

Pedagogical Beliefs, Techniques, and Practices towards Hands-on Science

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Abstract This research was conducted to determine the pedagogical beliefs, techniques, and practices on effective hands-on science among the teachers in a schools division in the Philippines. Using the descriptive inferential research design, 87 teachers were identified through stratified random sampling design. G*power was used to determine the required number of samples. The study revealed that (1) the teacher-respondents concur to the pedagogical beliefs in teaching science lessons; (2) the respondents give much emphasis on the pedagogical practices towards effective hands-on science; (3) the respondents agree to the pedagogical techniques towards effective hands-on science; (4) the respondents perceived hands-on science in the local of the study to be effective; and (5) the respondents' pedagogical beliefs are highly correlated to their pedagogical techniques and moderately correlated with their practices. In addition, their teaching techniques are moderately correlated to their pedagogical practices. Knowing the pedagogical beliefs, techniques, and practices of the respondents, and the significant correlation on their beliefs, practices and techniques bring opportunities in teaching hands-on science. Thus, this brings potential input along a possible intervention program that can be initiated to further improve the science instruction as this is an initial paper conducted in the locale of the study on effective hands-on science.

Keywords: hands-on science, pedagogical beliefs, pedagogical practices, pedagogical techniques

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1. Introduction

Science is the greatest feat and forefront of human civilization and technological innovation and advancement. This was evidently characterized by the first three industrial revolutions that had happened in the past. The development of new technologies affects significantly human civilization and communities, and the foundation of a more advanced way of life. Science education impinges profound consequences for the betterment of our local and global communities [1]. Hence, many countries are investing heavily in science and technology.

Elementary science is the foundation of higher and complex sciences. This education begins in their daily routines on performing tasks and finding solutions to problems encountered. The presence of real-life situations to deal with and the study of natural phenomena that involves experimentation, direct observation, among others make learning more engaging. This learning by doing leads to the discovery of new skills and abilities for both teachers and learners: the more they tend to engage in doing, the more they enjoy learning and discovering. Thus,

it cultivates and nurtures students' interest in the sciences [2,3]. Moreover, developing and engaging the learners in lessons through a hands-on approach profoundly develop higher-order thinking skills. This learning by doing or hands-on teaching as theorized by John Dewey instills science concepts and topics to pupils for their life-long learning.

Hands-on science, a philosophical and pedagogical standpoint, is practiced by many countries to strengthen and advance science curriculum and instruction. It was found out that the learners exposed to this approach develop critical skills along their scientific skills relative to the process and procedures of the sciences. In addition, it creates a more engaging and exciting learning experience [4,5]. Hands-on science includes the use of real objects for manipulation, models, laboratory, and other means that allows a real-life situation for the learners to experience. This involves a deep engagement of the learners to a certain topic or simply learning by doing. This opens doors and windows for children to explore beyond their textbooks, which could serve as an alternative assessment aside from the traditional pencil and paper. Beyond these known parameters, researchers still believe that high-quality, hands-on science education

is still lacking in many low-resource schools [6,7]. This stemmed to more issues and concerns in hands-on science especially during the outbreak of CoViD-19 pandemic in 2020. In the first two months of the pandemic, most countries around the world had temporarily closed educational institutions to contain the spread of the CoViD-19 pandemic and reduce infections.

Apropos of, educational institutions are now operating within in the realms of the new normal since 2020 and the now normal in 2022 with much challenges as the virus is constantly evolving. The closure of educational institutions, just like the case of the locale of this study, has affected more than 1.2 billion learners worldwide with more than 28 million learners in the Philippines [8,9]. The community lockdown and community quarantine of many countries including the Philippines led students and teachers to study and work from home which led to the delivery of lessons in different modalities, i.e., modular, online, blended learning [10,11]. However, the implementation of different learning modalities posed many risks, problems, and challenges to both the teachers and learners. Furthermore, the implementation of the learning modalities from the new normal to the now normal especially the online learning modality pose numerous problems to learners who have limited internet access, no gadgets, and the poor [11,12].

Accordingly, the Philippines has the lowest internet connectivity in Asia. Besides, challenges abound centering on equity gaps, students' security and safety, quality of learning, poor assessment results, among others [12,13,14,15]. Despite the presence of these education roadblocks, the present pandemic education must continue. Teachers are maximizing all possible means including the adaption of best practices in teaching to deliver quality education. Thus, it is the goal of this paper to improve the elementary science by proposing a developmental plan to improve the implementation of elementary hands-on science in the locale of the study based on the pedagogical beliefs, techniques, and practices of the teacher-respondents.

1.1. Objectives of the Study

This paper is geared to determine the pedagogical beliefs, techniques, and practices of elementary science teachers towards hands-on science.

Specifically, this research worked on the following objectives:

1. determine the pedagogical beliefs of elementary teachers towards hands-on science;
2. determine pedagogical practices of the elementary teachers towards hands-on science;
3. determine the pedagogical techniques of the elementary teachers towards hands-on science;
4. evaluate the significant relationship on the beliefs, techniques, and practices of the respondents when grouped by profile.

1.2. Theoretical Framework of the Study

Learning by doing. Learning by doing had been a principle for thousands of years. It has had many proponents including Plato, Thomas Hobbes, Karl Marx,

Mao Zedong, Montessori, John B. Watson, and B. F. Skinner [16]. Science learning is a pedagogical approach situated within the idea and concepts of experiential learning theory [17,18]. For the purpose of this research, hands-on science is defined as the use of real objects for manipulation, models, laboratory, and other means that allow real-life situations for the learners to experience.

While debates continue on what constitutes an effective science instruction, science education has received renewed attention for a scientifically literate citizenry in this increasingly technological society. The use of hands-on approach in lessons may provide students with opportunities to confront their preconceptions about scientific phenomena, or it may simply be an activity for the activity's sake, stimulating students' interest but not relating to important learning goals. Lessons that engage students in scientific inquiry can be effective whether they are structured by the teacher or instructional materials, or very "open," with students pursuing answers to their questions. Whatever the mode of instruction, philosophers, educationists, and researchers suggest that students are most likely to learn if teachers encourage them to think about ideas aligned to concrete learning goals and relate those ideas to real-life phenomena [19]. Similarly, effective instruction requires skilled and knowledgeable teachers and researchers who support the idea on the importance of teacher's understanding of the content. Teachers with stronger content knowledge are more likely to teach in ways that help students construct knowledge, pose appropriate questions, suggest alternative explanations, and propose additional inquiries [20,21].

Learning by doing (or experiential learning) is based on three assumptions: (1) people learn best when they are personally involved in the learning experience; (2) knowledge has to be discovered by the individual if it is to have any significant meaning to them or make a difference in their behavior; and (3) a person's commitment to learning is at highest when they are free to set their own learning objectives and are able to actively pursue them within a given framework. Furthermore, learners perceive and process information in a continuum from concrete experience, reflective observation, abstract conceptualization, and active experimentation.

In the first stage (concrete experience), students are motivated by the question, "What would happen if I did this?" They look for significance in the learning experience and consider what they can do, as well as what others have done previously. These learners are good with complexity and are able to see relationships among aspects of a system. The teacher engages students in a new experience encouraging independent discovery.

During the stage of observation and reflection, students are motivated to answer the question, "What is there to know?" as they like accurate and organized delivery of information. Moreover, they are not that comfortable to random exploration to a system and they like to get the right answer to the problem through a concrete understanding supported by evidences.

In the abstract conceptualization, students are motivated to discover the relevance or the "how" of a situation. Application and usefulness of information is increased by understanding detailed information about the system's operation. The teacher should make instruction interactive

and provide problem sets or workbook for students to explore.

Lastly, testing in new situations requires students to discover the relevance or "why" of a situation. They like to reason from concrete and specific information, and to explore what a system has to offer in a detailed and systematic inquiry. The teacher can use lecture method focusing on specifics such as the strengths, weaknesses and uses of a system or do a hands-on exploration of a system [22].

2. Methodology

The study employed the descriptive correlational approach to examine and describe the relationship on the pedagogical beliefs, techniques, and practices of the respondents towards effective hands-on science. Data were collected to describe the characteristics of the respondents pertaining to their pedagogical beliefs, techniques, and practices in teaching effective hands-on science. The data set was analyzed and presented using descriptive statistics. The descriptive design was utilized in the study since the researchers aimed to measure the pedagogical beliefs, techniques, and practices of the respondents to hands-on science. Thus, it described the existing phenomenon by using numbers to characterize the concordances of the respondents along their employment of hands-on science amidst the pandemic.

The researcher used a structured questionnaire to gather data and information needed in the research. It is divided into five parts. The first part is a checklist on the profile of the respondents containing their educational attainment, number of years in teaching, and school type. The second part is the eleven item-checklist on the pedagogical beliefs of the respondents. The third part is composed of fifteen items that determine their pedagogical techniques in teaching science. The fourth part is a checklist on pedagogical practices in teaching science adopted from Horizon Research, Inc. 2000. Lastly, the fifth part is a checklist for effective Hands-on Science (Adapted from Smith, Smith, & Banilower, 2014). The Cronbach Alpha

reliability test posted the following results; beliefs (.847), techniques (.957), practices (.968), and effective hands-on (.955). The results ensured the reliability of the questionnaire. According to Taber [23], an alpha of at least .70 suggests reliability. Hence, a valid and reliable research instrument.

The respondents of this study were teachers from a school's division in the Philippines. One of the proponents sought permission from the teacher-respondents to conduct survey using google docs and printed questionnaires. The survey questionnaire was sent to the known teacher-respondents who at the time of the study, could be reached online. A total of 87 teachers voluntarily participated in the survey. The online survey questionnaire was sent to the respondents with the privacy consent and given the liberty to deny the survey if it causes them discomfort.

3. Results and Discussion

Table 1 presents the mean pedagogical beliefs of the respondents towards Hands-on Science. As presented in the table, the respondents marked "strongly agree" to the beliefs that most class periods should provide opportunities for students to share their thinking and reasoning, students should be provided with the purpose of the lesson as it begins, Inadequacies in students background can be overcome by effective teaching, and Hands-on or laboratory activities should be used primarily to reinforce a science idea that the students have already learned.

The grand mean results presented the agreement of the respondents towards effective hands-on science which is "strongly agree". This implies that teachers' beliefs are anchored on effective hands-on science. This supports the findings of reference [24] when they concluded that teachers' beliefs are products of several variables including how often they teach science. Their beliefs and number of hours participating in the research-based professional development program were significantly predictors of students' science achievement.

Table 1. Pedagogical Beliefs of the Respondents towards Hands-on Science

Pedagogical Beliefs towards Hands-on Science	Mean	Description
1. Most class periods should provide opportunities for students to share their thinking and reasoning	3.34	Strongly Agree
2. Most class periods should conclude with the summary of key ideas addressed	3.17	Agree
3. Students should be provided with the purpose of the lesson as it begins	3.29	Strongly Agree
4. Most class periods should include some review of previously covered ideas and skills	3.16	Agree
5. Inadequacies in students background can be overcome by effective teaching	3.40	Strongly Agree
6. At the beginning of instruction on science idea, students should be provided with definitions for scientific vocabulary that will be used	3.06	Agree
7. It is better for science instruction to focus on ideas in depth, even if that means covering fewer topics	2.95	Agree
8. Hands-on or laboratory activities should be used primarily to reinforce a science idea that the students have already learned	3.30	Strongly Agree
9. Teachers should explain an idea to students before having them consider evidence that relates to the idea	3.11	Agree
10. Students should be assigned with homework in most of the days to continually make them wonder	2.63	Agree
11. Students learn science best in classes with students of the similar abilities.	2.80	Agree
Grand Mean	3.11	Agree

Table 2. Pedagogical Practices of the Respondents towards Hands-on Science

Pedagogical Practices towards Hands-on Science	Mean	Description
1. Increase students' interest in science	3.53	Strongly Agree
2. Learn basic science	3.48	Strongly Agree
3. Learn important terms and facts of science	3.55	Strongly Agree
4. Learn science process/inquiry skills	3.52	Strongly Agree
5. Prepare for further study in science	3.30	Strongly Agree
6. Learn to evaluate arguments based on scientific evidence	3.32	Strongly Agree
7. Learn how to communicate ideas in science effectively	3.47	Strongly Agree
8. Learn about the application of science in business and industry	3.31	Strongly Agree
9. Learn about the relationships between science, technology, and society	3.49	Strongly Agree
10. Learn about the history and nature of science	3.47	Strongly Agree
11. Prepare for standardized tests	3.29	Strongly Agree
Grand Mean	3.43	Strongly Agree

Table 2 presents the mean pedagogical practices of the respondents towards effective hands-on science. As presented in the table, the respondents give much emphasis to the practices stated towards effective hands-on science with a grand mean of 3.43 and interpreted as strongly agree. This implies that the respondents give much emphasis to the stated practices towards effective hands-on science. This implies further that the teacher-respondents' teaching practices are anchored on the practices towards effective hands-on science. The foregoing results construe with the findings of references [25,26,27] stating that teachers' beliefs and practices in teaching made impact on the curriculum. The increase in teachers' content knowledge is correlated with their teaching efficacy in science. Furthermore, there are shreds of evidences that teachers' experiences participating in inquiry science have a significant influence on teacher beliefs in teaching [28].

Table 3. Pedagogical Techniques of the Respondents towards Hands-on Science

Pedagogical Techniques towards Hands-on Science	Mean	Description
1. I engage the whole class in discussion	3.10	Agree
2. I explain science ideas to the whole class	3.32	Strongly Agree
3. I make students work in small groups	3.24	Agree
4. I require students to supply evidence(s) in support of their claims	3.09	Agree
5. I employ hands-on laboratory activities	3.20	Agree
6. I make students read from a science textbook, module, or other science-related material in class, either aloud or to themselves	3.11	Agree
7. I focus on the literacy skills, e.g., informational reading or writing strategies	2.84	Agree
8. I require students to write their reflections in class for homework, i.e., in journals	2.84	Agree
9. I require students to represent and/or analyze data using tables, charts, or graphs	2.90	Agree
10. I give tests and/or quizzes that are predominantly short answer, e.g., multiple choice, true-false, fill in the blank	3.23	Agree
11. I give tests and/or quizzes that include constructed responses or open-ended items	3.07	Agree
12. I engage students in project-based learning activities	2.95	Agree
13. I require students to practice standardized test	2.99	Agree
14. I require students to make formal presentations to the rest of the class, i.e., individual or in group	2.97	Agree
15. I employ team teaching	2.98	Agree
Grand Mean	3.06	Agree

Table 3 presents the mean results on the pedagogical techniques of the respondents towards hands-on science. As presented in the table, respondents agree to almost all the parameters of techniques in effective science except in explaining science ideas to the whole class which posted "strongly agree". Furthermore, the 3.06 grand mean implies that teacher respondents were using pedagogical techniques towards effective hands-on science. This supports the findings that teachers who are using the right hands-on teaching strategies perceived it effective in developing the critical thinking of their students [29]. On the other hand, lesser hands-on teaching instruction to learners is found to have poor performance [2,5,28,29].

Table 4. Effectiveness of Hands-on Science

Effectiveness of Hands-on Science	Mean	Description
1. At the beginning of instruction on a science concept, students should be provided with definitions of new scientific vocabulary that will be used.	3.36	Very Effective
2. Hands-on activities and/or laboratory activities should be used primarily to reinforce a science concept that the students have already learned.	3.36	Very Effective
3. Students should rely on evidence(s) from classroom activities, labs, or observations to form conclusions about the science concept they are studying.	3.09	Effective
4. Teachers should allow students do hands-on activities along the concept(s) they are studying.	3.00	Effective
5. Teachers should explain a concept to students before having them consider evidence that relates to the concept.	3.22	Effective
6. Teachers should provide students with opportunities to connect the science they learn in the classroom to what they experience outside the classroom.	3.49	Very Effective
7. Teachers should ask students to support their conclusions about a science concept with evidence(s).	3.33	Very Effective
8. Students should do hands-on or laboratory activities for them to reflect on what they learned.	2.95	Effective
9. At the beginning of instruction on a science concept, students should have the opportunity to consider what they already know about the concept.	3.29	Very Effective
10. Students should do hands-on activities after they have learned the related science concepts.	3.17	Effective
11. Teachers should provide students with opportunities to apply the concepts they have learned in new or different contexts.	3.33	Very Effective
12. Students should use evidence(s) to evaluate claims about a science concept made by other students.	3.21	Effective
13. Teachers should allow students do interesting hands-on activities relative to the concept(s) being studied.	2.79	Effective
14. At the beginning of lessons, teachers should 'hook' students with stories, video clips, demonstrations or other concrete events/activities to gain students' attention.	3.29	Very Effective
15. Students' ideas about a science concept should be deliberately brought to the surface prior to a lesson or unit so that students are aware of their activities.	3.15	Effective
16. Teachers should provide students with the rationale of an activity in advance so the students may track their progress in the activity.	3.09	Effective
17. Students should have opportunities to connect the concept they are studying to other concepts.	3.30	Very Effective
18. Students should consider evidence that relates to the science concept they are studying.	3.20	Effective
19. When students do a hands-on activity and the data do not turn out correctly, teachers should assist students do the correct methodology or procedure.	3.16	Effective
20. Students should be allowed to predict the results of an experiment based on scientific concepts.	2.99	Effective
21. Students should present evidences to prove the concept(s) they are studying or analyzing	2.95	Effective
Grand Mean	3.18	Effective

Table 4 presents the mean perception of the respondents on the effectiveness of hands-on science. As presented in the table, respondents perceived the statements as effective to very effective remarks. The grand mean 3.18 with a qualitative description of "effective" implies that teachers perceived hands-on science as an effective approach in teaching science lessons. This corroborates the findings of reference [30] when he concluded that teachers feel confident of their effectiveness when students are framed in learning situations pursuant to the provisions of an effective hands-on science.

Table 5. Correlation Coefficient on Beliefs, Techniques, and Practices of the Respondents on Hands-on Science

Particulars	r	p-value	Decision
Beliefs vs Techniques	.854	< .001	Reject Ho
Beliefs vs Practices	.608	< .001	Reject Ho
Techniques vs Practice	.677	< .001	Reject Ho

Table 5 presents the correlation coefficients on beliefs, techniques, and practices of the respondents on effective hands-on science; tests posted significant relationship. Pearson r posted a high correlation on beliefs and techniques while moderate correlation between beliefs versus practices and techniques versus practices. These imply that the pedagogical beliefs of the respondents on

effective hands-on science affect their pedagogical techniques and practices in teaching science subjects and their techniques affect their beliefs and vice versa. This is similar to the findings of references [31,32] stating that teachers hold complex systems of beliefs that influence how they view teaching and learning, their students, and subject matter. These beliefs could be congruous or incongruous with their classroom practices. In addition, references [32,33] averred that teachers' beliefs play an important role on how teachers think about how students learn, and how content should be organized and taught. It was also found that teachers' views on teaching science changed after being exposed to intense instructions.

3.1. Developmental Plan

Title: Enhancing the Hands-on Science Instruction in the Elementary.

Rationale. The 21st century learners need 21st century teachers; hence, the modernization of classroom instructions has evolved. The teachers' beliefs are key players to what would take place during and while they are engaged in teaching. Thus, it affects their teaching techniques and practices in delivering science lessons wherein the effectiveness of science instruction lies.

Modernization of science classrooms provides learners with an in-depth, more meaningful, and greater

appreciation of science lessons and processes. This makes classes more realistic, fun, and useful. The modernization of the world is entitled to how people acquire and lived scientifically. Thus, modern science instruction is the entitlement of our future. Adapting the modern science classroom will bring us closer to hands-on science instruction. This makes a classroom more of dealing with real-life situations and empower learners to deal with the advancing and technology-driven world.

This intervention aims to enhance hands-on science instruction in the elementary schools on the locale of the study. It is a process designed for teachers to improve science instruction in the classroom.

The schematic diagram presented in Figure 1 depicts the processes that can be done to improve teachers' science lesson delivery for a more effective and interactive hands-on science program in the elementary. This would help teachers address the learning needs of the 21st century learners. This includes more hands-on driven activities, teachers benchmarking to modern philosophy in science education, indigenization, and digitization of science instruction.

The School Learning Action Cell (SLAC) may be designed to rationalize the teachers' professional development. It is a learning avenue for teachers to discuss their beliefs, techniques, and practices preferably with a more knowledgeable or experts from the field. Teachers review and reflect from past experiences and data from students' performance.

Moreover, SLACs are believed to help teachers reflect and learn integration of tech laboratory programs or applications which will help students experience lab simulations and the likes. Aside from tech-laboratories, investigatory projects are also good avenues for teachers and students to conduct and study interactively.

The intervention is expected to bring educational opportunities of an enhanced, effective, and interactive science program in the elementary. This is the inclusion of hands-on teaching techniques and practices, community immersion, and niche program with shepherding from external stakeholders like DOST, SUC, and industry partners, and research camps and expos that will make classrooms as modern science avenues of the realms of innovative classroom in the 21st century. This is the hands-on science in the now normal.

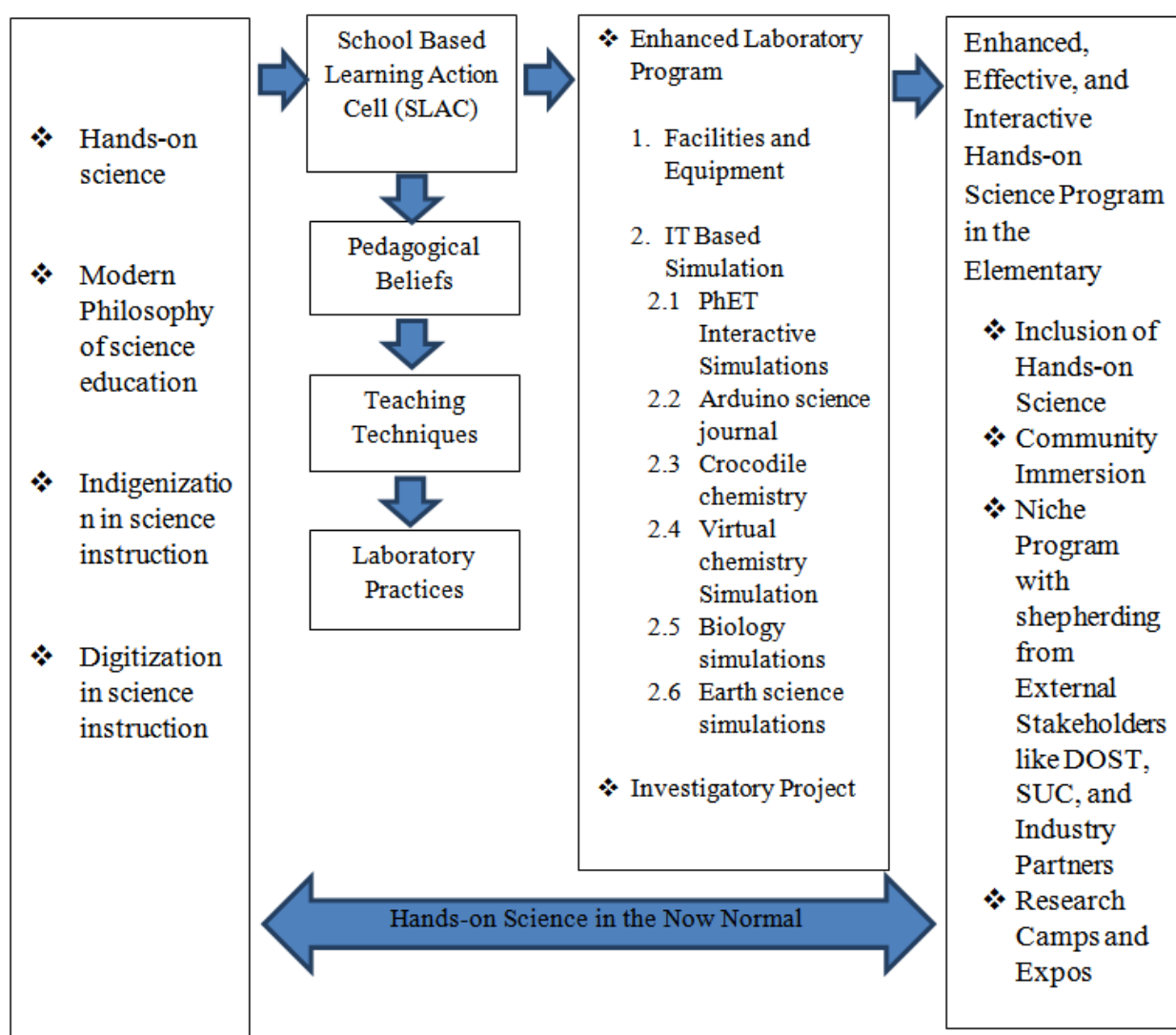


Figure 1. Developmental Plan on the Implementation of Hands-on Science

3.2. Details of the Developmental Plan

Activity/Task	Resource Person	Persons Involved	Budget Source	Expected Outcome /Success Indicator
School Learning Action Cell (SLAC) • Indigenization in science instruction • Digitization in science instruction • Lesson Demonstrations • Inclusion of technology-assisted lesson delivery • Investigatory project • Return demonstration	Resource persons may be invited from DepEd, DOST, DICT, SUC, and other Industry Partners	• School heads • Teachers • Experts	• School MOOE • Registration	• Successful IT-based simulations (PhET Interactive Simulations, Arduino Science Journal, Crocodile Chemistry, virtual Chemistry Simulations, Biology Simulations, Earth Science simulations) • Successful demonstration of experts in doing hands-on science • New assistive technologies learned • Cutting-edge Research and Investigatory Project • Hands-on science demonstration from teachers.
Employing hands-on Teaching • Experimental research	Resource persons may be invited from DepEd, DOST, DICT, SUC, and other Industry Partners	• School heads • Teachers • Experts • Pupils	• School MOOE • Registration	• Recorded students' performance. • Corroborated data on teachers' and students' experiences during implementation.
Monitoring • What went well and not? • What to improve?		• School heads • Teachers • Experts	• School MOOE • Registration	• Inputs to areas for improvement and intensifying the strengths of the experimental group teacher.
Re-employing hands-on teaching		• School heads • Teachers • Experts • Pupils	• School MOOE • Registration	• Enhanced, Effective, and Interactive Hands-on Science Program in the Elementary
Evaluation • Controlled and experimental group		• School heads • Teachers • Experts • Pupils		• Measured impact of hands-on science to pupils' performance. • Gathered pupils' reaction on the experience.

The action plan was designed from the developmental plan and on the results of the study. The results revealed that hands-on science was perceived by teachers as effective. Thus, this action plan was crafted and ready to be implemented as action research to test the effectiveness of hands-on science in the elementary classroom based on pupils' performance.

The results of this study suggest the state of the beliefs, techniques, digitization, indigenization, and practices of the respondents towards effective hands-on science. This would be the basis of the experts in SLAC. Upon knowing these results, experts can enhance the teacher's beliefs, techniques, and practices through lecture, teaching demonstrations, and other inputs. After which, a return teaching demonstration from teacher-participants is required. This will showcase the hands-on approaches learned from the experts. A post evaluation is highly wanting which may center on the teaching demo processes: what went well and what to improve. After an intelligent scrutiny, teachers are to employ the hands-on techniques and practices to the experimental classroom.

During the class, experts and school heads are to sit and observe the teacher and learners. They will serve as evaluators of the teacher's hands-on classroom. Their observations are the bases for monitoring to what went well and which needs improvement. After the class, a post conference is held through a focused group discussion to polish the approach.

The teacher will administer a pretest to both controlled and experimental groups. The enhanced hands-on approach will be employed in the experimental group. The experts and school heads still sit to monitor the teaching process. After the treatment period, a posttest will be administered to evaluate the extent of learning as evidence of an improved state and effectual evidences on the efficacy of the treatment condition and learning climate.

Statistical analyses will be employed to evaluate the effectiveness of the program.

4. Conclusion

Based on the foregoing results, the following are concluded: (1) the teacher-respondents concur to the pedagogical beliefs in teaching science lessons; (2) respondents give much emphasis on the pedagogical practices towards effective hands-on science; (3) the respondents agree to the pedagogical techniques towards effective hands-on science; (4) the respondents perceived hands-on science in the local of the study to be effective; and (5) the respondents' pedagogical beliefs are highly correlated to their pedagogical techniques and moderately correlated with their practices. In addition, their teaching techniques are moderately correlated to their pedagogical practices.

Having the knowledge of the pedagogical beliefs, practices, and techniques of teachers in teaching hands-on science gives us a wide array of opportunities in improving science education. The significant relationship of the beliefs, techniques, and practices of the respondents is a profound basis in improving teachers' affordances in teaching science lessons. Thus, this bridges the science teachers and curriculum planners' efforts to improve the delivery of science lessons.

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