

# Project SIKAP Upscales Students' Scientific Attitude

Marjorie V. Cabañero<sup>1</sup>, Jaybert M. Cabañero<sup>2</sup>, Novemy C. Ignacio<sup>2</sup>, Romiro G. Bautista<sup>3,4,\*</sup>

<sup>1</sup>Student Teacher, College of Teacher Education, Quirino State University, Philippines

<sup>2</sup>Faculty, Science Department, Diffun National High School, Philippines

<sup>3</sup>Faculty, College of Teacher Education, Quirino State University, Philippines

<sup>4</sup>International Relations Officer, Quirino State University, Philippines

\*Corresponding author: [romiro.bautista@qsu.edu.ph](mailto:romiro.bautista@qsu.edu.ph)

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**Abstract** This study explores the efficacy of a teacher-made intervention program along the development of scientific attitude among students. The researchers believe that scientific attitude should be in a continuum despite the pandemic by employing Predict Observe Explain (POE) strategy, hands-on science through home-based laboratory, laboratory simulation, and Focus Group Discussion (FGD). The Mixed Method design was employed in this study particularly the Exploratory design involving quantitative and qualitative data on the efficacy of the teacher-initiated intervention program along the effects of the treatment conditions on the scientific attitude and the experiences of the participants in undergoing such provisions of reframing learning engagements. The quantitative data were gathered through One Group Pretest-Posttest Design (OGPPD) of the Pre-experimental Design and evaluated inferentially through statistical analyses. On the other hand, the qualitative data were gathered through Narrative Analysis and analyzed thematically. It was found out that there is an increased positive attitude and a decreased negative attitude among the respondents which posted significant results while medium and large effects are posted along the positive and negative scientific attitude of the respondents. The provisions of Project SIKAP provided the students the feeling of enjoyment and excitement, experimenting through computer simulations, and difficulty in solving and experimenting in the midst of the pandemic; albeit guided with the computer simulations. Owing to the results, science teachers may still consider computer-mediated experiments – a practical applications of learning concepts, as this is where students can better understand concepts in Science during home-based schooling like the current educational state.

**Keywords:** *action research, hands-on science, POE strategy, project SIKAP, scientific attitude*

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## 1. Introduction

Attitude towards learning is always been a concern among all educators particularly among science teachers. This is even escalated during the CoViD-19 pandemic as students went for home-schooling. The transformation of students' attitudes towards learning has been an emphasis of most researches in the so-called new normal of education as brought about by the pandemic.

Attitude is mostly used in discussing interest in science education or the so-called scientific attitude [1]. This scientific attitude was classified into four [2]: first, attitude towards science leading students to aspire scientific career [3-6]; second, scientific results as used in evidence-based policy making [7,8]; third, investing to science [2]; fourth, attitude that allows the public to engage in decision-making processes related to science, technology, and the society [9].

Aptly, attitude towards science and scientific attitude are two main categories derived from a dogmatic literature

review. Scientific attitude, a particular interest in science, is coined at the beatitude of scientists and their social responsibility. Hence, scientific attitude includes the feelings, beliefs, and values exuded as one endeavors science and school science across all levels: a component of science learning that must be sustained impacting the scientific concordances of learners cognizant to the overarching principles of science, technology, and society [1,10]. Scientific attitude is the desire to know and understand phenomena that involves search for data and their meaning, search for verification, and consideration of consequences [11].

Introducing intervention programs like Project SIKAP to develop students' scientific attitude is another concern in this new normal of education, mostly residential learning at the helm. Common intervention program introduced to students in developing their scientific attitude is through sustained experimentation to keep them wonder [12,13,14,15]. However, intervention programs to instill and propagate scientific attitude among students faced mounting roadblocks due to numerous considerations like the facilities and equipment to be used, experimentation

(laboratory) condition and set-up, precision and accuracy, among others [16-21].

Apparently, variety of innovative programs are implemented this pandemic. Reference [22] introduced take home experiment to enhance students' scientific attitude since conventional laboratory set up is not possible. Apparently, the provision and availability of reagents including equipment and apparatus to students seem to be one of the major concerns in its adoption. Thus, contextualization in the process of experimentation where localization of materials is needed. Localization in science instruction is found effective and recommended by different researchers especially in this time of pandemic [23-26].

Considering the herein literature, survey played the most modality in discussing the interest of students in science education and in developing students' scientific attitude. On the other hand, some approaches to study attitude towards science include interviews and case studies. Thus, survey and interview are considered in this present study as it intends to analyze students' scientific attitude through Project *SIKAP* in both quantitative and qualitative designs.

### 1.1. Objectives of the Study

This study explored the efficacy of the Project *SIKAP* along the scientific attitude of students.

Specifically, it aimed to (1) evaluate the significant difference on the mean scores of the participants before and after their exposure with the provisions of Project *SIKAP*; (2) evaluate the effect size of the provisions of Project *SIKAP* on the scientific attitude of the students; and (3) describe the experiences of the students on the provisions of project *SIKAP*.

### 1.2. Theoretical Framework of the Study

Inquiry-based Learning Model [27]. In this model, the combination of scientific processes and scientific knowledge is evidently observed in the process in developing critical thinking skills and at the same time communication skills as students are requested to share their observation and realization on their actual experiences, considered as firsthand learning. Firsthand learning, availing of inductive method where learning focuses on the students, is specified in the theory of John Dewey.

John Dewey Theory [28]. The theory posits that people learn best through a hands-on approach where in this present study considered experimentation, independent learning and collaborative learning. Independent learning as students have home-based laboratory activities and exposures to online simulator, and collaborative learning as other experimentation processes were conducted in group.

These two theories were considered in this study as it has the intention of upscaling scientific attitude of students and at the same gauging the potential of Project *SIKAP* in improving it.

## 2. Methodology

The Mixed Method design was employed in this study particularly the Exploratory design involving quantitative

and qualitative data on the efficacy of the researcher-initiated intervention program along the experiences of the participants. The context encompassing a quantitative analysis which is a predominant effect of the intervention is supplemented by a rich experience of the participants. Aply, the One Group Pretest-Posttest Design (OGPPD) of the Pre-experimental Design and Narratology were employed.

The OGPPD of the Pre-experimental Design was used in this study as it intends to collect viable data on the employment of Project *SIKAP* as a way of leveraging the scientific attitude of Junior High School (JHS) students. Project *SIKAP* involves the development of home-based laboratory activities and the employment of online simulation. This design involves a pretest or baseline observation which allows the investigator to determine the effects of the treatment conditions by comparing the pretest and posttest results. Aply, pre-test results are used as covariate values in establishing the causal effects of the treatment condition.

On the other hand, Narratology is employed to determine the experiences of the participants in undergoing the localized, teacher-made intervention – the Project *SIKAP*. Moreover, narratology is described as a theory, method, and a discipline.

**The Intervention Program – *SIKAP* (Science thru Innovative and Keen continuum of the Alternative hands-on science program in the midst of the Pandemic).** In this particular study, the proponents designed home-based laboratory activities based on the self-paced learning modules developed by Department of Education (DepEd) for the science program in JHS.

The Project *SIKAP* was implemented in the following procedure:

1. **Discussion with the Predict, Observe, Explain (POE) Strategy.** Topics were discussed in a conjecture manner using POE Strategy. The teacher demonstrates the lesson for better concept assimilation – discussion of the theoretical underpinnings of the scientific phenomena.
2. **Home-based Laboratory using Arduino Science Journal APP,** Students were given home-based laboratory activities to be conducted. Each activity has specific procedure to follow which results can be validated using an online science app with simulated procedures and results. Specific links for each activity were given to the students for them to verify their findings and for enrichment purposes. Simulation activities are shown in each link.

There are four home-based laboratory activities synchronized with eight sessions using the Arduino Science Journal APP, an interactive and handy application that covers theoretical and laboratory sessions along various branches of science across grade levels. The home-based laboratory activities used in this study are as follows: (1) Water Bottle Fountain Experiment; (2) Balloon Experiment; (3) Starch Test; and (4) Lipid Test.

Water Bottle Fountain Experiment is used to demonstrate the concept of Boyle's Law. It requires soda bottle, used straw, and balloon. In the experiment, students are required to set-up a water bottle fountain through setting a hole in the middle portion of the bottle and filling it with water. The highlights of the experiment centers on witnessing a water fountain through the set-up.

Balloon Experiment is used to demonstrate the concept of Charles' Law. Two inflated balloons with the same circumference are needed in this activity. In this experiment, students are required to subject the two balloons in two different conditions. The first one will be subjected to boiling water for two minutes and the other one will be poured with cold water for two minutes. At the end of the experiment, students will compare the changes on the size of the two balloons.

**Starch Test.** The experiment was used to demonstrate abilities in tracing starch to select samples.

**Lipid Test.** The experiment was used to trace lipids from kitchen materials such as oil, vinegar, egg, milk, peanut butter, apple, sugar. In this experiment, students are asked to draw small circles on a manila paper where they will place small amount of each material in liquid form. At the end of the experiment, students can identify what material contains lipids through the trace or spot created in the manila paper after it was subjected to blower for 3-5 minutes.

### 3. Wrap-up Session with Focus Group Discussion.

Students were given a wrap-up session where they can share and discuss their findings with their classmates and teacher. Students in science need a learning segment where they can present their thoughts, discuss results, make inference, and draw scientific knowledge. Focus Group Discussion was done.

The respondents of this study are the tutees of one of the authors in her pandemic student teaching during the school year 2021-2022. They are exposed to all the sessions: tutorial, hands-on, online, and wrap-up sessions. The respondents who will successfully complete all the session will be considered as the participants for the quantitative and qualitative aspects of the study.

The questionnaire from where the students' attitude in science were measured is adopted from Moore and Foy [29] – the Scientific Attitude Inventory II (SAI II). Albeit old, the questionnaire is used by several studies on determining the scientific attitude of students across the globe. There are 52 questions contained in the questionnaire. Twelve questions of which are indicators of their scientific position or measured effects of such interventions like conditioning measures, strategies, and approaches are analyzed. The original instrument had a reliability of .781 while it has .827 in the current study. According to reference [30], an alpha of at least .70 suggests reliability. Hence, the instrument is valid and reliable.

On the other hand, one of the proponents personally interviewed the informants to gather the needed data for

the study. Before the interview was conducted, the interviewers briefed the informants that their participation in the interview is voluntary and they can terminate it anytime. Transcripts of the interview were carefully transcribed and coded which were validated by a researcher whose credibility is beyond compare.

The quantitative data in this study were treated with mean, Wilcoxon Signed-Rank Test, and Cohen's D for the effect size: all were done in SPSS.

On the other hand, the qualitative data were analyzed thematically to analyze the problem as contextualized by the participants of the study. Audit trail was employed in routing the transcripts of the interview to the informants in ascertaining the veracity of the claims. Audit trail is an in-depth approach to illustrating that the transcripts are based on the participants' narratives. It also involved a description on how the data were gathered and analyzed [31,32]. The transcribed data were routed back among the informants after the transcription process to ascertain the veracity of their claims during the interview and FGD sessions – 100% of the transcripts were documented and processed via audit trail. Moreover, the informants agreed on the transcriptions and vouched for the veracity of the content presented therein to be analogous to what they intend to express. Henceforth, the data are considered verified and valid.

Moreover, the gathered data were analyzed thematically. This is an approach in qualitative data analysis that systematically and rigorously synthesizing unequivocal qualitative data into curated and connected findings in a thematic framework of analysis and presentation [33]. Aply, the analysis done in the research includes familiarization and organization, coding and recoding, and summarizing and interpreting [34].

## 3. Results and Discussion

### 3.1. Efficacy of Project SIKAP on Students' Scientific Attitude

As it is shown in the table, all positive enabling conditions are increased in the posttest results. Albeit increased, only one posted for significant results: laws and theories of science are approximation of truth and are subject to change. This implies that the respondents earned an understanding that science brings the cognition of truth through validation upon the presentation of cognizable and reliable information from rigorous experimentation.

**Table 1. Wilcoxon Signed-Rank Test on the Mean Pretest and Posttest Scores on the Scientific Attitude of Students along Positive Perceptions**

Particulars	Pre (M)	Post (M)	Z	p-val.
The laws and/or theories of science are approximation of truth and are subject to change.	2.70	3.70	-2.64	.008*
Observation of natural phenomena and experimentation is the basis of scientific explanation.	2.40	3.00	-1.29	.196
To operate in a scientific manner, one must display such traits as intellectual honesty, dependence upon objective observation of natural events, and willingness to alter one's position on the basis of sufficient evidence.	3.20	3.30	-1.34	.180
Science is a technology-developing activity. It is devoted to serving mankind. Its value lies in its practical uses.	3.00	3.30	-.879	.380
Progress in science requires public support in the age of science; therefore, the public should be made aware of the nature of science and what it attempts to do. The public can understand science and it ultimately benefits from scientific work.	3.10	3.40	-1.00	.317
Being a scientist or working in a job requiring scientific knowledge and thinking would be a very interesting and rewarding life's work. I would like to do scientific work.	3.10	3.40	-.750	.453

Legend: \*significant at .05 level.

The results of the study are similar to the results of the research conducted by reference [35]. It was concluded that there is a positive correlation between the scientific attitude levels of secondary school students and the inquiry learning perceptions of the students. Similar conclusion is posted in the study of reference [36] which states that there was a positive relationship between students' scientific attitude and their inquisitive learning perceptions. It is emphasized that this relationship was also related to the methods and techniques used in the lessons.

**Table 2. Wilcoxon Signed-Rank Test on the Mean Pretest and Posttest Scores on the Scientific Attitude of Students along Negative Perceptions**

Particulars	Pre (M)	Post (M)	Z	p-val.
The laws and/or theories of science represent unchangeable truths discovered through science.	2.70	1.70	2.23	.026*
The basis of scientific explanation is in authority. Science deals with all problems and it can provide correct answer to all questions.	3.30	3.00	1.00	.317
To operate in a scientific manner, one needs to know what other scientists think; one needs to know all the scientific truths and be able to take the side of other scientists.	3.20	3.10	.333	.739
Science is an idea-generating activity. It is devoted to providing explanation of natural phenomena. Its value lies in its theoretical aspects.	3.10	1.80	2.39	.017*
Public understanding of science would contribute nothing to the advancement of science or to human welfare; therefore, the public need not to understand the nature of science.	2.10	1.60	1.41	.160
Being a scientist or working in a job requiring scientific knowledge and thinking would be dull and uninteresting; it is only for highly intelligent people who are willing to spend most of their time at work. I would not like to do scientific work.	1.90	1.50	1.41	.157

Legend: \*significant at .05 level.

As it is shown in the table, all negating conditions are decreased in the posttest results. Albeit decreased, only two posted for significant results: laws and theories of science are approximation of truth and are subject to change, and science is an idea-generating activity. It is devoted to providing explanation of natural phenomena. Its value lies in its theoretical aspects.

The foregoing findings imply that after their exposure to the provisions of Project *SIKAP*, the student-respondents attained a profound understanding on the scientific laws and theories. Moreover, it can be inferred based on the foregoing that their understanding on the value of Science does not rely in theoretical aspects.

It was concluded that the value of scientific knowledge centers on the increased dependence of contemporary life on sophisticated artefacts that make them communally dependent on individuals with a high level of scientific and technological expertise and competence [37]. Moreover, science learning is underscored as supporting conditions to the central dogma of academic performance and critical thinking in school science [38].

In the cases of the foregoing, the provisions of Project *SIKAP* are in consonance with the valued scientific knowledge as underscored by the conditions relevant to the realms of developing scientific attitude vis-à-vis school science.

**Table 3. Effect Size of Project *SIKAP* to Upscales Scientific Attitude**

Particulars	r	Description
Positive Perceptions	.495	Medium
Negative Perceptions	.750	Large

Presented in the table are the approximate value of r showing the effect size of Project *SIKAP*. According to the Cohen's criteria [39], the value of r shows that there is medium effect of Project *SIKAP* for the positive perceptions and large effect for the negative perceptions. This implies that the provisions of Project *SIKAP* impacted significant effects on shaping the scientific attitude of the students. Thus, it can be inferred that the provisions of Project *SIKAP* are significantly effective in upscaling scientific attitude of students.

### 3.2. Experiences of the Students on the Provisions of Project *SIKAP*

**Feeling of Enjoyment and Excitement.** Students' details in showcasing their participation depend on their beliefs and personal states. Their beliefs and personal states are influenced by the ongoing academic situation or learning modality. This study provided engaging activities from the start that caught their interest to participate in the different phases of learning as offered by Project *SIKAP*.

The following transcripts qualify the claim of the study that the conducted classes utilizing home-based laboratory activity made the informants enjoy the learning sessions with a sense of excitement:

"...I enjoyed doing the activities in the home-based laboratory experiment, particularly the water bottle fountain experiment..." S2

"...I enjoyed doing experiment and learning new things such as observing the changes of the balloon as the temperature gets high or low..." S3

"...I enjoyed doing experiments as it is already more than two years when we were required of doing experiments..." S5

"...The best thing that happened is the experience and the excitement I felt when observing the home-based laboratory experiments..." S6

"...as a group, we always learned new things; excited in doing experiment..." S7

"...when we conducted home-based laboratory experiment, I learned a lot: it is fun and interesting..." S1

The foregoing observations are similar to the results of the research conducted by reference [22]. As a result of their research, it was stated that the mean score for scientific attitude of the Take-Home-Experiment group was higher compared to both the laboratory-experimental group and the conventional group through a quasi-experimental design. It can be realized from this present finding that engaging activities although independent learning, greatly affect students' participation as evidently shown from quantitative data: their scientific attitude was upscaled after the implementation of Project *SIKAP*. Furthermore, this supports the claim of reference [40] that

the laboratory method may produce significantly better results among advanced students rather than using other methods of teaching science.

The provisions of the Project SIKAP on using POE strategy, home-based experimentation with computer simulation, and FGD are in time effective for the current modalities of this pandemic education. These provide a continuum of learning as learners are put into situations of wondering, a progressive thought of thinking naturally occurring scientific phenomena.

**Experiment through Computer Simulations.** The learning engagements as part of the intervention program offered in Project SIKAP expound the ideas and heightened curiosity of the learners. Ideas presented in group discussions are generated by a healthy discussion followed by the integration of the actual experiences as engaged by the students.

The following transcripts qualify the claim of the study that students gained new concepts and realized the possibility on the adoption of home-based experiments through computer simulations despite the ongoing academic set-up:

“The best things happened, or I experienced was having new learnings and understanding things that I need to learn, and I better understood the lessons through experiment and engagement to simulation activities...” S8

“I learned a lot through the experiment in class and at home through simulations...” S3

“...doing experiment and learning new things such as observing the changes of the balloon as the temperature gets high or low...” S4

“The best things happened is I was able to conduct experiments after so many years having this pandemic although I am at home...” S7

“...while doing our home-based experiments, we discovered a lot of learnings as we coped up to do the processes...” S9

The above transcripts support the claim of reference [41] that students look forward to experiments, and therefore, instructors should not omit them. Conducting experiments in science classes enables students to appreciate the distance learning along science area like in the case of the current study using simulation activities as elucidated by student 8 and 3.

Moreover, it was elucidated in one of the studies that computer simulations bring interesting and exciting supplemental activities at the helm of reinventing hands-on science in the home-schooling modality. The interactive virtual learning through software engineering like the case of Arduino Science Journal APP fosters augmented learning because it supplies and extracts information needed for further analysis and exploration. This, according to the authors, makes students wonder and think of the scientific processes which in turn develop better attitude in learning scientific concepts and procedures [15].

Aptly, various authors claimed that the developed pedagogical approaches or innovative intervention introduced during the pandemic are found to be efficient in improving students' academic standing. Some of these interventions as introduced to Science subjects include take-home-experiment [15,21], localization of instructional materials [23-26], and selection between deductive and inductive method with respect to the students' mental capacity [40].

**Difficulty in Solving and Experimenting.** The provisions of Project SIKAP include adoption of both self-paced learning where students may develop skills of self-reliance and collaborative learning as they create meaningful tasks and engaging group responses.

The following transcripts qualify the claim of the study that the provisions of the Project SIKAP made the informants to accomplish their tasks properly:

“...I experienced difficulty in solving because I am not really good in math, but I slowly understand the concept and on how to solve the equation because of the online simulation...” S4

“...I encountered difficulty in solving problems...” S5

“I found difficulty in doing experiment because there were times that I do not know the next things to do...” S8

“...I encountered difficulty in predicting the possible outcome of the experiments. I had difficulties in this because predicting needs a large or wide imagination which I lack...” S6

“I realized that working alone in doing experiment is very difficult. The experiments and groupings went smoothly until the end despite the fact that I did not get along with my classmates at this time in class...” S9

“...we are not aware on the damages and mistakes that we may apply while doing the experiment but still we managed our time to redo our output...” S10

The above transcripts support the claim of reference [41] on the claim that the transition to distance learning in science education is more challenging than the non-science courses because of the experimental nature of the subject. Moreso, students are required to base their answers on observations and evidence. In fact, 33% of the student-participants in the study of reference [41] complained that they had problems with understanding learning materials during classes and that teachers run classes too quickly, without enough time for asking questions, discussion, and taking notes. In the implementation of Project SIKAP especially in the computer simulations as claimed by students 6, 8, and 10.

Likewise, students found difficulty in doing home-based laboratory experiment particularly on some procedures to be done. Thus, it is necessary for teachers to spend time in acquainting the learners on the navigation procedures prior to execution. The present finding also support findings of reference [42] stating that students face anxiety challenges in dealing with Mathematics related science concepts. This means that the subject itself as Mathematics or the nature of the learning content as ruled by laws of Mathematics is the problem. As a result, when numbers are involved in the instructional delivery, impression of difficulty of the learning content from the start is expected to learners which is apparently shown in the above transcripts. The admissions of students 4 and 9 manifested that they get through with the activities through the activities especially the simulation activities along Boyle's and Charles' Law which require numerical manipulation and calculation.

## 4. Conclusion

Based on the findings and parameters of the study, the following are drawn:

1. There was an increased positive attitude and a decreased negative attitude among the respondents which posted significant results;

2. The Project SIKAP posted medium and large effects along the positive and negative scientific attitude of the respondents;

3. The provisions of Project SIKAP provided the students the feeling of enjoyment and excitement, experimenting through computer simulations, and difficulty in solving and experimenting in the midst of the pandemic; albeit guided with the computer simulations.

## 5. Implications to Theory and Practice

The increased positive perceptions and decreased negative perceptions, and the documented experiences and encounters of the student-participants are effectual attributes of the different phases of learning offered by Project SIKAP as it provided engaging activities. Despite the pandemic situation, science teachers may still consider computer-mediated experiments – a practical applications of learning concepts, as this is where students can better understand concepts in Science during home-based schooling like the current educational state.

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