question, (2) explanation to the answer and (3) students' confidence rating. An example of the test question is shown in **Figure 3**.

The test included 10 items that target students' conceptual understanding and 10 items that measure their science process skills. In this paper, however, the results of the conceptual understanding portion will be focused on and discussed thoroughly. The type of questions were multiple choice and open-ended. The items were not arranged in any specific manner.

2. Refer to the diagram. There is no induced current in the coil so the reading in the galvanometer is 0 microampere. Why is there no induced current in the coil?




*Answer*

a. There is no magnetic flux in the coil.
b. There is magnetic flux in the coil but it is not changing with time.
c. The coil is not moving with respect to the bar magnet.

*Explanation/Reasoning*

a. In order for current to be induced in the coil, the number of turns should be not less than 100 turns.
b. The cross-sectional area of the wire used in the coil should be less (thinner) to allow current to pass through smoothly.
c. For current to be induced, the magnet should be moved repeatedly. A changing magnetic field induces current in a conductor.

**Figure 3.** EMT-G9 sample test item

In evaluating the results of the tests, students' answers were evaluated as illustrated in **Table 1**. Interpretation of the results of the test involved measuring the frequency of the students who acquired 1,1; 1,0 and 0,1 or 0,0. After which, the results were discussed with reference to the contribution of students' experiences in the corridor demonstration activities.

**Table 1.** Rubric for assessing students' answers to EMT-G9

| Student response | Interpretation/decision |
|---|---|
| 1, 1 | Correct answer (A) and explanation (E), equivalent to 1 point |
| 1, 0 | Correct answer (A) and wrong explanation (E), equivalent to 0 |
| 0, 1 and 0, 0 | Wrong answer (A) and wrong explanation (E), equivalent to 0 |

This study adopted the levels of proficiency presented by the Department of Education. Therefore, students' over-all scores from the tests were interpreted according to DepEd's levels of proficiency as follows: advanced (A), proficient (P), approaching proficiency (AP), developing (D), and beginning (B).

Data on learners' conceptual understanding were collected and analyzed using IBM Statistical Package for Social Science (SPSS) 20. The mean, standard deviation (SD) and a paired samples t-test were used to establish comparison between the pre-test results and the posttest results.

Additionally, a focus group discussion accompanied with written interview forms were conducted to gather data on a selected number of students to discuss and share their experiences and feelings about using the corridor demonstrations. This set of data allowed the researcher to support the quantitative findings of the study.

## Results and Discussion

### *Average student performance in conceptual understanding*

Using paired samples t-test, the results showed that students' post-test average conceptual understanding (49%) is significantly higher than their pre-test result (29.3%), with p=.002.

### *Students' proficiency levels in conceptual understanding*

This difference may be attributed to the students' experiences using the corridor demonstrations, that helped them understand the relationship of variables, apply the concepts that they learned, and acquire a deeper understanding of how things work. Qualitative data including quotations from the focus group discussions and written responses in test items provide an in-depth look at the influence of using corridor demonstrations in the students' conceptual understanding in physics. Recommendations for further research on the learning materials and its pedagogical practicality conclude this paper.

## Conclusion and Recommendations

### *Conclusion*

The K to 12 education have focused on honing active learners who possess both competent knowledge of science and a mastery of essential science process skills (Department of Education 2016). This implies the importance of outlining a curriculum such that the educational process is one that allows opportunities for scientific inquiry and discovery to occur. Scientific inquiry may be achieved using an inquiry-based approach in the teaching-learning process.

This study is exploratory and it involves in-depth investigation of the usefulness of the implementation of inquiry-based approach with the use of corridor demonstrations—an innovative learning tool that involves activities setup on a platform which are installed in school corridors for students to use. This study is a prospective source of detailed information about how an inquiry-based science classroom can influence the improvement of students' conceptual understanding.

Based on the results of the study, it may be concluded that inquiry-based approach using corridor demonstrations as learning tools may improve students' science achievement to a substantial degree. The approach and learning tool employed may also further students' competence in conceptual understanding. Similar findings were generated and discussed on previous researches (Apedoe, Xornam, Reeves, & Thomas, 2006; Casimiro, 2017; Woods-McConney, & Wosnitza, 2016; Setiono, Rustaman, Rahmat, & Anggraeni, 2019; Arantika, Saputro, & Mulyani, 2019).

### *Recommendations*

Favorable results were found in this study after implementing the approach in a regular grade nine class in a public secondary school. Thus, it is recommended to replicate the approach and the learning tool in other settings (e.g. the same grade level, different programs/types of students; across different grade levels; study the approach in comparison to another strategy; etc.) to validate the conclusions made in this study. In replicating the study, it is also suggested to consider more conducive groupings of students (i.e. 3 to 4 students in a group), so they will not crowd around a single demonstration which might hinder productive discussions. Students' confidence rating before and after the intervention was not analyzed per item which could actually help determine misconceptions among the students in the topic electricity and magnetism. Thus, analysis using the confidence rating data is recommended.

Topics in electricity and magnetism were the foci of the intervention. The study only examined students' conceptual understanding, science process skills and attitudes on the topic. Hence, it is viable to develop tools and implement the approach focusing on other physics topics, and even on subjects about chemistry, biology and earth science. Since only a few studies were done about corridor demonstrations in physics and its use as alternative for proper laboratory activities, there is no adequate information on the status of the knowledge and skills of secondary school teachers in maximizing the use of corridor demonstrations. It is then recommended to pursue further studies and establish teacher trainings for secondary science teachers.

Scientific inquiry is not bound by just the concepts and principles of physics; rather, it is the core of all sciences which paves the way for discoveries and inventions. It is suggested that the same approach be employed in science disciplines other than physics.

## References


Apedoe, X. S., Reeves, T. C. (2006). Inquiry-based learning and digital libraries in undergraduate science education. *Journal of Science Education and Technology, 15*, 321-330. https://doi.org/10.1007/s10956-006-9020-8

American Chemical Society. (2018). *Importance of hands-on laboratory science.* Retrieved from: https://www.acs.org/content/acs/en/policy/publicpolicies/education/computersimulations.html

Arantika, J., Saputro, S., & Mulyani, S. (2019). Effectiveness of guided inquiry-based module to improve science process skills. *Journal of Physics: Conference Series,* 1157, 042019. https://doi.org/10.1088/1742-6596/1157/4/042019

Bouquet, F., Dauphin, C., Bernard, F., & Bobroff, J. (2019). Low-cost experiments with everyday objects for homework assignments. *Physics Education, 54*, 025001. https://doi.org/10.1088/1361-6552/aaf6d6

Cabiles, M. G. (2019). *Inquiry-based approach using corridor demonstrations and students' science achievement and attitude* [Master's thesis]. Quezon City: Ateneo de Manila University.

Casimiro, M. A. F. (2017). *Interactive lecture demonstration and inquiry-based instruction in addressing students' misconceptions in electric circuits* [Master's thesis]. Quezon City: Ateneo de Manila University.

Department of Education (2016). *K to 12 Curriculum Guide Science (Grade 3 to Grade 10).* Retrieved from: http://www.deped.gov.ph/wp-content/uploads/2019/01/Science-CG_with-tagged-sci-equipment_revised.pdf

Domović, V., Vlasta, V. V., & Bouillet, D (2017). Student teachers' beliefs about the teacher's role in inclusive education. *European Journal of Special Needs Education, 32*, 175-190. https://doi.org/10.1080/08856257.2016.1194571

Duit, R. & Treagust, D. F. (1998). Learning in science: from behaviourism towards social constructivism and beyond. In B. J. Fraser & K. G. Tobin (eds.), *International Handbook of Science Education* (pp. 3-25). Dordrecht, Kluwer.

International Bureau of Education – The Chinese National Commission for UNESCO (2000). *Science education for contemporary society: problems, issues and dilemmas.* Retrieved from http://www.ibe.unesco.org/sites/default/files/resources/finrep-beijing2000_eng_0.pdf

Josey, S., Alvi, P. A., Kattayat, S., & Asha, J. V. (2018). Effectiveness of low cost experiments in assimilating fundamentals of physics. *International Journal of Mechanical Engineering and Technology, 9*, 860–866.

National Association for Research in Science Teaching (1990). *Research matters - to the science teacher, the science process skills.* Retrieved from: https://www.narst.org/publications/research/skill.cfm

Panti, P. G. (1997). *Teacher-constructed corridor demonstration experiments: an approach to improve laboratory instruction in Philippine schools* [Master's thesis]. Quezon City: Ateneo de Manila University.

Said, Z., Friesen, H., & Hiba, A. (2014). The importance of practical activities in school science: perspectives of independent school teachers in Qatari schools. *Proceedings of EDULEARN14 Conference*, 7th-9th July 2014, Barcelona, Spain.

Setiono, S., Rustaman, N. Y., Rahmat, A., & Anggraeni, S. (2019). Student's inquiry skills and learning achievement in plant anatomy practical work using open-guided inquiry. *Journal of Physics: Conference Series,* 1157, 022089. https://doi.org/10.1088/1742-6596/1157/2/022089

Shamsudin, N. M., Abdullah, N., & Yaamat, N. (2013). Strategies of teaching science using an inquiry based science education (IBSE) by novice chemistry teachers. *Procedia - Social and Behavioral Sciences*, 90, 583–592. https://doi.org/10.1016/j.sbspro.2013.07.129

Singer, S. R., Nielsen, N. R., & Schweingruber, H. A. (2012). *Discipline-based education research.* Washington D.C.: National Academies Press.

Taber, K.S. (2011). Stella Vosniadou (Ed): International Handbook of Research on Conceptual Change. *Science & Education, 20*(5-6), 563–576. https://doi.org/10.1007/s11191-010-9283-6

Tsui, C.-Y. & Treagust, D. F. (2004). Conceptual change in learning genetics: an ontological perspective. *Research in Science & Technological Education, 22*, 185-202. https://doi.org/10.1080/0263514042000290895

Wang, J., Tsay, R., Lee, K., Lin, S., Kao, H. & Huang, B. (2011). A meta-analysis of inquiry-based instruction on student learning outcomes in Taiwan. *The Asia-Pacific Education Researcher*, 20(3). https://ejournals.ph/article.php?id=4220

Woods-McConney, A., Wosnitza, M., & Sturrock, K. L. (2016). Inquiry and groups: Student interactions in cooperative inquiry-based science. *International Journal of Science Education, 38*, 842–860. https://doi.org/10.1080/09500693.2016.1169454